IS THE LAW IRRELEVANT…?

An Institutional Analysis of Road Safety Outcomes

by

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Abstract

This thesis aims to investigate the interaction between formal and informal institutions, and the enforcement thereof with the aim of developing an understanding of how to design holistic policy interventions that definitively change outcomes. Many governments choose to turn, primarily, to changes in laws and regulations in order to change economic outcomes. However, the field of institutional economics shows that simply considering legislation is not sufficient. Pejovich (1999) posits that it is extremely difficult to induce change if the formal institutions, or the law, and the informal institutions are not aligned, and that without appropriate accompanying changes in informal institutions and in enforcement, the law itself may be irrelevant in changing outcomes.

This institutional framework is applied to consider the most appropriate policy mix for reducing road fatalities. This thesis takes Du Plessis et al. (2020a) as a starting point, which shows that South Africa seems to have 'all the right laws' needed to attain low road fatalities, however, outcomes remain poor, and that appropriate changes to enforcement and informal institutions are necessary. This study considers the incidence of road fatalities across the world against the backdrop of their formal institutions, enforcement, and informal institutions, so as better to understand the impact of these factors on economic outcomes. In addition to investigating enforcement, an attempt to open the 'black box' of informal institutions is made, to discern which attitudes and values seem to drive law abidance and road behaviour. This thesis combines data from the World Health Organisation on Road Safety, including data on road fatalities across countries, and different regulatory features within these countries, as well as data on norms, values and attitudes from the World Values Survey. Cluster analysis, principal component analysis and multiple correspondence analysis techniques, alongside ordinary least squares are employed, with the aim of exploring and understanding supplemental factors that need to be considered when employing law-making as a tool to change economic outcomes.

It is found that, whilst laws still have an important role to play, it is the enforcement thereof that is of paramount importance for improving traffic fatalities. It is also found that in countries with a strong suite of vehicle safety standards, road fatalities are significantly lower than observed in countries without vehicle safety standards. Lastly, informal institutions were found to be strongly correlated with road fatalities. Notably, values associated with political and economic participation, as well as those with social liberalism are most strongly correlated with low road fatalities.

Opsomming

Hierdie tesis ondersoek die interaksie tussen formele en informele instellings, en die afdwinging daarvan, met die doel om ’n begrip te ontwikkel oor hoe om holisitiese en effektiewe beleidsinterventies te ontwerp. Baie regerings draai hoofsaaklik na veranderinge in wette en regulasies te wend om ekonomiese uitkomste te verander. Die veld van institusionele ekonomie wys egter dat bloot die oorweging van wetgewing nie voldoende is nie. Pejovich (1999) beweer dat dit uiters moeilik is om verandering teweeg te bring as die formele instellings, of die wet, en die informele instellings nie in lyn gebring is nie, en dat sonder toepaslike veranderinge in informele instellings en in afdwinging, die wet selfs irrelevant kan wees in die verandering van uitkomstes.

Hierdie institusionele raamwerk word toegepas om die mees geskikte beleidsmengsel vir die vermindering van padsterftes te oorweeg. Hierdie tesis neem Du Plessis et al. (2019) as 'n beginpunt, wat toon dat Suid-Afrika blykbaar 'al die regte wette' het wat nodig is om lae padsterftes te bereik, maar die uitkomstes bly swak, en dat toepaslike veranderinge aan afdwinging en informele instellings nodig is. Hierdie studie beskou die voorkoms van padsterftes regoor die wêreld teen die agtergrond van hul formele instellings, afdwinging en informele instellings, om die impak van hierdie faktore op ekonomiese uitkomstes beter te verstaan. Benewens die ondersoek van afdwinging, word 'n poging aangewend om die 'swart boks' van informele instellings oop te maak, om te onderskei watter houdings en waardes blykbaar wetsgehoorsaamheid en padgedrag aandryf. Hierdie tesis kombineer data van die Wêreldgesondheidsorganisasie oor Padveiligheid, insluitend data oor sterftes tussen lande, en verskillende regulatoriese kenmerke binne hierdie lande, sowel as data oor norme, waardes en houdings van die Wêreldwaardesopname. Klusteranalise, hoofkomponent-analise en meervoudige korrespondensie-analise tegnieke, saam met die kleinste-kwadratemetode, word gebruik, met die doel om aanvullende faktore te ondersoek en te verstaan wat in ag geneem moet word wanneer wetgewing gebruik word as 'n instrument om ekonomiese uitkomste te verander.

Daar word gevind dat, alhoewel wette steeds 'n belangrike rol te speel het, die toepassing daarvan is wat van kardinale belang is vir die verbetering van verkeersterftes. Daar word ook gevind dat in lande met 'n sterk reeks voertuigveiligheidstandaarde, padsterftes aansienlik laer is as wat waargeneem is in lande sonder voertuigveiligheidstandaarde. Laastens is gevind dat informele instellings sterk gekorreleer is met padsterftes. Veral waardes wat verband hou met politieke en ekonomiese deelname, sowel as dié met sosiale liberalisme, is die sterkste gekorreleer met lae padsterftes.

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1 Introduction

The World Health Organisation (WHO) (2020) estimates 1.35 million deaths annually due to road traffic crashes. A further 20-50 million people are estimated to be injured as a result of these crashes, with a significant proportion sustaining life altering disabilities. As a result, many governments have developed strategic plans aimed at reducing the incidence of road fatalities and the severity of road traffic crashes.

Differing approaches to policy making across the world have resulted in different responses to the issue of road fatalities. Most countries explicitly legislate activities, such as speeding, drinking and driving, and wearing of seatbelts, that impact fatalities. In addition, many countries employ stringent customer safety regulations that constrain automotive manufacturers and the standards which their vehicles are required to meet, as well as road standards (WHO, 2018). The breadth in approaches to solving the issue of road fatalities is vast, as are the outcomes.

The field of New Institutional Economics offers insights into how legislation and regulation may influence economic outcomes. Institutions are thought to be "the rules of the game", where legislation and regulations are the 'the rules' and 'the game' refers to any economic interaction which the rules may be governing. Legislation and regulation are commonly termed *formal institutions*. These are contrasted by *informal institutions*. Informal institutions are 'rules' that are not formally written into law, but that govern human behaviour and economic interactions non-the-less. Cultural norms, values, beliefs, traditions, habits, attitudes and conventions, have all been shown to have influences on economic outcomes, (see, for example, Fernandez (2007), Alm and Torgler (2006) or Mokyr (2007)). A periphery factor influencing the efficacy of these institutions is the enforcement thereof (Dhillion and Riglioni, 2011). The field suggests that merely changing legislation will not necessarily change outcomes, such as road fatalities, and that enforcement and attitudes may play a larger role in inducing a change in behaviour (see for example: Dhillion and Rigolini (2011) or Pejovich (1999)). The efficacy of employing changes in formal institutions to generate changes in economic outcomes rests crucially on accompanying changes in informal institutions and/or enforcement. It is extremely difficult to induce change if the formal institutions, or the law, and the informal institutions are not aligned, and that without appropriate accompanying changes in informal institutions and in enforcement, the law itself may be irrelevant in changing outcomes (Pejovich, 1999).

Du Plessis et al. (2020a) show that this is precisely the case in South Africa. South Africa, on paper, has 'all the right laws' for road safety, however, outcomes remain poor. It is hypothesised that two key factors are driving the low outcomes: enforcement and informal institutions, and that appropriate changes to both factors are necessary.

This study considers the incidence of road fatalities across the world against the backdrop of their formal institutions, enforcement, and informal institutions, so as better to understand the impact of these factors on outcomes. In addition to investigating laws, regulations and enforcement, an attempt to open the 'black box' of informal institutions is made, to discern precisely *which* attitudes and values seem be associated with law abidance and road behaviour. Du Plessis et al. (2020a) is taken as a starting point: if the formal institutions are not enough to elicit the desired road safety outcomes, what is? As such, the research questions this thesis aims to answer are as follows:

1. To what extent do formal institutions, enforcement, and informal institutions influence road safety outcomes?
2. Precisely which informal institutions, if any, drive high/low fatalities?
3. What can be learned from analysing the interaction between formal and informal institutions for the design of more effective road-safety policy?

This thesis combines data from the World Health Organisation on Road Safety, including data on fatalities across countries, and different regulatory features within these countries, as well as data on norms, values and attitudes from the World Values Survey. Cluster analysis, principal component analysis and multiple correspondence analysis techniques, alongside ordinary least squares are employed, with the aim of exploring and understanding supplemental factors that need to be considered when employing law-making as a tool to change economic outcomes. The key finding of this thesis is that laws are not sufficient to change outcomes, and changes in laws ought to be accompanied by an appropriate level of enforcement. Additionally, the use of vehicle safety standards have been shown to be significantly correlated with road fatalities, with countries with a stronger suite of vehicle standards experiencing lower fatalities. Lastly, it is shown that countries that exhibit informal institutions that are consistent with a culture of individual economic and political participation, as well as social liberalism experience better road safety outcomes.

This thesis proceeds as follows: section two considers the literature, so as to garner a prediction of how institutions, enforcement and abidance may interact to achieve better road safety outcomes; section three introduces the data, summarises the empirical methodology and thereafter presents descriptive statistics, and discusses empirical findings; section four discusses the implications for road safety policy in South Africa; and lastly, section five concludes.

2 Literature Review

This review provides a brief overview of the academic literature relevant to this thesis. First, an outline of the road safety literature is provided. This outline discusses the foci of the economic literature surrounding traffic fatalities, specifically, the cost of crashes, as well as the relationship between economic growth and road fatalities, as well as the more general literature, which is primarily concerned with the causes and correlates of road crashes and fatalities. Thereafter, the prescriptions of the WHO (2018) are presented, who outline a five-part plan for reducing road fatalities. At the core of this plan, changes in laws and regulations are suggested. As such, this thesis then turns to the field of New Institutional Economics (NIE). NIE is well established as a field in economics that is concerned with how laws and regulations impact economic outcomes. An overview of the theories of how formal institutions and informal institutions interact to influence economic outcomes is provided. In addition, an overview of when it is appropriate for policy makers, such as governments, to intervene, whether formally, by changing laws, or informally, by employing nudges and other behavioural devices, is presented, so as to provide context for the validity of using laws to change outcomes. As enforcement of laws is also an important part of ensuring laws are able to change outcomes, a brief overview of theories of enforcement is presented next. Lastly, the literature on traffic outcomes in institutional economics is discussed, so as to provide context for this study.

2.1 Road Safety Literature

This thesis considers the incidence of road injuries and fatalities across the world. The WHO (2018) outlines that road safety injuries are a public health and economic issue. Fatalities have a widespread impact on individuals and their communities. In addition to causing grief, suffering and economic losses to those affected directly by crashes, their families and communities suffer too. In the USA, for example, motor vehicle crashes were the leading cause of death for individuals aged 8-24 in 2015 (National Centre for Health Statistics Mortality Data (USA), 2018). Whilst motor vehicle crashes were not part of the top ten leading causes of death for the general population in the United States, during the period studied, it still has one of the highest years of life lost statistics[1] in comparison to other causes of death. Motor vehicle crashes rank second, behind poisoning as a leading cause of unintentional injury death in the USA.

In South Africa, whilst transport crashes make up only 1.4% of the total death rate (ranking in top 10 causes of death), they remain the 3rd largest cause of non-natural death (StatsSA, 2018). De Abreu and Hoeffler (2021), in their examination of the impact of a reduction in road fatalities on the life expectance of South Africans, note that a just a 15% reduction in road fatalities per year, over a period

[1] I.e., the number of years an individual could have lived if they had not died.

of 10 years, would result in a gain of, on average, 0.85 years of life for men and 0.30 years of life for women. In addition, crashes and fatalities have a high cost to the health care system, impact productivity and prosperity and have severe social and economic repercussions. Fatality rates, however, are not the same worldwide. Some countries have very poor road traffic outcomes, with South Africa amongst them, whereas others have few fatalities (WHO, 2018).

Road traffic injuries and fatalities are a costly and largely preventable cause of morbidity and mortality (WHO, 2018). As such, it is necessary to consider the causes of these crashes, as well as ways to prevent them. This section considers the economic literature first, which focuses on quantifying the economic cost of road fatalities, as well as whether linkages between economic growth and road fatalities exist. This is done to attempt to make an economic argument for why road safety should be a priority policy area. Thereafter, the more general literature on traffic fatalities is considered. This literature aims primarily to identify the causes of crashes and road fatalities, as well as how to prevent further fatalities from occurring. This section concludes with the WHO's best practise recommendations for reducing road fatalities.

2.1.1 Road Fatalities in the Economic Literature

2.1.1.1 The Cost of Crashes

Most of the literature on traffic fatalities, in addition to highlighting unnecessary loss of life, grief, and suffering, focuses on attempting to quantify the economic cost of crashes. This often forms the basis of the argument for reducing road fatalities. This economic cost can be used to inform priority setting between different policy areas. Additionally, these estimates can be used in cost benefit analyses, to estimate the return on any investments in infrastructure, road safety (Wijnen and Stipdonk, 2016).

Wijnen and Stipdonk (2016), for example, consider the cost of crashes across high (HICs), and low- and middle-income countries (LMICs). International guidelines recommend including: the medical costs resulting from the crash; productivity and income loss resulting from temporary or permanent disability; the ('human costs') of pain, suffering, loss of life and/or loss of quality of life; damage to vehicles, roads, and fixed roadside objects; and administrative cost (see, for example, Silcock (2003))The way the cost of crashes is estimated differs slightly from country to country, with some basing the cost on compensation payments, willingness to pay, cost of fatality methods and rule of thumb methods. They find that the cost of road crashes is slightly higher in high income countries, at around 2.7% of GDP and is contrasted by a slightly lower 2.2% of GDP in LMICs.

International guidelines recommend that countries use a willingness to pay method, which estimates the loss of quality of life based on how much an individual is willing to pay for a reduction in crash

risk, to estimate human costs, so as to avoid underestimation. Wijnen and Stipdonk (2016) show that in countries where this willingness to pay methodology is used, road crash costs amount to 3.3% of GDP. In addition, only 23%-30% of these costs are attributable to fatalities; with the remaining share reflecting the cost attributable to serious and minor injuries, as well as property damage.

Labuschagne et al. (2017) consider the cost of road traffic crashes in South Africa, for example. They integrate human casualty costs (including, for example, lost productivity, pain and suffering, medical costs and funeral costs), vehicle repair costs, and incident costs (which includes items such as emergency response, legal costs, delays and congestion, and administration)[2]. They estimate costs to be R142.9 billion (approximately 9.6 billion USD), making up 3.4% of GDP, with nearly 70% of this cost being attributable to human casualty costs.

2.1.1.2 Economic Growth and Traffic Fatalities.

Part of the economic literature is concerned with establishing a link between traffic fatalities and economic growth. Consider Law et al., (2011), who attempt to show the existence of a Kuznets relationship between road fatalities. Simon Kuznets' (1955) seminal work on economic growth and income inequality inspired a vast literature attempting to establish a so-called 'Kuznets' curve to describe the relationship between a typically undesired variable (such as inequality or pollution (see, for example, Culas (2007) or Bhattari and Hammig (2004)) and income. Kuznets hypothesised a parabolic relationship between inequality and income: countries start with low inequality and low economic growth and prosperity. As the economy grows, inequality increases temporarily. Thereafter, as the economy matures, inequality eventually drops, resulting a very developed economy with low economic growth. Studies have shown that this relationship is not necessarily causal or deterministic in nature (see, for example, Acemoglu and Robinson (2002) or Piketty (2006)) and that economies may grow without experiencing growth in inequality.

Law et al. (2011) attempt to ascertain if such a relationship exists between traffic fatalities and income. Their hypothesis is that at lower levels of income countries do not have the capacity to devote resources to establishing institutions capable of developing and implementing road safety policies. As such, with increasing motorisation in the early stages of economic growth, road fatalities increase. As the income level increases, societies begin to focus on reducing fatalities as resources become available for investments in road safety. They consider 60 countries over the time period 1972-2004 to investigate whether a road-fatalities Kuznets curve exists. Similar to the literature on the inequality-based Kuznets curve, Law et al. (2011) find that the Kuznets effect diminishes as additional controls

[2] It should be noted that Labuschagne et al. (2016) do not include willingness to pay in their consideration of the cost of crashes in South Africa.

are employed. The controls that reduce the strength of the Kuznets effect are typically those that are associated with development, particularly, quality of medical care, technological development, and political and institutional development. They find that improvements in medical care and technology, accompanied by reductions in corruption, induce technological and managerial improvements that result in a reduction in road fatalities. Law et al. (2011) hypothesise that lowering corruption, as well as improving medical care and technology are possible ways to bypass the Kuznets effect and reduce road fatalities.

Similarly, Kopits and Cropper (2005) investigate the relationship between traffic fatalities and per capita income in 88 countries during the period 1963-1999. They find the existence of a U-shaped relationship between fatalities and per capita income, in which traffic fatality risk (which they define as $\frac{fatalities}{population}$) begins to decline around 8600 USD (in 1985 dollars). Furthermore, they outline that this is driven by fatalities dropping, and not population dropping. Their argument is that, as income rises, the number of vehicles per member of the population increases, thus this affect cannot be attributable to a reduction in population. Thus, they find that the Kuznets relationship exists, and it is driven by reductions in traffic fatalities. Kopits and Cropper (2005), similarly to Law et al. (2011) suggest that this relationship need not necessarily be deterministic, and that low-income countries can learn from high income countries and can adopt road safety policies at a faster rate than high income countries did.

Rodrígues-López et al. (2016) investigate the relationship between economic growth and prosperity and traffic fatalities. They find a downturn in road crashes in Spain preceding the publication of their paper. Their investigation attempts to uncover what factors are driving this downturn. Whilst the authorities cite the introduction of a Penalty Point System (PPS) (which they have termed an *institutional factor)* as the core driver of the reduction in fatalities, Rodrígues-López et al. (2016) find that the PPS is not statistically significantly related with crashes. They find that it is a significant driver of reductions in *fatal* crashes but does not result in a decline in crashes themselves. This is likely as a result of the PPS incentivising drivers to obey speed limits and drink driving laws, which, as will be discussed in section 2.1.3, are drivers of fatal crashes. They do, however, find that improvements in technology increase both active and passive safety. This includes technologies such as Electronic Control Systems (which helps prevent rolling of vehicles) as well as general improvements in the safety of vehicles. Lastly, they find collinearity between fatalities and fluctuations in GDP and fuel prices. They find that GDP fluctuations and the fuel price affect traffic intensity through income and substitution effects relating to the operating cost of vehicles, and that when the economy is thriving, fatalities increase. Ultimately, they find that the reductions in traffic fatalities were driven by a multitude of factors, and that in order to induce further reductions

additional measures should be used. Rodrígues-López et al. (2016) suggest further institutional interventions, including: incentive-based programmes, surveillance controls, fines, education, road quality and car safety interventions. They emphasise as a final point, that the co-linearity between crashes and cyclical fluctuations should not be neglected and is worth further research.

2.1.2 Causes and Correlates of Road Crashes and Fatalities

Many causes exist for road crashes and fatalities. It is worthwhile to consider both what leads to a crash or crash, as well as what determines the severity of that crash. First, the causes of crashes are examined. The cause of a crash in a system is attributable to either active failures or latent conditions (Reason, 2000). Active failures are errors that are made by individuals who are components in a system. These are unsafe acts such as slips, fumbles, mistakes, lapses or procedural violations. Latent conditions are flaws in the system itself, such as design, functionality or operational flaws[3]. As such, some crashes may be caused by road infrastructure. Traditionally, active failures are cited as the source of a crash, however, when an active failure occurs and it aligns with the latent conditions of the system, an adverse outcome occurs. (Reason, 2000)

Rolison et al. (2018) examine the views of drivers and police officers, as well as road crash records, to investigate the relationships between active failures and crashes. Building on the work of Klauer et al. (2014), they show that crashes caused by younger drivers occur typically as a result of inexperience; they may lack driving skill and make risky decisions. Similarly, older drivers often make errors due to impaired vision, cognition and mobility. In addition, their results reveal that there is likely under reporting present in respect to mobile phone use, drug and alcohol use, and factors relating to inattention and dangerous driving in crash reports. Typically, a road traffic collision occurs as a result of a breakdown in the interaction between road users, the traffic environment and vehicles (Thomas et al., 2013). Thomas et al. (2013) find that 54% of road users made errors of interpretation, 44% made observation errors, and 37% planning errors. Errors of observation and of interpretation refer to when drivers fail to: properly identify other road users and features of the traffic environment; and analyse the current and predicted behaviour of other road users. Planning errors occur after interpretation occurs and refers to errors made in deciding on a suitable course of action that would avoid a collision. Additionally, they find that 11% of drivers involved in crashes were found to be distracted, and 8% were found to be inattentive.

So far, only causes of crashes are discussed. Ma et al. (2019) explain that other factors may drive the level of fatality of the crash itself. They use machine learning techniques, including gradient boosting and grid analysis to establish the causes of traffic fatalities resulting from vehicle crashes in Los

[3] Latent conditions are considered in more depth in section 2.1.3.

Angeles County. They find that drink-driving is the most influential feature determining the fatality of crashes, however, seven other factors influence the severity of the crash. In order of influence, these factors are as follows: the number of parties involved, and the nature of the crash (e.g., whether it is a rear end crash, a hit object, a head on collision, etc.), the lighting conditions, pedestrian involvement, whether a motorcycle is involved; the day of the week; and the time of day.

Notably, whilst Ma et al. (2019) note that in the literature in general speeding is generally regarded as one of the drivers of high fatalities in crashes, it does not feature in their top 15 drivers of fatalities. Ma et al. (2019) suspect that this is due to their variable that captures driving at an unsafe speed may be an imperfect representation of the effect of speeding on accidents. However, throughout their analysis speeding seems to be correlated with the aforementioned drivers of high fatalities. For example, they note that overturning is often the result of the vehicle making a sharp turn at a high speed. Similarly, reckless behaviours, such as drinking and driving, not wearing seatbelts but also specifically speeding, are more common on the weekend when individuals are socialising and having fun. Thus, whilst speed does not explicitly feature in their analysis, it is an important factor that ought to be considered (as will be discussed in the proceeding section). The findings of Ma et al. (2019) findings are summarised in the table that follows, which shows how these factors result in higher fatalities or lower fatalities.

Table 1 Drivers of High Fatalities in Crashes

Feature	Higher Fatality Conditions	Lower Fatality Conditions
Alcohol	Crashes involving alcohol	Crashes involving no alcohol
Number of Parties	Crashes involving less than 2 parties, or more than 5 parties	Crashes involving 2, 3 or 4 parties.
Crash Type	Crashes where the driver hits an object, or the car overturns	Head on collisions, broadsides, side sweeps and rear ends.
Lighting Conditions	Poor Lighting, with no lights being the most fatal crashes, but night-time collisions generally have high fatalities	Daylight and dusk or dawn crashes
Collision Involvement	Pedestrians, fixed objects, non-collisions and animals	Parked vehicles, other objects, bicycles and other motor vehicles
Day of the week	Slightly higher over the weekend.	Slightly lower during the week.
Time of the Day	Highest between midnight and 6am, and fairly high between 9pm and midnight	Generally lower between 6am and 9pm.

Source: Summarised from Ma et al. (2019, p. 148067)

2.1.3 The World Health Organisation Strategy for Reducing Road Crashes

The WHO (2021) succinctly summarises the literature on causes of road morbidity and mortality. They outline several key causes of road crashes: speeding, driving under the influence of alcohol and psychoactive substances; non-use of motorcycle helmets, seatbelts and child restraints, distracted driving, unsafe road infrastructure, unsafe vehicles, and inadequate enforcement of traffic laws. They further outline that adequate post-crash care, that is prompt detection of fatalities and subsequent response, as well as quality pre-hospital and hospital care, are of paramount importance in reducing post-crash mortality. As a final point, they outline that safe transport systems should be forgiving of human error, and as such, promoting safe roads and roadsides, safe speeds, safe vehicles and safe road users should be addressed in order to reduce injury and fatality from road crashes.

In solving the issue of road fatalities, The WHO (2018) advises a five-part road safety framework: institutional management, legislation and road user behaviour, safe roads, safe vehicles and post-crash care. Institutional management forms the foundation of the road safety framework. This is

founded in the five pillars proposed in the United Nations Decade of Action (UNDA) for Road Safety (2011-2020) plan: road safety management, safer roads and mobility, safer vehicles, safer road users and post-crash response[4] (WHO, 2011). They suggest that establishing a sufficiently resourced 'lead agency' tasked with co-ordinating national road safety efforts. This lead agency would: assess current road safety; set targets and goals; establish appropriate road-safety strategies, plans and projects; manage financial and human resources; and monitor and evaluate activity.

Following this they suggest addressing legislation and road-user behaviour as a starting point in attempting to reduce road fatalities. The third step in their proposed road safety framework is addressing vehicle standards, to make vehicles themselves safer. Next, they suggest improving road infrastructure, so as to improve the safety standards of the roads. These may all be thought of as formal institutional arrangements, as they prescribe laws and regulations to be adhered to. It is useful to adopt the terms the 'laws' approach and the 'standards' approach for the purposes of this thesis, to describe the timelines associated with implementing this institutional change. Consider the latter first. The 'standards approach' is framed as a longer term-approach in tackling road fatalities. This approach considers vehicles, road users and the general road environment and attempts to ensure that cars and roads adhere to safe standards. However, in the short term, the WHO suggests using the 'laws' approach: some results may be achieved with comprehensive road safety legislation, accompanied by effective enforcement and road safety campaigns. Essentially, adequate road safety legislation sits at the core of their proposed ways to improve outcomes, however, periphery factors, such as the safety of roads and cars are also extremely important for improving injuries and fatalities.

The WHO (2018) outlines seven key risk factors that drive road fatalities and that should be addressed under the laws approach: speeding, drinking and driving, helmet wearing, seatbelt wearing and child restraints, distracted driving, and 'drug-driving'.

[4] The original UNDA placed less emphasis on legislation and regulation as a core area and focused more on using adequate road safety management as well as encouraging road users to be safer. Enforcement and legislation formed part of these regulations, however, as the decade has progressed, an emphasis on legislation has come to the forefront (RTMC, 2017; WHO, 2011; WHO, 2018).

The WHO best legislative practises for road safety outcomes are as follows:

Table 2 Best Practice Road Safety Legislation

Law	**Formulation**
Speeding Laws	National speed limit law
	Urban speed limits not exceeding 50km/h
	Local authorities having the power to modify speed limits to adapt to different contexts
Drink Driving Laws	The presence of a national drink-driving law
	Blood alcohol limit for the general population not exceeding 0.05g/dl
	Blood alcohol limit for young and novice drivers not exceeding 0.02 g/dl
Motorcycle Helmet Laws	Presence of a national motorcycle helmet law
	Law applies to both drivers and passengers
	Law applies to all road and engine types
	Law specifies that helmets should be fastened
	Law referring to or specifying a standard for helmets
Seatbelt Laws	The presence of a national seat-belt law
	Law applies to front and rear seat occupants
Child Restraints	Presence of a national child restraint law
	Requirement for children to use a child restraint at least until ten years of age or 135cm in height
	Restrictions for children under a certain age or height from sitting in the front seat
	Reference to a specification or standard for child restraints

Source: WHO (2018, p. 27-46)

The WHO (2018) does not specify ‘best practise’ laws for distracted driving issues, such as mobile phone use or drug driving due to insufficient scientific evidence at the stage of publication as to what the best practise is, however, these are noted as other areas in which legislation is required.

Similarly, the best practises for safer roads and safer cars are prescribed. They describe different levels of safety for certain usage circumstances. Table 3, below, shows how different types of road circumstances are rated based on their perceived safety for different road user groups. For example, a road with no sidewalk, no safe crossing and 60km/h speed limit is rated as being unsafe for pedestrians. In contrast, a road with a sidewalk and a refuge, signalised crossing, and a 40km/h speed limit is rated as being much safer for pedestrians. Similarly, a winding, undivided road, with a narrow

centre line, trees close to the road and a 100km/h speed limit is rated as being unsafe for vehicles. In contrast, a straight road with a safety barrier separating traffic from oncoming vehicles and roadside hazards, with a 100km/h speed limit is considered much safer. Their prescriptions are summarised below:

Table 3 Best Practise for Safe Roads

Star Rating	Pedestrians	Cyclists	Motorcyclists	Vehicles
*	No sidewalk, No safe crossing, 60km/h traffic	No cycle-path, No safe crossings, Poor road surface, 70 km/h traffic	No motorcycle lane, Undivided road, Trees close to road, Winding alignment, 90km/h traffic,	Undivided road with narrow centre line, Trees close to road, Winding alignment, 100 km/h traffic,
***	Sidewalk present, Pedestrian refuge, Street lighting, 50km/h traffic	On-road cycle lane, Good road surface, Street lighting, 60km/h traffic	On-road motorcycle lane, Undivided lane, Good road surface, >5m to any roadside hazards 90km/h traffic,	Wide centreline separating oncoming vehicles, >5m to any roadside hazards, 100km/h traffic
*****	Sidewalk present, Signalised crossing with refuge, Street lighting, 40km/h traffic,	Off-road dedicated cycle facility, Raised platform crossing on major roads, Street lighting	Dedicated separated motorcycle lane, Central hatching, No roadside hazards, Straight alignment, 80km/h traffic	Safety barrier separating oncoming vehicles and protecting roadside hazards, Straight alignment, 100km/h traffic

Source: Table 3 in WHO (2018, p.53)

Lastly, vehicle standards are also prescribed. The table that follows lays out the best practise standards for impact, stability control, seatbelts, child restraints, and motorcycle breaking.

Table 4 Best Practise Vehicle Safety Standards

Standard	**Specifications**
Frontal Impact Protection	Ensure that cars withstand the impacts of a frontal and side impact crash when tested at certain speeds to help protect occupants from impacts.
Side Impact Protection	
Electronic Stability Control	Prevention of skidding and loss of control in cases of over or understeering so as to reduce and avoid single car and roll over crashes
Pedestrian Front Protection	Softer bumpers and modifications of the front ends of vehicles to reduce the severity of a pedestrian impact.
Seat Belts	Ensure that seatbelts are fitted in vehicles manufactured.
Seat Belt Anchorages	Ensure that the seatbelt anchor points can withstand crash impact, so as to avoid belt slippage and that passengers can be removed from their seats in the case of a crash.
Child Restraints	Ensure that the child seat is in place with the adult seatbelt and that the ISOFIX child restraint anchorage points are fitted to secure the restraint.
Motorcycle Anti-Lock Braking Systems	To help the rider maintain control during an emergency braking situation and to reduce the likelihood of a road traffic crash and subsequent injury.

Source: Box 9 in WHO (2018, p.62)

Lastly, they outline that adequate post-crash care ought to be addressed. This involves improving the capacity of the health care system to promptly detect and respond to road crashes, as well as to adequate trauma training within hospitals.

2.2 Does the Law Matter? An Overview of Institutional Economics

Taking inspiration from the recommendations of the WHO regarding best practise laws and regulations as the first step in reducing road traffic fatalities, the effect of the law on economic outcomes is considered more generally. Institutional economics considers the effect of laws, regulations, norms, values and other institutions on economic outcomes, as well as how to use institutions as a tool for changing economic outcomes. First, the general economic literature on

legislation and regulation is considered. Thereafter, the economic literature on road safety and road fatalities is considered.

In New Institutional Economics (NIE) institutions are often defined as 'the rules of the game' (North, 1990), where the rules may be formal (such as laws, rules and regulations) or informal (such as cultural customs, norms, values). 'The game', then, refers to any interaction between two parties, whether it be at the macro, meso or micro levels. Institutions can be further conceptualised as 'humanly devised constraints that structure human interaction' (North, 1994, p.360) and as being the foundation of the incentive structure within a society (North 1994, p.359). New Institutional economics has been part of the forefront of economic analysis in the past 50 years, with several institutionalists being awarded Nobel Prizes. The work of Nobel Laureate, Ronald Coase titled 'The Nature of the Firm' (1937), which considered transaction costs in the organisation of firms and markets, is thought to have spurred economic thinking in the field (Alston, 2008; Coase, 1998), with subsequent work by Laureates Douglass North, Oliver Williamson and Elinor Ostrom on the institutions of development, transaction costs and property rights being seminal in the field (NobelPrize.org, 2021).

Institutional economics is pre-occupied with how these rules affect economic outcomes; which institutions are associated with positive, or desired outcomes; and which institutions are associated with negative outcomes. A significant part of New Institutional Economics is also concerned with how formal and informal institutions interact, and how conflict between these two types of institutions may lead to adverse outcomes (Pejovich, 1999).

New Institutional Economics (NIE) emerged in the mid-late 20th century as a response to the perceived shortcomings of Neoclassicism (North, 1994). Neoclassical economics is mathematical in nature, where assumptions (or axioms) build the foundation of modelling, and these models are employed to obtain predictions (Arnsperger and Varoufakis, 2006). North claimed that neoclassical theory is "…simply an inappropriate tool to analyse and prescribe policies that will induce development." (North, 1994, p.359). The root of this insufficiency is that Neoclassicism is concerned with how markets operate, and not the development of markets; Neoclassicism is static in nature. If one hopes to create policies aimed at developing economies, one needs a theory of economics that understands how economies develop.

NIE, in its conceptualisation, drew inspiration from 'Old' Institutional Economics. 'Old' Institutionalism, as popularised by economists John R. Commons, Wesley Michel, Clarence Ayres and Thorstein Veblen, was methodologically distinct from Neoclassical Economics. Hutchison

(1984) eloquently describes this form of institutionalism as the study of economics which emphasises collectivism: institutions, and organisations (and not individuals) are the primary economic agents.

Rather than existing in opposition, NIE attempts to adapt concepts drawn from Neoclassical Economics to investigate the precise role institutions play in the economic activities and outcomes (Coase, 1984). NIE is less in conflict with Neoclassical economics than 'Old Institutionalism' was, and more of a modification of existing neoclassical theory (Furubotn and Richter, 2008). The key issue with the 'Old Institutionalists' was that they simply disagreed with the abstraction present in mainstream economic thinking, however, they did not propose an alternative theory of economics (Williamson, 1985).

In attempting to synthesise a theory of economics with institutions and efficiency at its core, three schools of thought came to exist within NIE: transaction-cost economics; property rights economics; and the new institutional approach to economic history (Furubotn and Richter, 2008, Williamson, 1984). The two most prominent schools of thought are those most cited to Williamson, and North: Transaction Cost Economics (TCE) and The New Institutional Economics of History (NIEH) (Furubotn and Richter, 2008). These two schools of thought can also be thought of as the study of the institutions of governance, and the study of the effects of institutional environments on economic performance.

TCE, as first theorised by Williamson extends the neoclassical model to include a more realistic view of transactions. Where Neoclassicism views individuals as rational optimising agents with perfect foresight, Williamson concedes that individuals do not have unlimited cognitive ability, but are rather, boundedly rational, and due to difficulty in communication and imperfect foresight, contracts are typically incomplete (Hart 1995, p.23). These contracts are unable to deal with all eventualities that may occur. It is in these circumstances that institutions step in. Courts, as the custodians of formal institutions, may be employed to enforce contracts or to mediate when ambiguity occurs. His theory of incomplete contracts posits that in most scenarios, courts may be a costly and inefficient way to enforce contracts, and rather, in the spirit of maintaining harmony between parties in the long-term, inefficiencies may be allowed to persist in the short run. These inefficiencies would erode away over time, as the loopholes would be discovered and eliminated, and in the long run, more efficient contracts would persist (Furubotn and Richter, 2008).

The Northian School, in contrast, is concerned with explaining the structure and performance of economic systems through the course of time. The NIEH is primarily concerned with establishing the linkages between existing institutions and economic performance. North considers, primarily, property rights. Property rights define the opportunity set available to individuals, including rights to

use and disposal of resources and knowledge (North 1990, p.67). These property rights are determined by the formal and informal rules (i.e., the institutional environment) at play. These institutions exist to reduce uncertainties present in interactions (such as matters of incompleteness in contracts) as well as the costs of co-ordination.

Williamson (1985) eloquently describes NIE as synthesising three core disciplines: economics (specifically, optimisation), law (especially contracting) and organisation theory (in order to understand the larger behavioural context). It aims to develop deeper implications than are typically found in mainstream economics (Williamson, 1985, p.191) and to create an understanding the historical evolution of economics for the purposes of economic development (North 1994).

2.3 Changing Outcomes Using the Law

2.3.1 Institutional Change

Much of the work in NIE in the last half century has been around understanding the linkages between institutions and economic performance. Many revolutionary papers have been written in the field of Economic History, attempting to understand the long-term effects of institutions. For example, Acemoglu, Johnson and Robinson (2001), in their work titled: 'The Colonial Origins of Comparative Development', show that the initial mortality in colonies determined the type of institutions that developed in these economies. High mortality ensured that colonists did not settle in their colonies, and rather developed extractive institutions (such as those employed in the Belgian Congo), for the purposes of exploiting natural resources. These institutions did not protect private property and had fewer accountability measures against government expropriation. Low mortality led to colonists settling, necessitating institutions (such as those in Australia and the United States) that emphasised the protection of property rights, and constraints on the power of the government. Acemoglu, Johnson and Robinson (2001) posit that many of these colonial institutions persist to this day and have led to vast differences in economic development between these countries.

Another popular paper of this type (that focusses more acutely on informal institutions) is Mokyr (2007): 'The Institutional Origins of the Industrial Revolution". There is a great debate in the literature as to the true origins of the industrial revolution. The literature asks two primary questions: 'Why did the Industrial Revolution occur?' and 'Why was Britain First?'. Much of the literature cites the Glorious Revolution[5] and the development of stronger property rights and fewer transaction costs in Europe as the root cause of the Industrial Revolution. North (1981), for example, claims that the property rights system (i.e., the presence of a patent system which protected intellectual property

[5] The Glorious Revolution is the series of events that led a shift in power in Great Britain from the Monarchy to Parliament, ultimately leading to the development of its democracy.

rights), which allowed inventors to profit off their inventions, made innovation attractive. This created an incentive structure that ultimately led to an industrial revolution. Allen (2009), (in a more neoclassical lens) for example, cites the differences in labour costs between countries making capital investment, and ultimately the development of machines, as the reason behind why Great Britain industrialised first. Mokyr (2007), however, unearths that patents were rarely filed or even attained, primarily due to the sheer expense of patenting, but also due to a lack of interest in patenting. Rather, an underlying and prevailing culture of scientific curiosity and openness (as nurtured by the guilds) led to a culture of inventiveness. Mokyr concludes that the origins of the Industrial Revolution, as well as why it occurred in Great Britain first, are, in part, attributable to the institutional environment in the country: both the formal and informal institutions created an incentive system that supported industrialisation.

This literature is very good at uncovering linkages between types of institutions and types of economic outcomes. It is almost universally accepted at this point that institutions matter for economic development. The prevailing view is that weak institutions are the root of developmental issues (Chang, 2011). However, the majority of these studies are not deterministic and lack a clear thread of causality. The literature favours 'western institutions', characterised by liberal economic policy, supporting economic freedom and property rights protection. Many of them employ cross-sectional analysis: they consider a given country with given institutions, but not the effect of changing institutions. It is not sufficient to simply conclude that there are 'good institutions' and 'bad institutions. In order to achieve economic development, one cannot simply change the institutions in countries with poor outcomes to these so-called 'good institutions' (Chang, 2011).

It is Pejovich (1999) that gives a basis for tackling the problem of institutional change. Pejovich (1999) considers the interaction between formal and informal institutions. His premise is that institutions are associated with their own incentives and transaction costs. It is these incentives and transaction costs that link institutions to economic outcomes. In order for changes in formal institutions to result in changes in outcomes, they ought to be in harmony with the informal institutions. If the institutions are aligned, the incentives in both the formal and informal institutions will act together to reduce transaction costs and will increase the production of wealth in the economy. That is, harmony between formal and informal institutions leads to positive economic outcomes. Conversely, disharmony leads to an increase in transaction costs, ultimately leading to poor economic outcomes. To illustrate, take, for example, the case of prohibition in the United States in the 1920s. The formal prohibition laws and the underlying social drinking culture were disharmonious. As such, consumers found ways around the laws, at higher transaction costs than would have been present than

would have been present under free sale of alcohol, and ultimately, the high costs of maintaining and enforcing the prohibition laws eventually convinced the government to remove the laws.

In order to affect true institutional change, it is the view of Pejovich (1999) that imposing new formal rules that are out of harmony with the existing informal rules provides incentives for rent-seeking behaviour, leading ultimately to poor economic outcomes. True institutional change must occur from within the economy; imposed formal rules are insufficient, especially if those formal rules are not in harmony with the prevailing informal rules.

Platteau and Wahhaj (2014) add further context to this discussion. They consider the implementing of formal laws to help victims of damaging or harmful customs. That is, unlike Pejovich (1999), who considers the effect of informal institutions and the incentives they create on the efficacy of laws, Platteau and Wahhaj (2014) discuss circumstances where a law is implemented specifically as a response to a damaging informal institution. Their paper considers specific cultural activities in which a practise is harmful to a clearly identifiable victim, such as Chinese foot binding, or female genital mutilation, however, their taxonomy is still quite useful for the purposes of this thesis. They propose three ways in which a new law may interact with an existing custom. The first possibility is that a new law remains a 'dead letter', where no individual of the group the law was intended to assist appeals to the law and the custom prevails. In direct opposition to this is that the law succeeds in displacing the custom completely. This results as members of the affected group readily seek litigation in the modern courts to ensure the custom is displaced. Between these two outcomes sits the most likely third: a small number of the individuals affected by the law seek judicial enforcement, but it assists in heling the custom evolve towards the outcome intended by the use of the law. At the core of their taxonomy is the level of radicality of the law; more radical laws that are not supported by any members of the community are more likely to fall into the 'dead letter' category, however, laws that are more moderate, especially if the roots of the opposition to the cultural custom are already prevailing in the community to some degree, are far more likely to be effective. They conclude that emphasising the well-being of the disadvantaged group, as well as overcoming obstacles such as ignorance of the law, or a lack of economic opportunities outside of the community domain, may result in more effective legal interventions. Lastly, they emphasise a bottom up led approach, to achieve a level of internal empowerment that can assist in generating support for this law.

In addition to grassroots level approaches and moderate laws being preferred over radical ones as proposed by Platteau and Wahhaj (2014), one of the key proposals of Pejovich (1999) is a method for institutional reform. He proposes, instead of imposing new formal rules, that in order to change formal institutions, governments should provide a legal environment that enables citizens to choose between different institutional arrangements. In an almost neoclassical fashion, he suggests that this

'market for institutions' would not lead directly to a given growth path, but rather, it would allow for citizens to engage with the institutions of capitalism, experiment with approaches, and in the long run, select those that perform best.

The WHO proposes institutional change as a first step in changing road fatalities. Heeding the warnings of Chang (2011), Pejovich (1999), and Platteau and Wahhaj (2014); it may not be the best idea to simply transplant laws. Whilst the suggestions of the WHO (2018) do not suffer from the same causality issues described by Chang (2011), that is, the laws prescribed are founded in a strong literature, that has established how speeding, driving under the influence, helmet wearing, child seats, phone use and seatbelts causally influence fatalities, there is still some concern about whether implementing these institutions will truly result in change. As described by Pejovich (1999), if these new institutions are introduced into a country, and they are at odds with the prevailing informal institutions, the desired outcomes will not be achieved. If the institutions are disharmonious, alternative approaches may be necessary to ensure true change. In addition, enforcement and abidance play an important part in influencing whether laws are followed. As such, the literature review progresses as follows. Section 2.3 considers the law itself; when is it appropriate for policy makers to intervene by changing formal institutions, and should they choose to do so, how do they intervene? Thereafter, in section 2.4, theories of enforcement are considered. Lastly, section 2.5 departs from abstraction, to consider the work that has been done in institutional economics concerning road fatalities.

2.3.2 The Theoretical Underpinnings Justifying Government Intervention

2.3.2.1 General Market Failure Theory

So far, a lot has been said about designing policies for the purposes of development. However, before proceeding with determining how to change outcomes using the law, it is useful to first examine, theoretically, why intervention is necessary, and the point at which it becomes necessary, so as to examine whether the issue of traffic fatalities is one in which government intervention is appropriate. This section convers the traditional economic theoretical underpinnings for government intervention first. Thereafter, the perceptive of libertarian paternalism, as discussed by Thaler and Sunstein (2008) is presented, to extend the circumstances in which government intervention in the market may be considered. Lastly, this is redirected to more narrowly to consider how government intervention may be justified to help solve the issue of road fatalities. It should be noted that this is a normative discussion that covers how and when governments could or should intervene, however, it is acknowledged that many politicians and governments may choose to intervene in ways that do not fit into this theoretical framework, whether driven by inappropriate incentives and objectives, or by political will.

In the neoclassical model of the economy, there is typically no government. Here, agents with perfect knowledge and perfect rationality make decisions, and the market mechanism results in efficient equilibria. In a world with perfect rationality and perfect information, a government is not necessary, as the market co-ordinates to an efficient economic equilibrium (Black et al. 2015). However, this is not what is seen in the real world. The field of Public Economics attempts to make the case that governmental intervention is necessary by identifying frictions that can be observed in the real world. At its core, this argument is based on market failures: where the market falls short, external intervention is necessary. Stiglitz (1989) describes markets themselves as institutions. In attempting to understand differences in development across the world, Stiglitz (1989) begins with the idea that differences may be attributable to differences in how individuals (as factors of production) organise themselves, and to the institutions that co-ordinate and mediate these interactions. He notes that the most important co-ordinating institution is the market (p. 197). In general, if a market fails, intervention is necessary (see for example, Black et al (2015) or Stiglitz (1989))[6].

Black, et al. (2015) outline six key market failures: lack of information; friction and lags in economic adjustment; incomplete markets; non-competitive markets; macroeconomic instability; and unequal income distribution. The type of market failure determines the appropriate course of action. The role of government failure (i.e., when a government fails to correct a market failure effectively and efficiently) is also an area that warrants attention. If a government fails to correct the market failure well enough, additional work is required (Black et al. 2015). Whilst not all of these forms of market failures are relevant to this thesis, the two most pertinent ones are discussed in turn below.

The first key area considered here is incomplete information. Black et al. (2015) argue that when incomplete information is present, decision-making agents are not able to make rational, informed decisions, and may reach inefficient conclusions. Take for example harmful or dangerous products: if a consumer is unaware of the harm a product may cause them, they are not able to make an informed or rational decision about how much of this good to consume (p.29).

Conversely, incomplete markets may result when markets are unable to supply the efficient quantity of a good or service. This argument is typically based on the provision of so called ‘public goods and services’. It is difficult for the market to co-ordinate in such a way that goods which are non-rival in consumption or non-excludable are produced at the right cost or quantity (Black et al. (2015). Rival goods, for example, are goods in which the consumption of one individual reduces the consumption of another. These are goods which are limited in quantity. Non-rival goods, conversely, are goods

[6] Poignantly, Stiglitz (1989, p.202) notes that in order to solve (macroeconomic) development issues in least developed countries (LDCs), it is wise to start with an understanding of their microeconomic contexts.

where the use of these goods by one user does not lead to less consumption by another (Black et al. 2015, p. 39). In neoclassical economics, the limited nature of a good is what determines its price. The theory proposes that a perfectly competitive firm charges any additional consumers the marginal cost of producing one extra unit of the given good. How can a market price a good in which adding an additional consumer carries no cost (p.45)?

Similarly, an excludable good is one in which users can be prevented from using the given good (p.39). Excludable goods are typically those in which a consumer can only consume the good if they have paid for it. Non excludable good suffer from the free rider problem, it is difficult for firms to exclude non-paying customers from consumption of these goods. It is difficult for the market to establish a way to exclude non-paying customers from benefitting from the provision of a non-excludable good when it is possible for non-paying customers to still benefit from the presence of the good (p.45).

In addition to properties of rivalry or non-rivalry, some goods may have externalities associated with them that result in incomplete markets. Take for example the ideas of Pigou (1932). If a good has some associated external benefit or cost, the amount of the good produced by the market is not a socially optimal quantity, and the price is not a socially optimal price. To illustrate, consider the pollution associated with the production of a good or service. The cost to the environment of pollution is not typically internalised by the firm, and hence is not passed on to consumers. The optimising firm may choose to supply a large amount of this product to their consumers, at a low price, but the long-term harm done, the cost of cleaning up pollution and all other externalities result in a market quantity that is too high, and a market price that does not reflect the true economic and social cost of providing the good (Black et al. 2015: p.49-53).

Black et al. (2015) have outlined key areas in which markets fail. However, many of these market failures still occur within a neoclassical framework. The perfectly rational consumer cannot make a decision that results in the most efficient quantity of a good being supplied when they do not have full information, nor can they improve distribution of income when the roots thereof are unjust. In these circumstances where market failures occur, Black et.al (2015) outline that government intervention is necessary.

For example, governments may choose to supply goods that are non-rival and non-excludable as these goods not efficiently provisioned for by the market mechanism. It is difficult for the market to determine both the appropriate price or quantity of these goods to produce, as the forces of supply and demand do not reach the appropriate equilibrium. It is these goods that have the strongest case for pure public provision (Stiglitz, 1989: Black et al. 2015).

However, direct provision by government is not the only route possible and is undoubtedly not always the best mechanism through which intervention may be achieved. Instead, governments may choose to regulate markets. With changes in technology, it is difficult to find goods that are perfectly non-rival and non-excludable. For example, with enough toll booths, it is possible to make roads excludable. However, even goods that display some degree of non-rivalry or non-excludability (mixed goods), however minor, may still require some form of intervention, whether in the form of regulation, technological intervention or more, to ensure the optimal quantity of goods is provided. Similarly, in scenarios where externalities may occur, it is often appropriate in these cases for the government to impose a tax on the good with the negative externality (or in the case of a positive externality, such as those associated with education, a subsidy). These so called Pigouvian taxes (and subsidies) are a popular tool for governmental intervention in ensuring that market failures due to incomplete markets are solved (Black et al. 2015).

2.3.2.2 Libertarian Paternalism

The classes of intervention detailed in the previous section may be thought of as direct interventions by the government. Direct intervention often takes the form of making laws, establishing regulations, and allowing or disallowing certain practises to occur under prespecified conditions.

However, a case can be made for governmental, or external, intervention to be made when decision makers are not perfectly rational or are affected by difficulties in decision making. In these cases, a purely paternalistic approach to governance, which may involve 'outlawing' certain behaviours may not be appropriate.

Consider the work of Cass Sunstein and Richard Thaler (2008). Thaler and Sunstein (2008) describe that sometimes individuals have enough information, but they struggle to make 'good' decisions. They discuss the idea of helping decision makers make better decisions. In the real world, and not in the perfectly rational neoclassical one, decision making is far more complex. Decisions made irregularly, for example, may prove more difficult for individuals to make a rational choice about. Thaler and Sunstein (2008), poignantly point out that some of the most important decisions an individual may make in their life, often with the highest associated stakes, (such as what career to choose, what university to attend or who to marry) are not decisions that come with a lot of practice. In these cases, individuals may struggle to make the best, 'utility maximising', decision (p.74).

Similarly, individuals may struggle with time biases (p.73). Individuals often struggle with decisions that result in immediate utility and satisfaction, but that have long term consequences. Take for example, the decision to smoke. Individuals know that smoking has long term consequences, such as cancer, but in the short term, they still chose to have that cigarette. Thaler and Sunstein (2008) argue

that the market will often cater to people's shortcomings in decision making, and in fact, will often exploit them. In addition, sometimes decision makers just make mistakes. Individuals do not always make decisions that are in their best interest. As such, Thaler and Sunstein (2003, 2008) propose an approach of libertarian paternalism.

The term paternalism is typically met with a lot of resistance. Paternalism is often seen as 'anti-freedom': it is misconceived to involve coercion and restriction of choice (Thaler and Sunstein, 2003). A paternalist policy is understood as one in which affected parties will be made better off. Libertarian paternalism is an approach that retains freedom of choice, but that allows institutions to guide individuals towards decisions that will improve their welfare. It is an approach that nudges individuals towards better decisions without actively forcing, ultimately helping them overcome difficulties in decision making them (Thaler and Sunstein (2008). Remaining with the smoking example, scientists have proven that smoking is a bad decision in the long run. However, even with this information, smokers may not choose to quit smoking (often in spite of them really wanting to). Some governments have responded to this by changing the way in which smoking is advertised (or not allowing them to advertise smoking at all). For example, they place images of cancerous lungs on packaging to make the long run effects more salient.

Thaler and Sunstein (2008) eloquently describe libertarian paternalism as: "… [offering] nudges that are most likely to help and least likely to inflict harm," and 'nudges' designed with this golden rule in mind may help humans align their short and long-term interests, and ultimately, make them better decision makers.

2.3.2.3 Government Intervention in Road Safety

Consider the issue of traffic fatalities once again. As discussed, traffic fatalities may be caused by a number of reasons: poor road infrastructure, unsafe vehicles, or inappropriate driver behaviour. Under the classic model of market failures, most national highways and roads are provisioned by governments as public goods, as they are non-rival and non-excludable in nature. As such, poor road quality that results in fatalities may be considered a government failure that needs governmental rectification, rather than a traditional market failure. However, unsafe vehicles and inappropriate driver behaviour are two additional circumstances that may warrant government intervention. There are two primary arguments that may be relevant here: intervention to avoid negative externalities, and intervention to align long term and short-term interests of individuals.

Consider driver behaviour first. If individuals engage in unsafe driving behaviour, such as speeding, or drinking and driving, not only do they risk injuring themselves, but they also risk injuring or killing others, as well as destroying property. In a purely neoclassical framework, an individual may decide

that a certain amount of speeding satisfies their utility maximisation constraints, however, speeding creates unsafe roads, results in higher fatality crashes when both other vehicles and pedestrians are involved. These crashes may be thought of as the social cost of speeding, and, as per the work of Pigou (1932), an externality is present, and government intervention is justified. Governments may then, through regulation, fines or jail time, influence drivers to reduce their speeding preferences so that they are in line with more socially optimal levels.

Continuing with the analysis of driver behaviour, the spirit of libertarian paternalism would perhaps justify intervention as a tool to align an individual's long term and short-term goals. If an individual chooses to speed, they may perhaps not be considering the longer-term actions of their consequences. Speeding may satisfy an immediate need, such as attempting to get somewhere on time, trying to get out of traffic faster, or satisfying a preference for driving faster. However, this view could be seen as short sighted. As the thought of a crash is not latent, it may be necessary to for a third party to intervene. A government that employs the ethos of libertarian paternalism in their approaches to governance may choose to regulate speeding, as disallowing speeding may cause a lot more good than it does harm. Thaler and Sunstein might suggest direct regulatory intervention, but they may suggest employing a 'nudge' which may give the individual a more latent choice between speeding and not speeding that aligns the individual's long- and short-term goals.

The argument that underlies regulating vehicle safety may be two-fold. First, governments may choose to regulate vehicle safety under the externality argument as well. Safer vehicles, if involved in crashes, are less likely to cause fatal crashes, thus reducing social costs resulting from crashes. Consider the pedestrian protection standards prescribed by the WHO. Softer bumpers and impact standards result in crashes with pedestrians being less fatal, effectively reducing the social cost involved. Similarly, safer vehicles that are less likely to roll, or that protect drivers when crashes occur, may be thought of as embodying the spirit of libertarian paternalism, as safer vehicles do no harm to the owner, but they protect them if they choose to engage in risky driver behaviour.

2.4 Ensuring the Law is Followed: Compliance and Enforcement

2.4.1 Determining Optimum Enforcement

Enforcement adds an additional layer to the efficacy of formal and informal institutions in changing economic outcomes. Enforcement may be both formal and informal, with formal enforcement being carried out by the law-making authorities, and informal enforcement referring more to societal punishment and reward for behaviours. It is not a necessity that formal laws may only be enforced formally, for example, societal disapproval of inappropriate road behaviour, such as speeding, may

result in fewer individuals choosing to speed than they would have if formal enforcement by the traffic authorities was the only mode of enforcement present.

The work of Nobel laureates George Stigler and Gary Becker provides the framework for considering enforcement of laws. Becker (1968) and Stigler (1970) and Becker and Stigler (1974) present the macroeconomic considerations to be employed when determining the optimal levels of enforcement in an economy. Laws can be described being explicit or implicit contracts underlying prescriptions of behaviour (Stigler, 1970). The goal of enforcement is thus to achieve a degree of compliance with the prescribed behaviour that society desires. 'Complete' enforcement, however, is costly. It takes manpower, and economic resources, and prosecuting each and every crime is infeasible. It is up to society to decide the level of enforcement that is justified by its cost. For example, given a large enough police force, every speeding offence could be caught[7].

Becker (1968) explores the relationship between crime and punishment. His consideration is why different enforcement levels may occur. He creates a mathematical model in which enforcement expenditure, that is the probability an offence is discovered, apprehended and convicted and the corresponding size and form of the punishment, is chosen, subject to the damages caused by illegal actions, the cost of achieving the probability an offence is discovered, and the effect of changes in this probability on the damages caused by this illegal action. He describes that the optimal decision minimises the social (or public) loss in income from offences (that is, damages or costs). As a result of this he recommends, that bigger crimes should suffer bigger punishments, and specifically, that bigger crimes, such as rape or murder should be punished both more frequently and more severely. Conversely, relatively smaller crimes, such as theft and petty larceny should be punished less regularly.

Becker (1968) notes, that fines may be preferable forms of punishment as they both compensate society and conserve resources (relative to imprisonment), and that punishment by imprisonment (or other forms) in lieu of fining should be equivalent to the monetary punishment. Lastly, he prescribes that minimising social loss (rather than prioritising factors such as vengeance, deterrence, safety, compensation and rehabilitation) are more desirable as minimising social loss focuses on compensating victims fully and is thus a much more general and wide-reaching metric. He views enforcement as an optimal allocation of resources.

Stigler (1970), similarly, prescribes an economic model to determine optimum enforcement. He describes that rational enforcement has two properties: expected penalties increase with expected

[7] Stigler (1970) is quite an old paper; and it is plausible that with the presence of 21st century technology that enforcement becomes much easier. However, it is still financially (and likely politically) infeasible for speeding cameras to be placed everywhere.

gains from committing the offence; the marginal cost of spending on enforcement should be equal to the marginal benefit of spending elsewhere. He notes, crucially, that the penalty structure should integrate a social appraisal of the importance of reducing offences, that is, priority setting should be driven by societal valuations of the cost of the offence. This gives a better picture of the 'true' cost of the offence. Stigler suggests that to avoid over enforcement and the punishment of non-guilty parties, the quantity of resources allocated to enforcing particular crimes should be proportional to the seriousness of the crime and that if enforcement is to be considered rational, the punishment must match the crime. He notes that some difficulty may be faced where the public has a desire for the law to not be enforced. This may perhaps be a symptom of the formal and informal institutions not being aligned, as described by (Pejovich, 1999), and this may result in what he describes as 'inappropriate sanctions'; sanctions in which the punishment does not match the crime, and excess enforcement is used.

Lastly, Stigler and Becker (1974) consider whether enforcement and litigation are economically wasteful. They find that both prevent harm. Litigation systematically presents facts, resolves doubts and reduces conflicts, all with the aim of ensuring non-guilty parties are not found guilty. Similarly, they suggest that enforcement may be improved through ensuring public enforcers are better compensated. Lastly, they suggest that privatising enforcement may gain the benefits of competition.

2.4.2 Behavioural Ethics and Compliance

The work of Stigler and Becker can be considered neoclassical in nature. Feldman and Kaplan (2021) however, present a view of compliance and enforcement that is founded in principles of behavioural ethics. They outline that the 'traditional' view of compliance is founded on neo-classical principles: wrongdoers act as a result of calculated and deliberate cognitive processes. Individuals choose to not comply with the law as the benefit of failing to comply, or the benefit of wrongdoing is large enough, that it outweighs the cost of sanctions and overcomes moral inhibitions. However, research from the field of behavioural ethics outlines that this may not always be the case. This 'perfectly rational' view of compliance is referred to as calculated wrongdoing. This is contrasted by self-justified non-compliance and self-blinded non-compliance. Self-justified non-compliance occurs when an individual employs biased ethical reasoning. The perpetrator typically understands that they have been confronted with a moral dilemma, however, their self-interest prevents them from assessing the situation objectively. Their judgement is distorted, and consequently, they excuse their own wrongdoing. Self-blinded non-compliance occurs with the individual's self-interest makes them biased, and results in them failing to recognise moral dilemmas altogether. This may result from individuals ignoring some facts and emphasising others, or by interpreting situations in a way that serves their own self-interest. Feldman and Kaplan (2021) outline that this type of unethicality may

occur when specific victims are not latent, and as such, it is easier for the wrongdoer to disconnect their actions from the consequences thereof. Similarly, legal ambiguity creates grounds for self-justified unethicality and self-blinded unethicality to thrive, as ambiguous norms may be easier to disregard, or to interpret in such a way that wrongful actions are justified.

Feldman and Kaplan (2021) outline two additional important considerations surrounding compliance that are especially pertinent to this thesis. First, individuals comply with the law if they perceive the law to be fair and just. This effect is enhanced if the law is made in a procedurally legitimate manner (Kahneman et al., 1986; Tyler, 1990). Thus, if individuals feel that a law is unjust, if it has been established in an unjust manner, or if the motives of the policy makers are in question, they may be more likely to justify not following the law. Additionally, they outline that in order to have better compliance with 'minor' infringements, that lawmakers and enforcers should not focus on extreme violations of the law as the greatest manifestation of the issue of illegality. Most people are unable to justify extreme violations, such as murder, and as such, these infringements are relatively rare. In contrast, individuals can and do justify 'minor' infringements, that occur on a day-to-day basis. As is present in the case of traffic fatalities, at a long run level, the total cost of these violations to society is much larger than the summed cost of the extreme violations, due to their frequency of occurrence.

In this light, Feldman and Kaplan (2021) they suggest revising the traditional forms of enforcement. Traditionally, enforcement is concerned with improving behaviour and preventing misconduct through deterrence by use of sanctions, such as fines or imprisonment (see, for example Tittle (1980) or Zimring et al. (1973)). In this school, individuals would perform cost-benefit analyses, and the consequences of enforcement would factor in as a cost, and thus a deterrent (Coase, 1960). However, this school only considers calculated wrongdoing as the only source of non-compliance. As such, enforcement based on these models falls flat, and perpetrators fail to accurately assess the likelihood of sanctions occurring. As such, the degree of deterrence envisioned does not occur. In order to make allowances for non-compliance through self-justification or self-blindedness, Feldman and Kaplan (2021), when sanctions are employed, the way these sanctions affect decision making by real individuals should be considered. As such they prescribe the use of ethical nudges (in the spirit of Thaler and Sunstein (2008)), in the form of reminders and alerts that remind drivers of specific facts at the time that decision making occurs. Nudges need not only act to remind wrong doers of specific facts but may also act as an opportunity for perpetrators to slow down and employ more cognitive resources to decision making. They state it may be appropriate to specifically remind wrong doers of the legal and social sanctions associated with their actions at this decision-making junction.

2.4.3 Interactions Between Norms and Enforcement

Enforcement and compliance need not only act through formal channels. Mecuro and Medema (2006) consider the issue of compliance and enforcement alongside norms and values. They describe three possibilities for enforcement: the law only, norms only, or combinations of the law and norms. They note that using only the law to enforce infringements is negative in nature. In these circumstances, individuals comply to avoid negative impacts, such as fines or imprisonment. Norms are internalised through education, peers, religion, culture and family, and establish incentives for compliance. Enforcement and compliance that act through the channels of social norms may have negative or positive incentives associated with them. Where norms are negative in nature, individuals comply to avoid punishment by the community, disapproval, admonition or psychic cost. Conversely, compliance is positive in nature if the incentive structure results in the community rewarding individuals with feelings of virtue, duty fulfilment, praise, esteem, as well as larger resource benefits.

Mecuro and Medema (2006) note, similarly to Pejovich (1999) that norms can work both with or against the law, with social norms either incentivising behaviour that is not in line with the law or assisting in compliance. When the norms and the law are aligned, Kube and Traxler (2009) outline that the potential for crowding out exists. They investigate compliance with what they term ‘mild laws’ to determine whether institutions are complements or supplements. Mild laws are laws that are not regularly enforced. Their experimental design considers what happens when a society shifts from pure social sanctions to centralised enforcement. They find that legal sanctions partially crowd out enforcement by social norms, and in fact, that a higher level of compliance can observed at lower costs of social sanctioning. Thus, their work shows that purely relying on social sanctioning and decentralised enforcement is not optimal, and for some laws, a combination of centralised and decentralised enforcement lowers the cost of enforcement. However, Acemoglu and Jackson (2017) note that when laws and norms are not aligned the potential for backfire is high. In these circumstances, it is appropriate to gradually shift and tighten laws so that norms may be slowly influenced in the intended direction.

2.4.4 Discussion

The literature has suggested that compliance and enforcement are complex in nature, and that a significant amount of thought, planning and research should go into designing an optimal enforcement strategy. Part of this is budgetary in nature, as was outlined by Stigler (1974) and Becker (1968) respectively: it is infeasible to enforce every infringement. As such, some level of ‘natural compliance’ should be assumed, and the amount of resources devoted to enforcement should be in line with the seriousness of the crime. To this end, Feldman and Kaplan (2021) propose employing a holistic view of the seriousness of the crime, and not simply enforcing ‘big crimes’ but crimes that

have a large cost to society. In addition, simply relying on deterrence through the threat of sanctions is insufficient, due to deviations from perfectly rational behaviour on the part of the decision maker. As such, some degree of libertarian paternalism is necessary, and nudges are suggested to assist in ensuring that the consequences of failing to comply with the law become latent. Lastly, the role of norms should not be neglected. Norms may assist with compliance when they are aligned with the law, however, when alignment does not exist, some additional work is required to ensure enforcement does not backfire.

2.5 Institutions, Enforcement and Road Safety

2.5.1 Road Safety in the Institutional Literature

The institutional literature focuses largely on issues of economic development, and the roles played by a nations institutional setting in economic prosperity. The role played by institutions in impacting traffic fatalities, however, is not very broad. Only a few authors have considered this issue. The rest of this literature review focusses on authors that synthesise the literature on institutions, enforcement, and compliance to investigate issues related to traffic fatalities.

Du Plessis, et al (2020a) investigate the road safety outcomes in South Africa against the backdrop of their institutions. South Africa has many of the best practise laws for addressing road fatalities, with 15 of the 23 laws being exhibited in SA in 2015 and addressing six of the seven areas prescribed. The laws are generally well aligned with international best practises. However, fatalities in South Africa remain high (WHO, 2018). Du Plessis et al. (2020a) suggest that the issue here likely lies in a disconnect between formal institutions, informal institutions, and enforcement. This sentiment is echoed by de Abreu and Hoeffler (2021); who consider strategies to reduce road fatalities in South Africa. De Abreu and Hoeffler (2021) note that South Africa does have comprehensive road safety legislation, and that stricter enforcement may go a long way in reducing fatalities.

It is plausible that South Africa is suffering from the same issue described by Pejovich (1999): the formal and informal institutions are misaligned, and as a result, the traffic legislation is failing to produce optimal outcomes. Likely compounding this effect is the poor state of traffic enforcement in South Africa (see for example, the South African National Development Plan, 2030 (National Planning Commission, 2012: p.334)): there is something about the traffic institutional framework that is at odds with the prevailing informal institutions, and weak enforcement in South Africa allows individuals to successfully avoid following the law.

In this vein, Du Plessis et al. (2020b), employ a controlled laboratory experiment to investigate the effect of institutional changes in reducing harmful road behaviour. Beginning with the concept that the decision to adhere to traffic laws and to pay traffic fines are influenced simultaneously by the law,

by norms and values, and by enforcement, they investigate the implementation of discounts and penalties as an incentive to induce behavioural change. Their experiment considers the actions of a group of students when faced with a speeding fine. They consider willingness to pay a traffic fine as a measure of willingness to abide by the law. They present different financial incentives, in the form of discounts and penalties to the experimental subjects to investigate whether these incentives impact willingness to change behaviour. They find, crucially, that these legislative changes work, and that both discounts and penalties are capable of changing an individual's willingness to pay traffic fines and thus, ultimately, abide by the law. Additionally, they find that likelihood of being detected for infringements, that is, improved enforcement of traffic legislation, made subjects more likely to adhere to the law.

Du Plessis et al. (2020b), however, note that changing the law using fines may not be the optimal solution. Building on the work of Gneezy and Rustichini (2000), they describe that using a fine may send the message that speeding is a minor offence, and that, for some drivers, a fine is simply a price an individual pays to be allowed to speed. They further note that introducing discounts may result in lowering the 'price of speeding' and that this might lead to increases in traffic law violations. They further note, in line with the work of Stigler and Becker discussed in section 2.4.1 that improving enforcement may be detrimental, as it clogs up the court system with traffic offences that may be trivial, relative to bigger criminal offences.

This brings into question whether improving formal institutions, or the enforcement thereof is the optimal solution to improving road safety outcomes. As described by Mecuro and Medema (2006), it may be preferrable to turn to changing behaviour through appealing to norms, as this may use positive associations. Where individuals may typically comply with the law so as to avoid negative repercussions, informal institutions have both positively and negatively impacted enforcement (Mecuro and Medema, 2006). Individuals may choose to adjust their behaviour to avoid negative informal punishment, such as disapproval, or they may choose to comply with norms so as to reap the rewards provided by the community, such as praise, status, feelings of virtue and more. The additional benefit of this method is that informal institutions require no additional enforcement on the part of the policy maker. However, in order to rely on norms, values, and culture to change institutions, it is paramount to recognise precisely which informal institutions drive traffic behaviour, and to ensure that these institutions are aligned.

Gaygisiz (2010), building on the work of Özkan and Lajunen (2007), Melinder (2007) and Hofstede (2001), investigates linkages between cultural values, governance, and road safety outcomes in 46 countries across the world. They study the role of cultural characteristics on fatalities using Hofstede's cultural dimensions, as well as Schwartz' value dimensions. The Schwartz value dimensions

(Schwartz, 1994, 2006) are based on three key concerns all societies need to address: autonomy or embeddedness; egalitarianism or hierarchy; and harmony or mastery. The first concern, autonomy vs. embeddedness considers the interaction between an individual and the group, where in autonomous countries, individuals are encouraged to nurture and express their own feelings, preferences, ideas, and abilities. Similarly, in embedded countries, individuals are viewed as being embedded in the collective; and meaning in life is derived through social relationships, identification with the norm, and pursuing shared goals together. Similarly, the egalitarianism or hierarchy dimension described the way the social fabric is maintained, with egalitarian countries emphasising each individual as a moral equal who feels concern for the welfare of each member of the society, whereas hierarchical countries have respect for and rely on prescribed roles (with rules and obligations) to ensure responsible behaviour. Lastly, the harmony or mastery dimensions refers to the way the society regulates people's treatment of human and natural resources, with harmonic cultures emphasising fitting in with the social and natural world and accepting it, rather than attempting to change it, and mastery cultures encouraging active self-assertion, so as to direct and change the goals of individuals or the collective.

Similarly, Hofstede (2001)'s cultural dimensions are power distance ('PDI': the inequality between individuals), uncertainty avoidance ('UAI' the level of stress in a collective associated with uncertainty about the future), individualism vs. collectivism ('IDV': the level of integration of individuals into cultural groups) and masculinity vs. femininity ('MAS', the balance of emotional roles between men and women). Hofstede (2001) considers the correlations of these cultural dimensions with 1971 road safety outcomes and finds that MAS and UAI are positively related to fatalities, and that IDV is negatively associated with fatalities. Similarly, Özkan and Lajunen (2007) use Hofstede's cultural dimensions and Schwartz' value dimensions to investigate traffic fatalities in 34 countries. They find that traffic fatalities are positively correlated with PDI and UAI, and negatively correlated with IDV. However, when GDP is controlled for, only the UAI relationship remains significant. Additionally, they find that conservatism is correlated negatively with a factor they refer to as the 'traffic safety component' and that harmony is positively correlated with the same factor. They suggest that as the pursuit of harmony with the environment may lead to increased awareness of risks within the environment. They also find that egalitarianism is positively correlated with fatalities. They suggest that this is likely due to safe driving requiring adherence to rules without question, whereas egalitarianism does not promote this.

Melinder (2007) also uses Hofstede's cultural dimensions to investigate traffic fatalities in 15 European countries. Similarly to Hofstede (2001) as well as Özkan and Lajunen (2007), they emphasise the role played by UAI. Hofstede (2001)'s explanation for this phenomenon is that high

uncertainty avoidance is associated with high stress, emotionality, and feelings of urgency, which results in poor road traffic behaviour leading to speeding and low traffic safety.

Gaygisiz (2010) finds that that power distance, embeddedness, hierarchy, and mastery are all positively related with fatalities. Similarly, intellectual autonomy and egalitarianism are negatively related to traffic fatalities. They argue that power distance is important as the power structure in an economy undermines the importance of road safety legislation as well as compliance with this legislation, and compliance depends on an individual's status in the power hierarchy, rather than concerns about safety or being fined. Similarly, they describe that embeddedness, hierarchy and mastery are values characteristic of traditional and hierarchical societies. For these societies, the key aim is maintaining the status quo, and a social hierarchy with foundations in inequality is not questioned. In this light, enforcement fails, as one of the foundations of enforcement is that each citizen's rights are defined by their traffic role (e.g., driver, pedestrian, etc), and that each citizen is socially equal. However, embeddedness and hierarchy, when combined, undermine the equality assumption; sanctions are not the same for everyone, and some citizens may be less inclined to respect traffic rules than citizens in nations characterised by autonomous or egalitarian countries. Lastly, they hypothesize that the mastery value, which is embedded in a disregard for the social and natural environment results in poor traffic outcomes through poor driver behaviour. As an additional layer, Gaygisiz (2010) finds that they find that in countries with low governance quality, the hierarchy and mastery values had a stronger impact. They conclude that improvement of the quality of governance and institutions can improve road safety outcomes, even if the values system does not necessarily result in better outcomes.

2.6 Discussion

This literature review has provided an overview of theories on how institutions may be linked to economic outcomes. Specifically, the issue of traffic fatalities have been considered. Road fatalities are an unnecessary source of loss of life and disability. As such, the WHO prescribes strategies for reducing road fatalities, including amendments to a country's laws, vehicle safety standards, road safety standards, institutional management, and post-crash care. These strategies include changes in formal institutional arrangements as well as the enforcement of institutions. In this light the theories institutions and enforcement are considered in turn. The institutional literature suggests that institutions are undoubtedly capable of assisting in changing outcomes, however it is of paramount importance that formal institutions and informal institutions are aligned, or it may be difficult or impossible to achieve results. Peripherally, a brief consideration of when it is appropriate for governments to introduce legislation to intervene is presented. In this light, the work of Thaler and Sunstein (2008), on libertarian paternalism has been discussed, as this approach to governance is

emphasised throughout modern economic literature. The enforcement literature emphasises efficient enforcement, and cautions against over-enforcement, due to the costs involved. In addition, the modern literature emphasises understanding how humans make decisions around compliance, and points out that often, we are able to justify or ignore important factors in decision making. In this light, they propose employing nudges, as well as considering underlying norms, in designing policies on enforcement. Lastly, whilst the literature on institutions and traffic fatalities is not very broad, a brief overview has been presented here.

3 The Effect of Institutions and Enforcement on Road Fatalities

3.1 Data and Methodology

3.1.1 Data

This thesis combines two sources for the purpose of investigating traffic institutions: The WHO Global Road Safety Status Report (2018) and the World Values Survey Time Series, from 1981-2017 (Waves 1-6[8]) (Inglehart et al. 2020).

The Global Road Safety Status Report (2018) (hereafter, the GRSSR (2018)) considers the incidence of road fatalities across the world. The WHO studies road fatalities for the purposes of reducing needless death and disability caused by road traffic crashes. As discussed in section 2.1.3, the WHO focuses on five key areas for improving road safety outcomes: institutional management, legislation and road user behaviour, safe roads, safe vehicles, and post-crash after care. The WHO gathered data from 175 states, by means of self-administered surveys, publicly accessible databases, and data collected by the International Road Assessment Programme. In addition, where necessary, the WHO estimates data. Specifically, one of the fatalities measures used throughout this section is estimated by the WHO (2018, p.xv)[9]. This backdrop forms a unique source for considering the correlates of road fatalities. In this data set, variables on the institutional framework (i.e., the presence of a lead agency or a national road safety strategy), safer roads and mobility (design standards, inspections, investments and more), registered vehicles (both total and by type), vehicle standards, post-crash care, reported and estimated fatalities, speed limits, drink driving laws, helmet laws, seatbelt laws and child restraint laws, as well as mobile phone use and drug driving laws are documented in each country.

The WVS on the other hand is an international research programme that studies social, political, economic, religious, and cultural values of people around the world, for the purpose of assessing how values impact the social, political and economic development of countries and societies. The survey

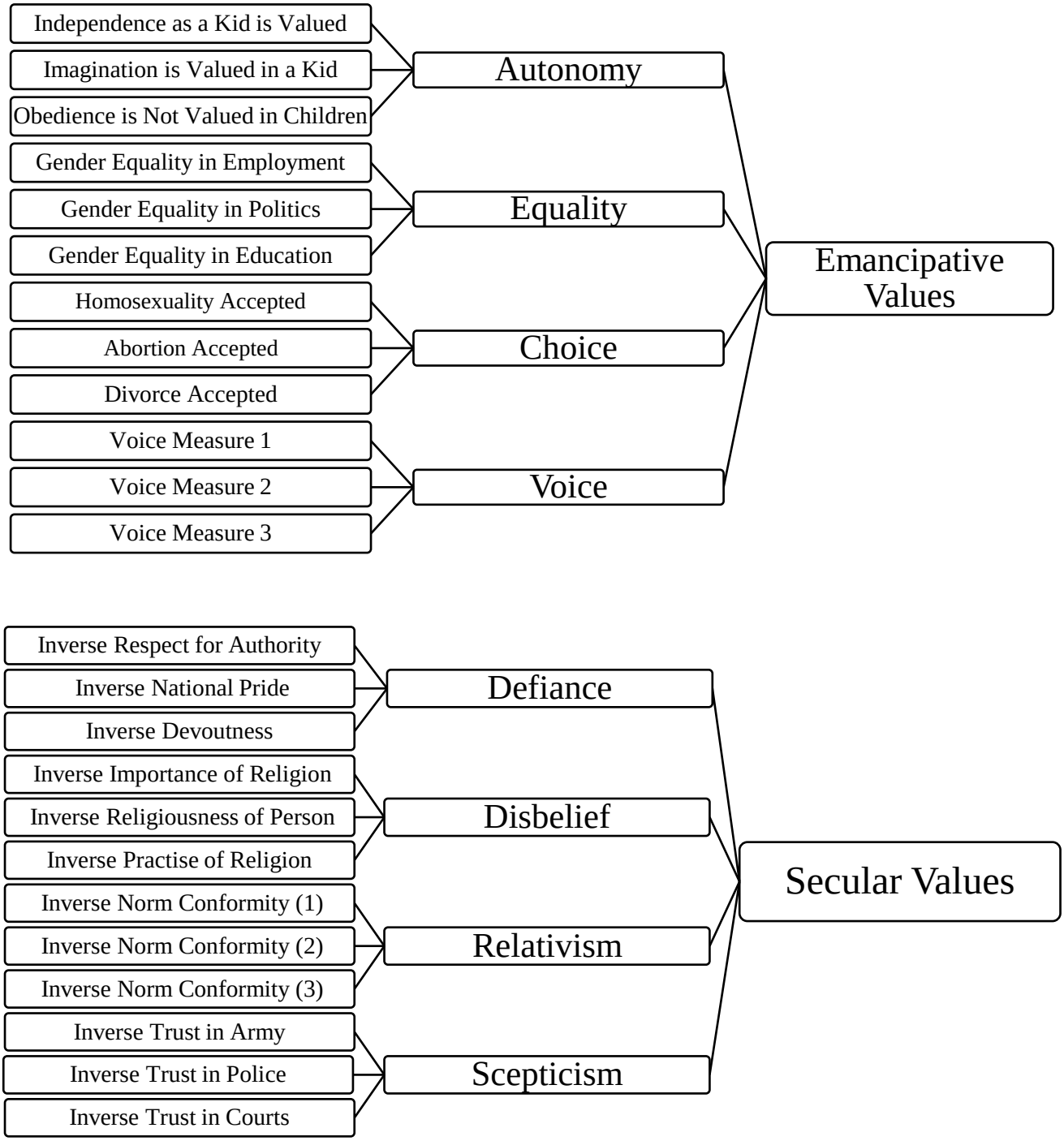
[8] Wave 7 (2017-2020) has only been conducted in 51 countries/territories and is still being conducted. As it is incomplete at this stage, only waves 1-6 have been used.
[9] For more information on the estimation methods used by the WHO, see Appendix A.

is conducted every five years in nearly 100 countries (encompassing 90% of the world's population) using a questionnaire. The survey is representative at the national level in each country. From the survey questions, the WVS calculates an individual's score in 24 broad values. Each value (or norm) is described in terms of an index which takes on either a value between 0 and 1 (typically '0, 0.33, 0.67 or 1', but also sometimes '0, 0.5 and 1' and '0 or 1'). This measure describes the degree to which the individual can be described by a given norm. For example, survey question E018 asks whether an individual believes that greater respect for authority is 1) a good thing, 2) something they don't mind or 3) a bad thing. This question is then used to determine an individual's score on the 'respect for authority' variable. The authority variable is defined inversely, i.e., high respect for authority has a low value (i.e., a 0) and low respect for authority has a high value (1). An individual who answers that greater respect for authority is good, scores a '0', if they don't mind it, they score a '0.5', and if they think it is a bad thing, a '1'. 24 broad values are obtained in this way. From these 24, the narrow values of defiance, disbelief, relativism, scepticism, autonomy, equality, choice and voice are obtained[10]. The former four values are used to create what is known as the 'secular values' index, which may be used to contrast religious and non-religious societies. The latter four values are used to construct the 'emancipative value' index, which is used to describe the importance a society places on freedom from domination (Welzel, 2013; Inglehart et al., 2020.).

With respect to the secular values index, the two contrasting values are referred to as 'traditional', which emphasise the importance of the nuclear family, religion, authority, and traditional family values, whereas on the other end, 'secular-rational' values, are in opposition. To illustrate, people who embrace traditional values typically: reject divorce, abortion, euthanasia, and suicide, and are typically nationalists, and vice versa for those with secular rational values. Similarly, the two sides of the emancipative coin are the 'survival values' side (which emphasises economic and physical security, with low levels of trust and tolerance), and the 'self-expression' values, which prioritise environmental protection, gender, sexuality and foreigner acceptance, and display demand for participation in decision making in economics and politics. Figure 1 summarises what the 24 broad values are, and how they are used to construct the emancipative and secular indices.

[10] Not every individual is asked every question in the survey. Where data is missing, the WVS does not calculate the value if it forms part of the 24 broad values, but in calculating the 8 narrow values, they simply aggregate over existing data.

Figure 1 Construction of the Secular and Emancipative Indices



Source: Summarised from Welzel (2013)

The two data sets are combined as follows. The WVS is at an individual respondent level, and not every country is represented in every wave. To obtain the largest sample size, aggregates are taken. For the 24 broad values, the eight narrow values (or norms), and for the emancipative and secular variables, an average is obtained. To illustrate, 'average autonomy' is calculated as follows: For 'Autonomy' in country, k, an average is obtained as follows:

$$Autonomy_k = \frac{\sum_{\forall i}^{n} Autonomy_i}{n}$$

Where n is the total number of individuals surveyed in country k in all 6 waves, and $autonomy_i$ refers to the value of the autonomy index for individual i. This is repeated for the 24 broad values, the 8 narrow values, and the final emancipative and secular variables. The 13 values that were coded inversely, (such as 'inverse respect for police', as well as 'obedience is not valued in children') had their signs reversed for ease of interpretation. Thus, in the rest of this thesis, each value is coded in the direction that its label suggests. For example, a low value on 'Importance of Religion' corresponds to low importance of religion. 105 observations exist in this database.

Thereafter, this database was appended to the GRSSR. There are 92 matches that are documented in both data sets. 13 countries are documented fully in the WVS data but are not documented in the GRSSR dataset. 83 countries are documented in the GRSSR data set but are not documented in the WVS data set. The resulting dataset thus contains 188 observations, of which 175 have information on laws, standards, and road safety matters (primarily formal institutions and the enforcement thereof), 105 have information on values (informal institutions), and 92 have information on both formal and informal institutions.

3.1.2 Methodology

As is outlined in the literature, economic outcomes are likely the result of a multitude of factors, including formal institutions, compliance, enforcement and informal institutions. As such, the rest of this section uses the merged WVS and GRSSR data sets to attempt to estimate the following equation for a given country i.

$$mortality_i = f(Formal\ Institutions_i, Compliance_i, Enforcement_i, Informal\ Institutions_i)$$

Mortality in a given country i is hypothesised to be a function of its laws (formal institutions), abidance to the law, enforcement of the law, and its values (informal institutions). This section proceeds as follows: first, a description of the data is presented, to assist in orienting the reader. Descriptive statistics are shown for all available data and are not limited to the overlapping sample between the GRSSR data and the WVS data. Compliance is not well represented in the data, as it is measured for very few countries, so at this stage, the effect of compliance is not. Thereafter, MCA and PCA are performed for dimensionality reduction, as there are several variables that may be used in estimating the above equation, but few observations. In order to find statistically significant results, dimensionality reduction is necessary. Thereafter, the MCA and PCA results are compared to fatalities. First, bivariate relationships are shown, using scatterplots, as well as Ordinary Least Squares lines of best fit and Locally Weighted Scatterplot Smoothing (LOWESS) lines of best fit.

Thereafter, OLS is performed to investigate linear multivariate relationships. Lastly, k-means cluster analysis is used to investigate non-linear multivariate relationships.

3.1.3 Descriptive Statistics

3.1.3.1 Fatalities

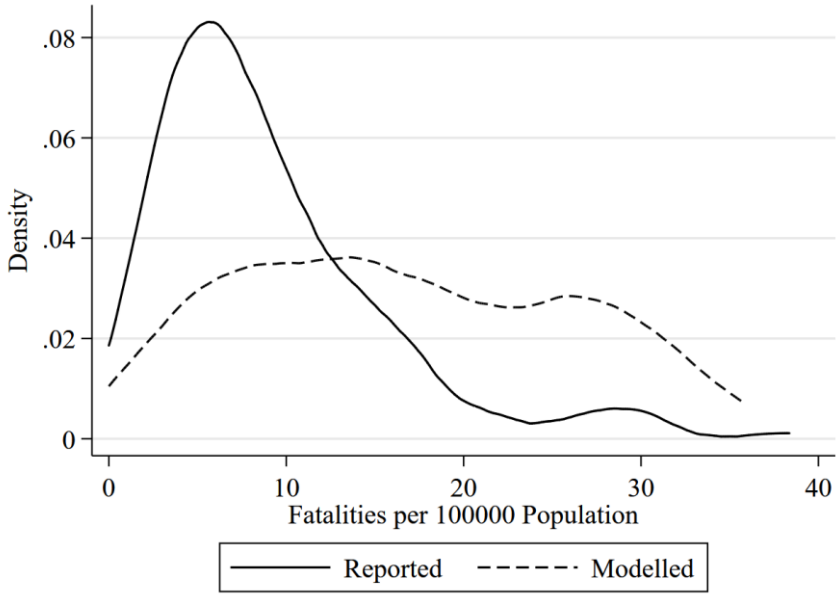
First, let fatalities be considered. Two fatalities measures exist. The first measure is reported mortality. These are the mortality figures directly provided to the WHO by each country's Ministry of Health. A fatality is classified as a road fatality when it occurs as a result of a road crash (regardless of when it occurs). This is in line with the International Classification of Diseases as published by the WHO. Other data sources may choose to employ a 'cut off' method, where fatalities that occur more than 30 days after the initial crash are not considered road traffic crashes. The preferred method of the WHO is in line with the International Classification of Diseases. Where a country's reporting method is not in line with this, the WHO generates estimates of 'true' mortality. In addition, in countries where reporting is not accurate, the WHO estimates fatalities.

The estimation strategy employed by the WHO (2018) varies by type of data provided. Depending on the type of data provided to the WHO, the estimation strategy differs. Some countries only have minor adjustments applied to ensure that the data is complete. For example, if the data is estimated to be 90% complete, the figures are simply multiplied by 10/9 to get complete information. However, for countries where data is not estimated to be complete or accurate, fatalities are estimated based on the work of Law (2009), Greenwood and Yule (1920) and Karlaftis and Tarko (1998). The WHO (2018) employs a negative binomial regression, with covariates such as GDP, total vehicles on the roads, road density, speed limits, access to the health system, alcohol consumption, working age population, corruption, national policies for walking and cycling, percentages of motorbikes and population. Most of the variables used in this estimation are correlates of economic development. This in line with the economic literature detailed in section 2.1.1 which attempted to establish economic relationships between fatalities and economic development. The full estimation strategy is detailed in Appendix A.

Both reported fatalities and modelled fatalities are used alongside each other in this thesis. Reported fatalities may be an inaccurate measure of true underlying fatalities, due to underreporting and inconsistent classification. However, modelled fatalities employs covariates of development, and as some of the variables that are investigated in the course of this thesis are also co-variates of development, results for reported fatalities and modelled fatalities are considered alongside each other throughout. The reported fatality measure used in this thesis is reported deaths per 100000 population,

for ease of interpretation. Similarly, the modelled fatalities measure used is modelled fatalities per 100000 population.

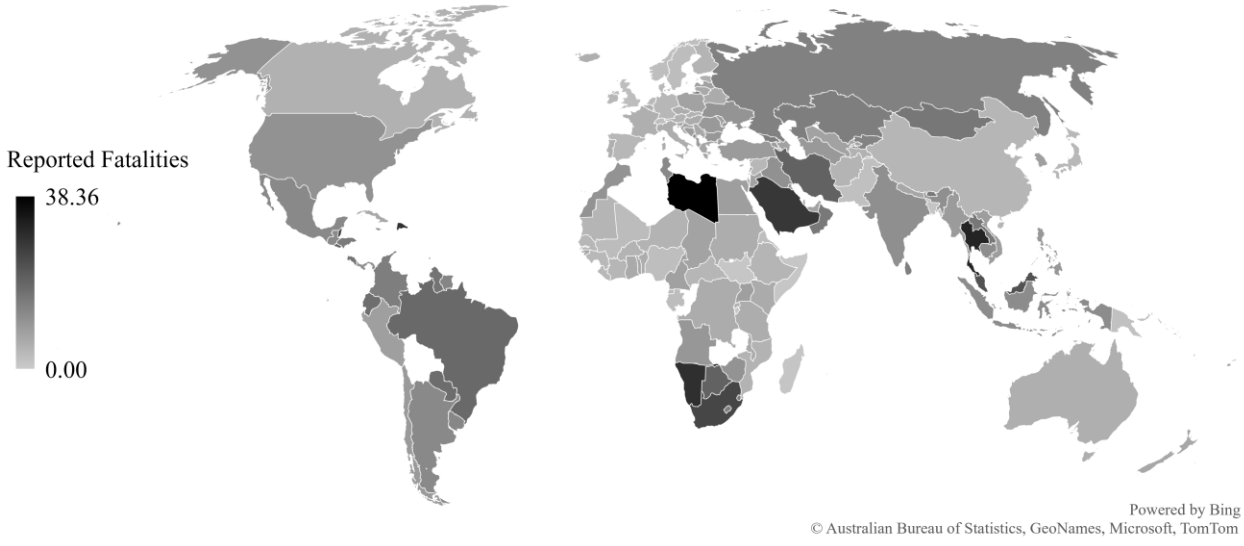
Figure 2 Reported and Estimated Road Fatalities



Source: Own Calculations from WHO (2018)

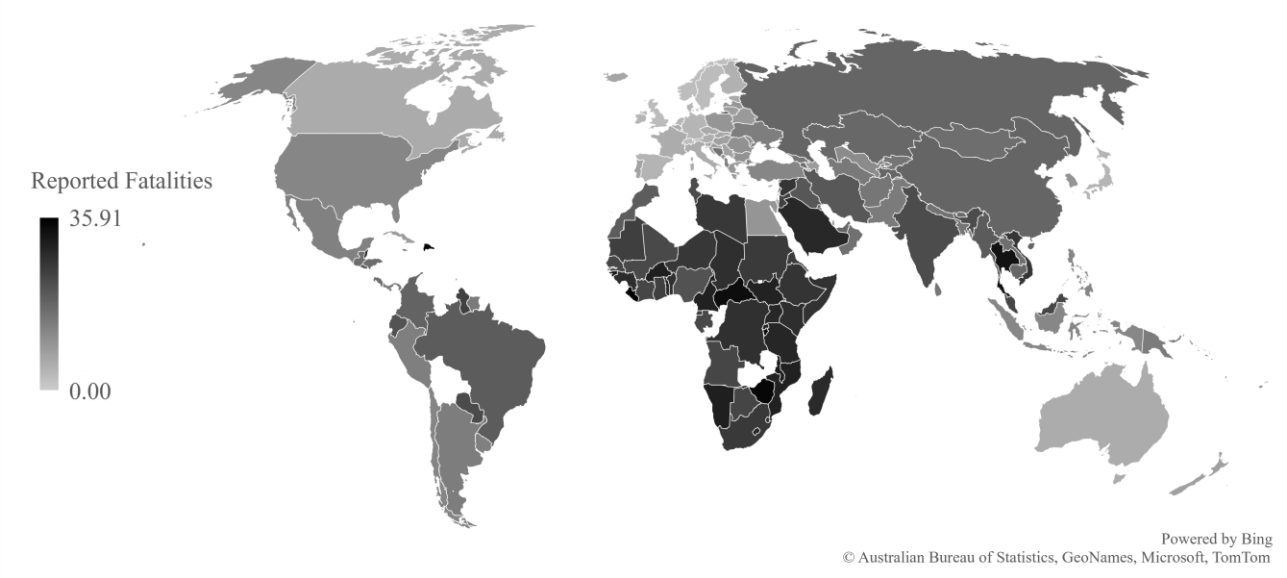
Figure 2 shows kernel density estimates for modelled fatalities and estimated fatalities. Reported fatalities shows a distribution with low average fatalities, and few countries with high fatalities. The WHO, however, estimates significant under-reporting, as shown by the dashed line. True fatalities may be closer to an approximately uniform distribution, with few countries displaying low fatalities, and most countries displaying fatalities of around 10 to 30 deaths per 100000 population.

Figure 3 Reported Fatalities per 100000 Population Across the World



Source: Own Calculations from WHO (2018)

Figure 4 Estimated Fatalities per 100000 Population Across the World



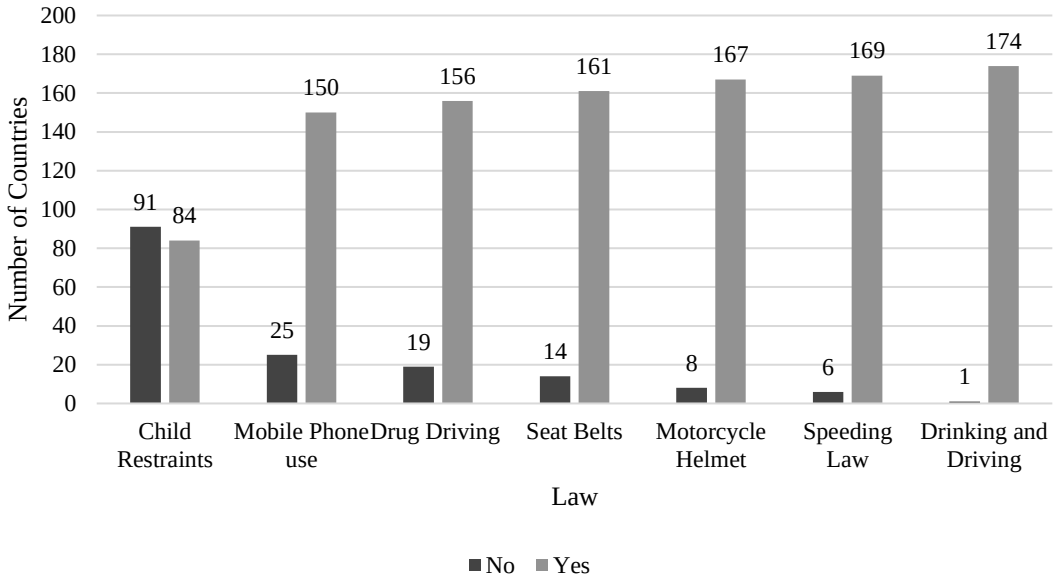
Source: Own Calculations from WHO (2018)

Figures 3 and 4 show how these measures differ across the world. Consider reported fatalities first. Darker regions correspond to higher fatalities, and lighter regions correspond to lower fatalities. Countries with no data are shown in white. Fatalities are reported to be higher in countries such as Namibia, South Africa, Libya, Saudi Arabia, Thailand and Malaysia. Notably, northern Europe, China and Canada have lower fatalities. Figure 4, however, seems to suggest that most of Africa and Asia suffer from underreporting, and have higher fatalities than reported.

3.1.3.2 The Law

The GRSSR data describes seven classes of laws: speeding, drink driving, motorcycle helmets, seatbelts, child restraints, drug driving and mobile phone use. The WHO collects data on whether such a law exists, as well as the functional forms of the laws, as per Table 1. The additional data on functional forms is difficult to use in data analysis, as there is a lot of variation in the data, and parts of the data is described as ranges rather than as values and has several missing values. For example, the urban speed limit variable has 11 missing values, 3 ranges and 51 unique values. Due to the issue of missing values, and difficulty in using the functional forms, the rest of this thesis simply considers the presence of a law in a given country.

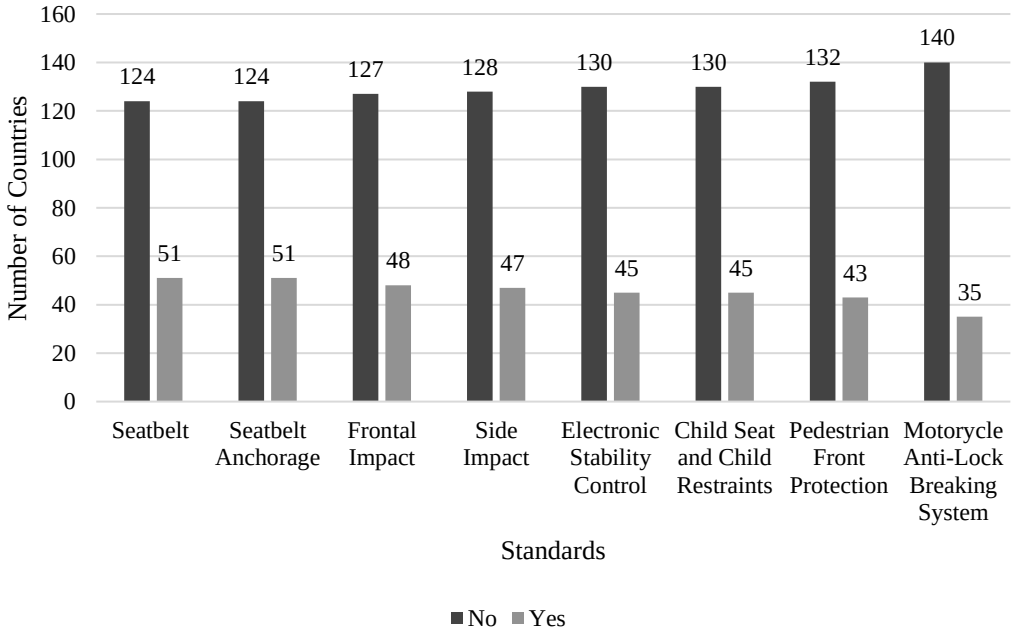
Figure 5 Best Practise Laws Across the World



Source: Own Calculations from WHO (2018)

Figure 5 shows how many countries have laws in each of the recommended areas. Generally, most countries have speeding and drink-driving laws. Helmet laws and seatbelt laws are also fairly common. Similarly, drug driving and mobile phone use laws are also not uncommon. Child restraints laws however, which refer to the use of child seats, not as common as the other classes of laws. For the most part countries have most of the categories of laws prescribed by the WHO.

Figure 6 Best Practise Standards Across the World



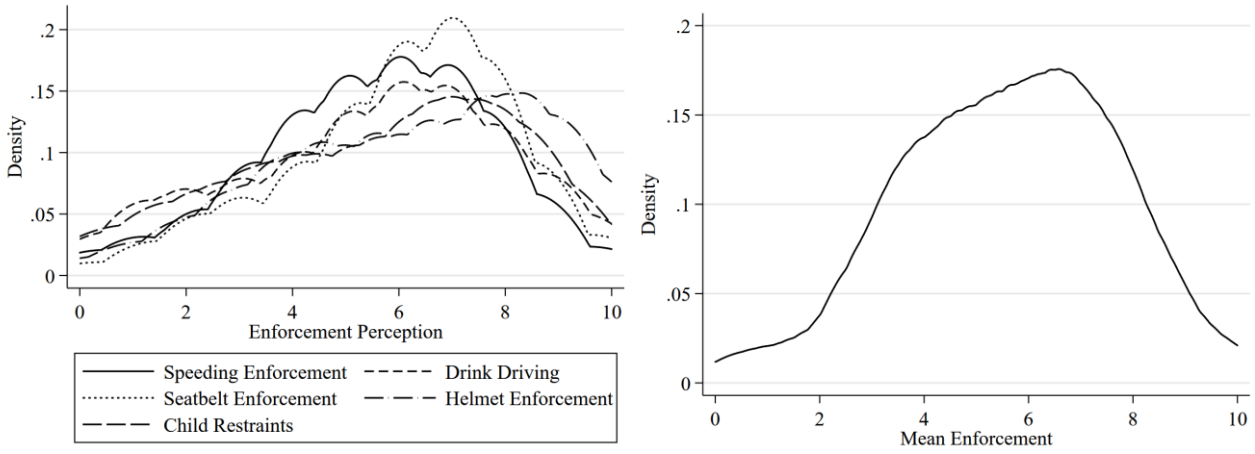
Source: Own Calculations from WHO (2018)

Figure 6 considers the use of the safer roads standards discussed in Table 2. Generally, most countries do not have the best practise standards prescribed by the WHO. Notably, standards corresponding to seatbelts are the most common, followed by vehicle impact standards. Motorcycle ABS standards are the least common.

3.1.3.3 Enforcement

The enforcement measure used in this thesis is based on perceptions of enforcement gathered by the WHO from the relevant Ministries of Health. Each country's report to the WHO was compiled by a panel of professionals and experts in road safety in the given territory (WHO, 2018, p.283). The respondents were asked to rate the enforcement of elements of the different parts of the road safety legislation in the country on a scale of 0 to 10, where 0 is described as 'not effective' and 10 is described as 'highly effective'. The (rounded off) median of these scores is documented by the WHO (2018). Some experts noted that assessing enforcement at a national level is not ideal as enforcement differs between regions in the country. Some countries did not supply enforcement scores, and for some countries, only a few of the laws were considered. For example, whilst the USA is well represented in both the WHO dataset and the WVS dataset for all other variables, no enforcement estimates are presented for the country as a whole. Only 73 countries provided statistics for perceived enforcement in all five laws surveyed, however, 170 countries have at least one measure of perceived enforcement that can be considered.

Figure 7 Perception of Enforcement: Kernel Density Estimates

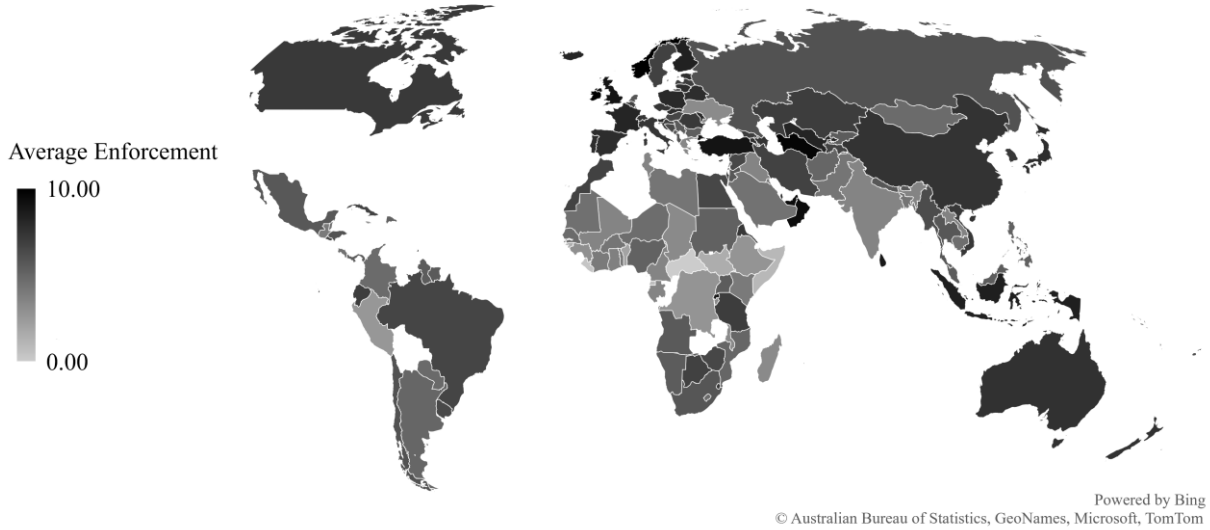


Source: Own Calculations from WHO (2018)

Figure 7 shows kernel densities of the various enforcement perception measures, to give a picture of what enforcement is like in general. Generally, enforcement is skewed to the right, with a mean of around seven. Speeding enforcement seems to have the lowest mean, whereas helmet enforcement has the highest mean. The distributions are still, however, fairly broad, with some countries displaying very low perceived enforcement, and some displaying higher perceived enforcement. The mean

enforcement graph on the right shows the mean of enforcement in a given country, generated as an average taken over only available enforcement perception data. Whilst the perceived enforcement measure is subjective, it is the best available proxy for actual enforcement.

Figure 8 Perception of Enforcement: Average Enforcement Around the World



Source: Own Calculations from WHO (2018)

Figure 8 displays the mean enforcement measure in each country across the world, with darker areas corresponding to better enforcement. Enforcement appears to be slightly higher in China, Australia and Canada, as well as Zimbabwe, Botswana, Brazil and Tanzania, as well as in some parts of Europe and Asia, such as France, Spain, Portugal, Japan, Indonesia, Uzbekistan and Turkey. However, it is lower in other parts of Europe, Asia and Africa. No clear trend is visible at this stage, further analysis will be taken to uncover other features common to the above countries.

3.1.3.4 Compliance

Compliance is not well documented in the data set. Only three classes of compliance measures exist: helmet wearing, seatbelt wearing and the use of child restraints. For the helmets measure, 123 (of 175) values are missing, with some values referring to general helmet wearing rates, and others referring to different rates for drivers and passengers. The child restraints abidance measure only has 35 observations. The seatbelt wearing rate is documented by type of passenger, with the seatbelt wearing rate for drivers as the best documented abidance measure. The driver's seatbelt wearing rate has 76 observations, with 53 of these countries appearing in the WVS data set as well. Figure 9 below documents seatbelt wearing rates for drivers across the world. It shows that the rate is high in most of the countries documented. The northern hemisphere has higher seatbelt wearing rates. In contrast, the southern hemisphere is less well documented, and has lower seatbelt wearing rates.

Figure 9 Seat Belt Wearing Rate (Drivers)

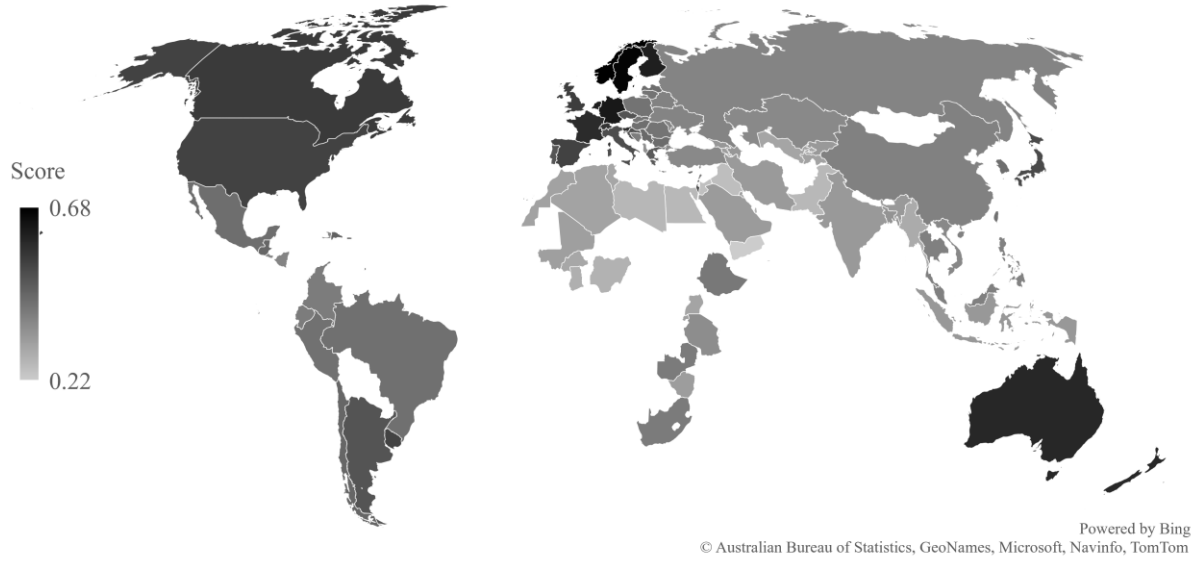
Source: Own Calculations from WHO (2018)

Whilst compliance is an important part of the relationship between formal institutions and economic outcomes, no clear compliance measure exists in this data set, so the effect of compliance cannot be considered further.

3.1.3.5 Values

In order to obtain a broader sense of values across the world, the two core values investigated by the world values survey are considered here.

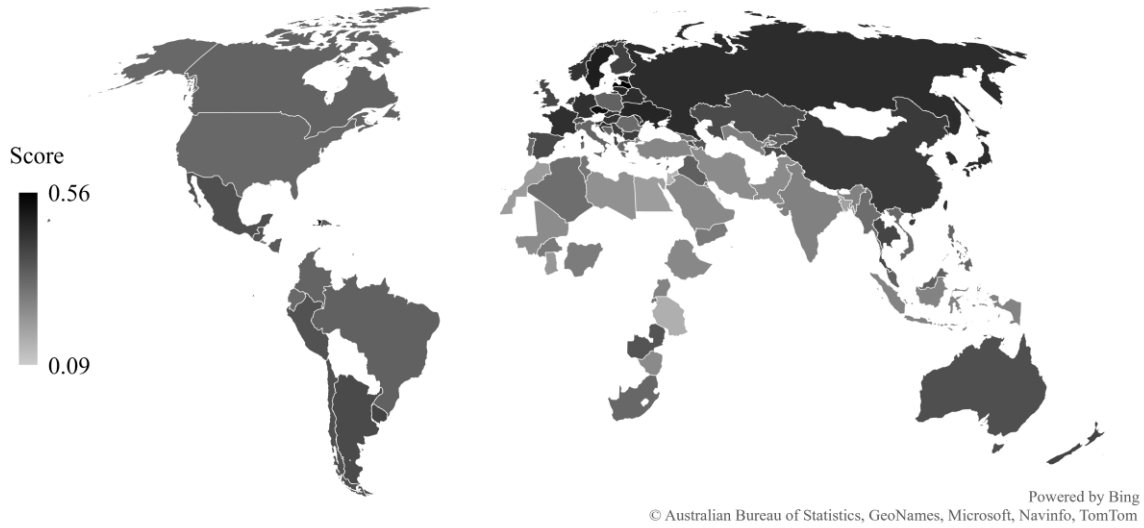
Figure 10 Emancipative Values Across the World



Source: Own Calculations from Inglehart et al. (2021)

Figure 10 describes the emancipative index across the world. The emancipative index describes the split between countries with predominantly ‘survival’ values and ‘self-expression’ values and is on a scale of 0 to 1. The survival values, which correspond to low levels of trust and tolerance, as well as a high emphasis on economic and physical security, have a low score on the emancipative index. In contrast, the self-expression values, which are associated with environmental protection, acceptance of sexuality and foreigners, as well as individual participation in economics and politics, have a high score on the emancipative index. The darker areas on the graph are regions that have higher emancipative scores, and vice versa for the lighter areas. The highest emancipative score is 0.68 (Norway). Other countries with high emancipative scores are countries in Northern Europe and America, as well as Australia. In contrast, countries such as Yemen, Nigeria, Pakistan, Libya and parts of Africa and the Middle East have lower emancipative scores. Eastern Europe, parts of Asia, and South America fall in the middle ground with scores of around 0.4 on the emancipative scale.

Figure 11 Secular Values Across the World



Source: Own Calculations from Inglehart et al. (2021)

In contrast, Figure 11 shows the secular index across the world. The secular index describes the split between countries with predominantly ‘traditional’ values and ‘secular-rational’ values. The traditional values, which place emphasis on the nuclear family as well as religion and authority have a low secular score, whereas the secular rational values are in opposition to this. As with the emancipative index, the darker areas in the graph are regions which have a higher secular score. In general, the world is more traditional than secular, with the highest countrywide secular score being exhibited by Latvia (0.56). Other countries with high secular scores are territories such as Russia, Norway, Sweden, Japan and parts of the Europe and Asia. In contrast, parts of Africa, South Asia,

the Middle East, and territories in Europe (such as Italy, Poland, and Romania) have lower emancipative scores.

3.2 Results

3.2.1 Multiple Correspondence Analysis and Principal Component Analysis

The combined datasets provide a very broad collection of descriptive information about each territory concerned. However, the small sample size necessitates the use of few variables in any further analysis to ensure predictive power (see for example, Qiu et al. (2014) or Greenacre and Blasius, 2006). This is commonly referred to as 'dimensionality reduction'. This thesis employs two methods of dimensionality reduction: Principal Component Analysis (PCA), Multiple Correspondence Analysis (MCA). Section 3.2.2 uses PCA and MCA to assist in reducing dimensionality in laws, standards, and enforcement, so as to better understand the correlates of fatality.

3.2.1.1 Laws and Standards

In order to retain statistical power so as to perform inference, high degrees of freedom are necessary. Higher degrees of freedom gives more power to reject false null hypotheses and find statistical results. As the core question in this thesis is 'to what degree do formal and informal institutions matter for improving road safety outcomes', it may not be necessary to investigate the precise effect of each law, standard or value, but rather the effect of legislation, regulation and norms in more general terms. Furthermore, due to the small sample size (i.e., only 93 matches for both data sets), it is necessary to be parsimonious.

Let laws be considered first. If regression analysis were to be performed without any dimensionality reduction and all seven laws were included in the regression, seven degrees of freedom would be lost, effectively reducing the predictive power of the analysis. Furthermore, if this were repeated with all the relevant variables, seven standards, seven enforcement variables, and up to all 24 values variables, around 50 degrees of freedom would be lost, effectively reducing the ability to draw inference from any statistical tests. As such, some form of dimensionality reduction is necessary.

A data set may be represented as a matrix. Take for example the data set in this thesis, which has 197 rows (observations) and 171 columns (variables). Several of the variables are correlated and adding additional variables to any analysis may not add a significant amount of predictive power or explanatory information. NIE predicts that a strong legislative framework may be associated with positive economic outcomes. Thus, the *number* of laws may be irrelevant, as may the specific functional forms of those laws, however, the presence of a strong legislative framework is important. The number of best practice laws may indicate a stronger legislative framework, but it is useful to have one variable that describes the strength of the legislative framework, rather than seven variables

that reduce power and don't add much value in isolation. To illustrate, consider the below correlation matrix:

Table 5 Correlation Matrix of Road Safety Laws

	Speeding Law	Drinking and Driving Law	Drug Driving Law	Helmet Wearing Law	Seat Belt Law	Child Seat Law	Mobile Phone Law
Speeding Law	1						
Drinking and Driving Law	-0.01	1.00					
Drug Driving Law	0.14	0.22	1.00				
Helmet Wearing Law	0.11	-0.02	-0.08	1.00			
Seat Belt Law	0.06	-0.02	0.03	0.54	1.00		
Child Seat Law	0.06	0.07	0.26	0.16	0.28	1.00	
Mobile Phone Law	0.10	-0.03	0.02	0.46	0.60	0.36	1.00

Source: Own Calculations from WHO (2018)

Take, for example, the correlation between seat belt laws and helmet wearing: 0.54. As the two variables are correlated, including one of the variables in analysis at least, in part, includes some of the information contained in the other variable, i.e., if one attempts to explain fatalities using seat belt laws as a correlate, given that seat belt laws and helmet wearing laws are correlated, some of the effect of helmet laws on fatalities is also represented.

PCA and MCA are dimensionality reduction techniques used on continuous and discrete data respectively to counteract precisely this phenomenon. Bro and Smilde (2014) provide a succinct and simple way of understanding PCA. If one were to take two correlated variables, and average them, thus creating a new variable to replace the previous two, no information would be lost. An average is a type of linear combination. It is a linear combination with equal weighting on the included variables. Linear combinations can also include different weightings. For example, if one were investigating the effect of laws on fatalities, and seat belt laws were considered slightly more important than helmet laws, one could weight seat belt laws higher when creating the new variable, for example, $0.7(seatbelt\ law) + 0.3(helmet\ law) = (new\ law)$ rather than the traditional $0.5(seat\ belt\ law) + 0.5(helmet\ law) = (new\ law)$ version that would be used in an arithmetic average. It is thus possible to use weights to condense the information in multiple variables into one 'representative' variable. PCA is a technique that computes the best weights, or the optimal linear

combination of the original variables, that explains as much as possible of the variation in the original variables (p.2815).

To be more precise, if PCA is performed on a set of variables[11], first, a covariance matrix (which describes the covariance of each variable with each other variable considered) is computed. Thereafter, the eigenvectors and corresponding eigenvalues of this covariance matrix are found using eigenvalue decomposition. This process produces orthogonal eigenvectors, that is, each eigenvector is perpendicular to the preceding eigenvectors. These are termed the principal components. Each eigenvector computed represents the direction of the axes with the most variance, and each eigenvalue describes the amount of variance in each principal component. Each principal component describes a different linear combination (or weighted average) of the original variables. Each additional principal component computed is uncorrelated with the preceding principal components. This results in the maximum possible information, or variance, being contained in the first component, and each component adds additional variance. By ranking each eigenvalue from largest to smallest, the eigenvectors, and thus principal components, describing the highest amount of variance are obtained. If all of the dimensions are used, 100% of the original variance would be explained. However, if dimensionality reduction is an aim, fewer variables may be used to represent the underlying data, without losing too much of the underlying variation in the data. In this way one could use the fewer variables (for example the first and second components) to capture a significant amount of the variability in the original variables with just one PCA component. When the data are amenable to successful reduction (i.e., there is enough similarity in all variables so that a single component is able to capture a large amount of the underlying patterns) this can improve the predictive power of a statistical model (Bro and Smilde, 2014: Jaadi, 2021).

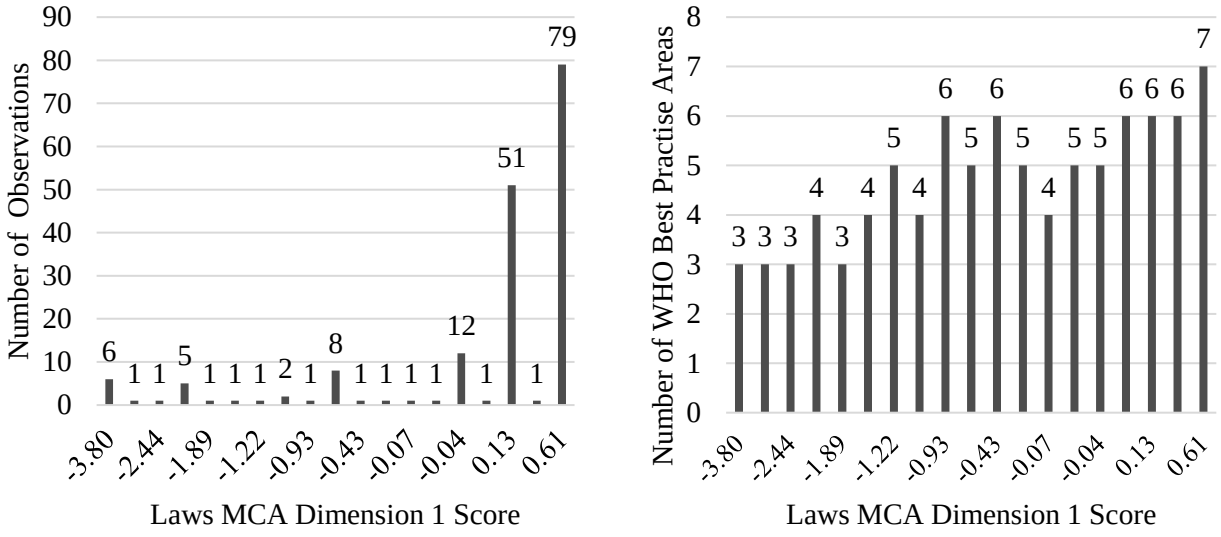
Multiple Correspondence Analysis is closely related to principal component analysis, with only a few differences needed to apply the data reduction methodology to discrete or categorical data (where PCA is built for continuous data) (Greenacre and Blasius, 2006). MCA is used when the variables are discrete or categorical in nature, i.e., a higher number does not necessarily correspond to a higher ‘value’ but merely a different category of the given variable. The type of data used in PCA is more quantitative in nature, whereas the type of data used in MCA is more qualitative. Greenacre and Blasius (2006) frame correspondence analysis (where correspondence analysis is a bivariate form of multiple correspondence analysis) as a type of Principle Component Analysis that specifically focuses on categorical data. Where PCA relies on true statistical definitions of variance and co-variance, MCA is geometric in nature. As in PCA, the columns of a matrix are taken as points in Euclidian

[11] If the variables do not have the same scale, the first step in PCA is to standardise them, so that the variances and co-variances are driven by true variance, not simply differences in scale.

space, and the method refines these dimensions so that the extracted principal dimensions capture as much of the variance in the original variables as possible, but in lower-dimensional descriptions. As with PCA, MCA utilises eigenvalue-eigenvector decomposition to obtain principal components. The terminology, however, differs slightly. In MCA, the eigenvalues are referred to as principal inertias, the percentage of explained variance as 'percentage of inertia, and principal components are referred to as dimensions.

If MCA[12] is performed on all the laws contained in the data set the following is obtained:

Figure 12 Number of Observations and Best Practise Areas by Laws MCA Dimension 1 Score[13]

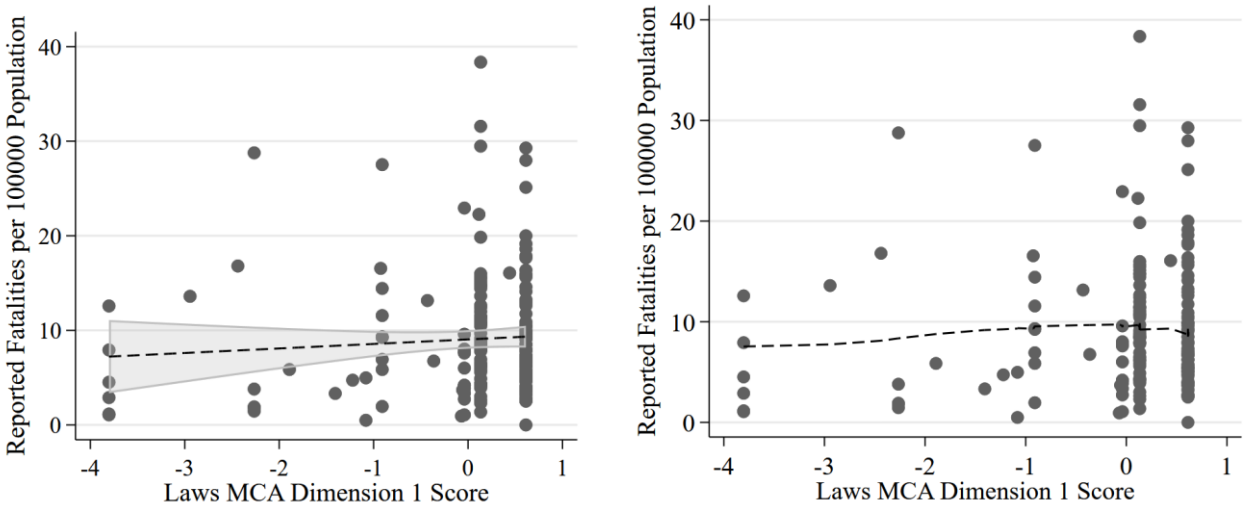


Source: Own Calculations from WHO (2018)

The first dimension explains 74.1% of the underlying variation in the data. The second component explains an additional 5.8% of the variation. Figure 12 shows that the first dimension can be interpreted as a measure of how many of the WHO's prescribed areas of legislation a country exhibits. A high value means that the country has addressed most of the prescribed areas, whereas a low value means that the country has few of the relevant laws. Thus, the higher a country's Laws Dimension 1 score, the better the country's legislative framework, as per the criteria of the WHO. Conversely, a lower Dimension 1 score corresponds to worse laws as per the WHO criteria. Dimension 2 has no obvious strong interpretation and explains only 5.8% of the underlying variation in the data, so only Dimension 1 is used going forward.

[12] The Laws MCA loading plot is shown in Appendix B.
[13]The MCA results here and in the rest of this section are standardised and have a mean of one and a standard deviation of zero.

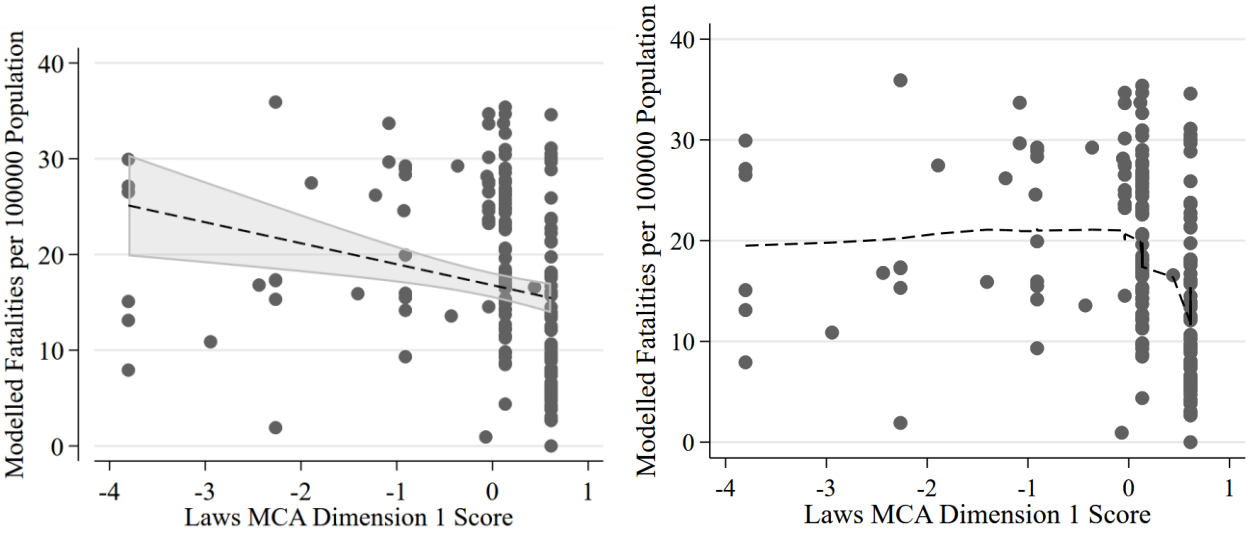
Figure 13 Reported Fatalities by Law MCA Dimension 1 Score



Source: Own Calculations from WHO (2018)

Figure 13 presents scatterplots describing the relationship between reported road fatalities and the Laws Dimension 1 score. The graph on the left has an OLS line of best fit superimposed on the scatter plot, whereas the graph on the right has a locally weighted scatterplot smoothing (LOWESS) line imposed. Both seem to suggest a weakly positive relationship between laws and fatalities, however, the confidence intervals on the linear regression graph diverge, so it is likely that this relationship is insignificant. There is, however, very little data on the left, so very little inference can be made at this stage.

Figure 14 Modelled Fatalities by Law Dimension 1 Score



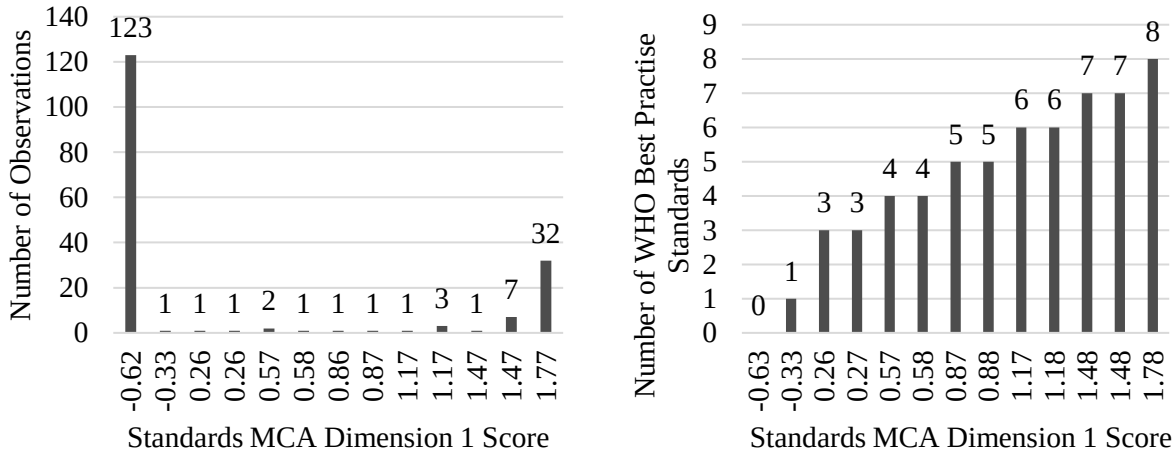
Source: Own Calculations from WHO (2018)

When the modelled fatalities measure is used, as is shown in Figure 14, there seems to be some suggestion that better laws are linked to better outcomes, especially when comparing countries with

a Dimension 1 score of 0 to countries with a Dimension 1 score of 1. However, as was observed in Figure 13, the lack of observations on the left side of each scatter plot makes it difficult to draw inference at this stage.

When MCA is performed on all the standards contained in the data set, it is obtained that Dimension 1 explains 99.83% of the variance in the underlying data.

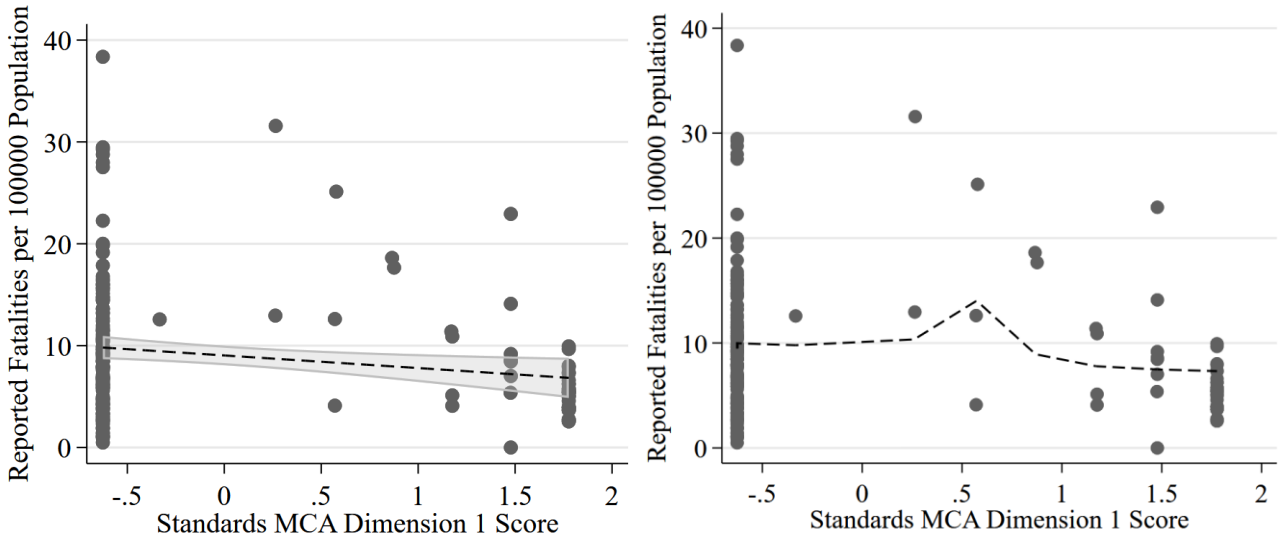
Figure 15 Number of Observations and Best Practise Standards by Standards MCA Dimension 1 Score



Source: Own Calculations from WHO (2018)

Figure 15 shows the number of observations for each Standards Dimension 1 score, as well as the number of best practise standards each MCA score represents. As with the Laws MCA results, a higher Standards Dimension 1 score corresponds to countries having better standards, as per the criteria of the WHO. In contrast, however, few countries have good standards, with the vast majority of countries having none of the best practise standards.

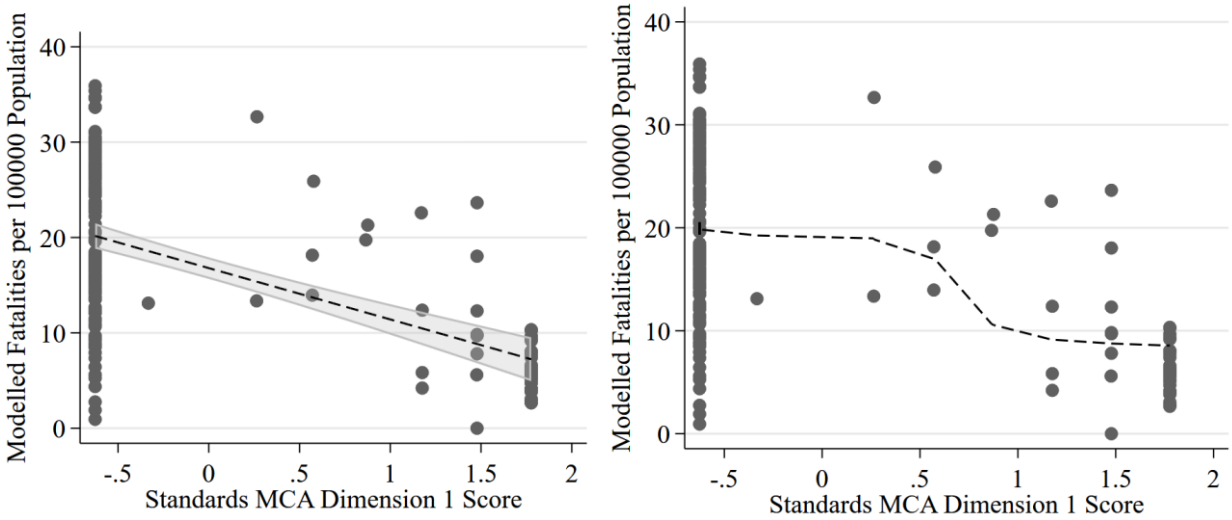
Figure 16 Reported Fatalities by Standards MCA



Source: Own Calculations from WHO (2018)

Figure 16 shows two scatterplots displaying relationships between the standards MCA results and reported fatalities. The scatter plot on the left has a linear best fit line, and the scatter plot on the right has a LOWESS best fit line. Here, there are few observations in the middle of the graph, so no inference can really be drawn in this region. The trend appears to be that higher fatalities are associated with worse standards, and lower fatalities are associated with better standards. However, the variation in fatalities on the left shows that some countries without the best practise standards still have good outcomes. However, the variation in fatalities on the right shows that in general, countries with better standards have better outcomes.

Figure 17 Modelled Fatalities by Standards MCA



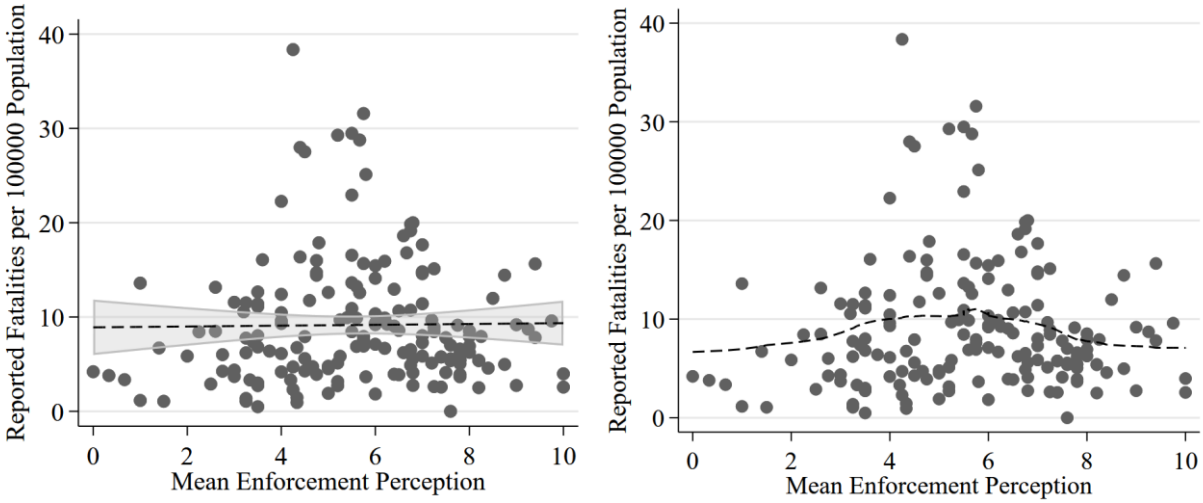
Source: Own Calculations from WHO (2018)

Figure 17 shows the results when modelled fatalities are used instead of reported fatalities. The scatterplots where modelled fatalities are used strengthen the result shown in Figure 16: low fatalities are associated with good standards.

3.2.1.2 Enforcement

When PCA[14] is performed on the 5 enforcement measures (speeding enforcement perception, drinking and driving enforcement perception, helmet enforcement perception and child set enforcement perception), it is obtained that Enforcement Component 1 explains 71.79% of the variation in the underlying data. Component 2 explains an additional 11.11% of the variation. However, as PCA requires that every observation has a value for every variable used in PCA, only 76 countries end up being used in the analysis, due to the number of countries that either chose to not report enforcement, or only reported enforcement for some of the laws investigated, as detailed in section 3.1.3.3. In addition, only 46 of these countries also feature in the WVS data set. As a result, mean enforcement, as calculated in section 3.1.3.3 is the preferred measure of enforcement used.

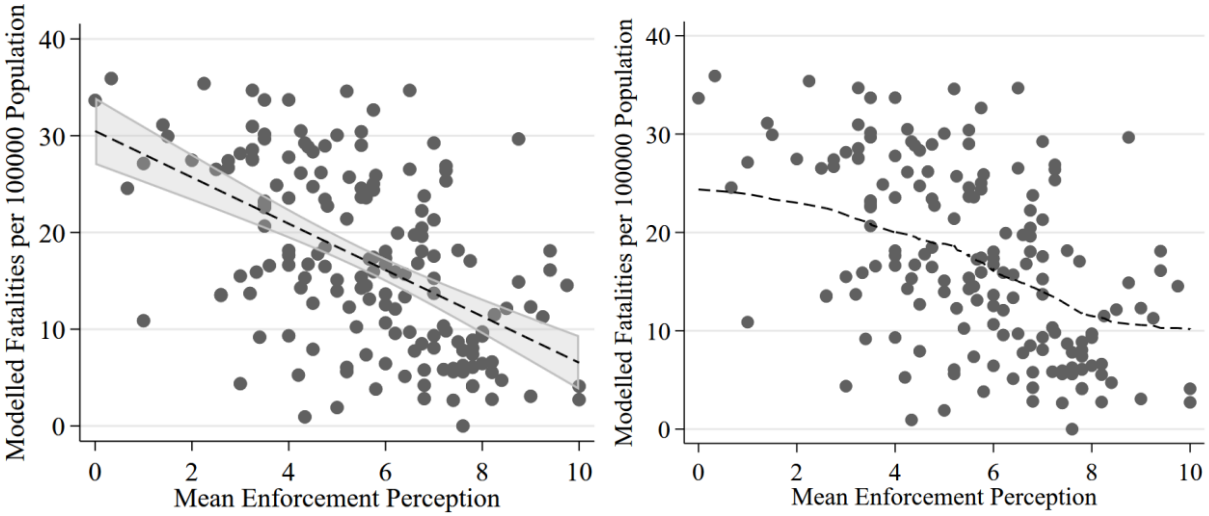
Figure 18 Reported Fatalities by Mean Enforcement



Source: Own Calculations from WHO (2018)

[14] The Enforcement PCA loading plot and fatalities scatterplots are shown in Appendix B.

Figure 19 Modelled Fatalities by Mean Enforcement



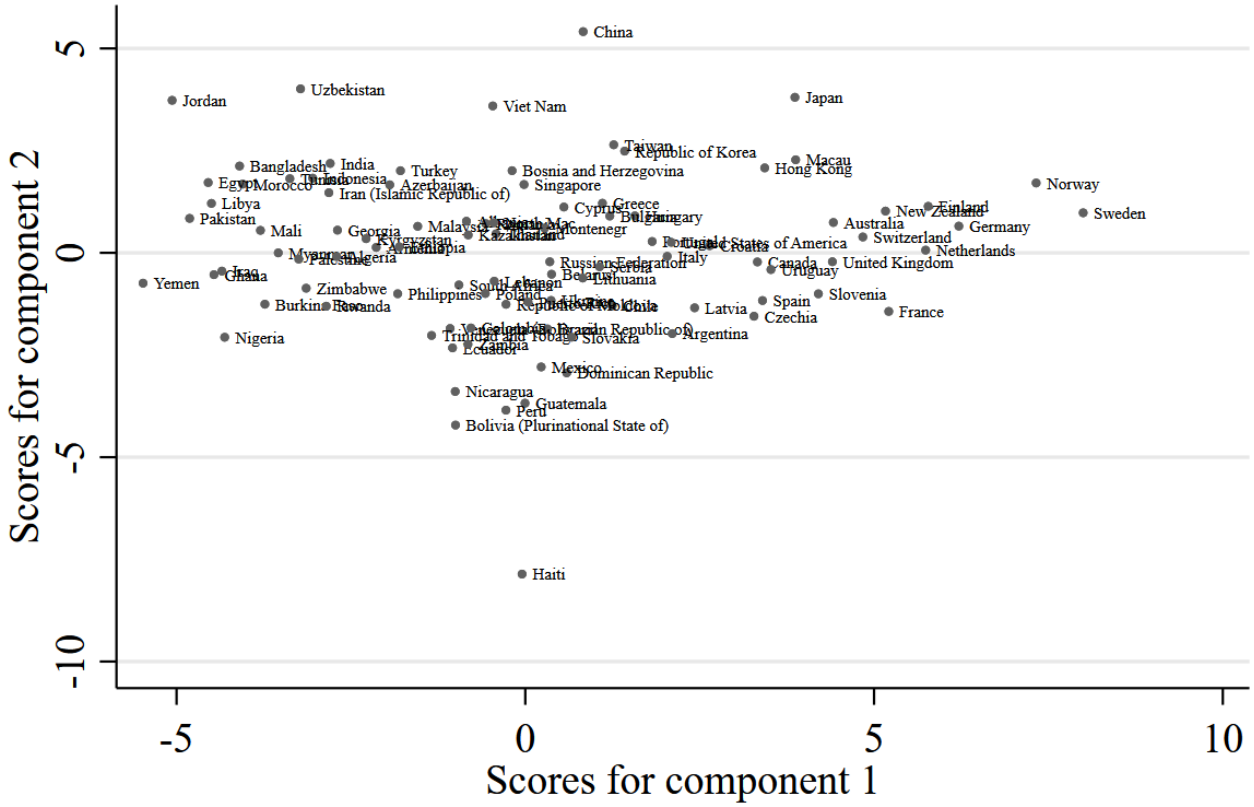
Source: Own Calculations from WHO (2018)

Figures 18 and 19 show the relationship between enforcement and fatalities using OLS and LOWESS lines of best fit. The line of best fit on the reported fatalities graph seems to suggest no relationship between fatalities and enforcement. If the LOWESS line of best fit is considered, there seems to be some suggestion of a Kuznets-type relationship, with low enforcement and low fatalities being observed initially, with enforcement growing as fatalities grow, and thereafter, fatalities falling as enforcement improves. However, when modelled fatalities are considered, there seems to be a negative relationship between enforcement and fatalities, with some suggestion of diminishing marginal returns to enforcement being observed at higher levels of fatalities. It is plausible that the relationship observed in the reported fatalities graph is due to countries with low enforcement also having poor recording of fatalities, so the relationship observed in the modelled fatalities graph may be closer to the true relationship between enforcement and fatalities. However, if only the scatterplots is considered, the amount of noise in the graph makes it difficult to draw any meaningful inference at this stage.

3.2.1.3 Values

When PCA is performed on the 24 values used in the construction of the emancipative and secular indexes, the first principal component explains 38.38% of the variance in the underlying data, and the second principal component represents an additional 16.08% of the variance in the data. Combined, they explain 54.41% of the variation in the data.

Figure 20 Principal Component Analysis: Values Loading Plot



Source: Own Calculations from Inglehart et al. (2021)

Figure 20 shows the Component 1 and Component 2 scores for each country in the WVS data. The algorithm is run on all 93 countries in the data, however, due to missing data in some of the 24 values included, results for only 83 observations are obtained. The precise points on this graph are not extremely relevant, however, it shows the groupings of countries with similar values. The extreme ends of this graph are most worth analysing.

Separating the graph into five regions, that is, the far left, the far right, the top, the bottom, and the middle region, may be used to gain an understanding of what high and low Component 1 and Component 2 scores represent. To be more precise, the graph above is separated into 5 regions: Region 1, which isolates countries on the far left, with very low Component 1 scores and average Component 2 scores; Region 2, which isolates on the far right, with countries with high Component 1 scores and average Component 2 scores; Region 3, which isolates countries at the top of the graph, with low Component 2 scores and average Component 1 scores; and Region 4, which isolates countries at the bottom of the graph. with high component 2 scores and average component 1 scores, and Region 5, which contains the rest of the countries. Region 1 contains: Yemen, Ghana, Libya, Egypt, Iraq, Mali, Pakistan, Morocco, Bangladesh and Jordan. Region 2 contains: Sweden, Norway, Finland, Germany, New Zealand, the Netherlands, Switzerland and Australia. Region 3 contains:

Haiti, Bolivia, Peru, Guatemala, Nicaragua, the Dominican Republic and Mexico. Lastly, Region 4: Hong Kong, Macau, Japan, the Republic of Korea, Taiwan, Vietnam and China. Region 5 contains all other countries.

Table 6 displays the average score for each of the 24 values employed in the WVS data for each region. To illustrate, the value of 0.91 in the first row and column of the graph is the average nationalism score in Region 1. The data is standardised to a mean of zero and a standard deviation of one for ease of interpretation. For further ease of interpretation, the three values with the lowest and highest scores are highlighted in light grey and dark grey respectively. The difference columns show the difference in scores between the two regions, so as to ascertain what the differences are in values between countries with high scores and low scores in the components considered. Lastly, all values where the difference in scores between the regions is greater than 2 standard deviations are highlighted in the difference column.

Table 6 Average Values by Values PCA Component Scores

				Values Dimension 1			Values Dimension 2		
				Low Dimension 1	High Dimension 1		Low Dimension 2	High Dimension 2	
		Number	Value	Region 1	Region 3	Difference	Region 2	Region 4	Difference
Secular	Defiance	1	Nationalism	0.91	-0.80	1.71	0.57	-1.39	1.96
		2	Respect for authority	0.78	-0.94	1.72	0.73	-1.55	2.28
		3	Devoutness	1.20	-1.82	3.02	0.48	-0.86	1.34
	Disbelief	4	Practise of religion	0.93	-1.06	1.99	0.41	-2.21	2.62
		5	Religiousness of person	0.81	-1.22	2.03	0.56	-1.29	1.85
		6	Religion important	1.23	-1.37	2.60	0.33	-1.43	1.76
	Relativism	7	Conformative 1	0.94	0.41	0.53	-0.86	0.26	-1.12
		8	Conformative 2	0.86	-0.17	1.03	-0.16	0.46	-0.62
		9	Conformative 3	0.58	0.46	0.12	-0.62	-0.10	-0.52
	Scepticism	10	Trust in courts	0.44	0.57	-0.12	-1.77	1.04	-2.81
		11	Trust in police	0.24	0.88	-0.65	-1.77	0.72	-2.49
		12	Trust in army	0.61	-0.24	0.85	-1.68	0.37	-2.05
Emancipative	Autonomy	13	Independence valued in kid	-0.56	1.18	-1.74	-1.04	1.08	-2.12
		14	Obedience valued in kid	0.78	-0.88	1.65	0.99	-1.33	2.32
		15	Imagination valued in kid	-0.54	1.39	-1.93	-0.32	0.22	-0.54
	Gender Equality	16	Political	-1.43	1.60	-3.03	0.79	0.20	0.59
		17	Education	-1.49	1.57	-3.06	0.65	-0.12	0.77
		18	Jobs	-0.97	1.58	-2.55	-0.23	-0.21	-0.02
	Choice	19	Homosexuality Acceptable	-0.91	1.91	-2.82	0.13	0.31	-0.18
		20	Divorce Acceptable	-1.04	1.45	-2.49	-0.08	0.00	-0.08
		21	Abortion Acceptable	-0.97	1.62	-2.60	-0.51	0.12	-0.63
	Voice	22	Voice 1	-0.83	1.47	-2.30	0.87	-0.27	1.14
		23	Voice 2	-1.01	1.47	-2.47	0.72	-0.42	1.14
		24	Voice 3	-1.01	1.54	-2.55	0.81	-0.38	1.19

Source: Own Calculations from Inglehart et al. (2021)

Consider Region 1 first. Region 1, which is representative of countries with low Component 1 scores is characterised by high devoutness (that is, an emphasis on respect for elders), high importance of religion and high conformism. Region 1 is also low in political and educational gender equality, as well as acceptance of divorce. In contrast, Region 2 is characterised by high political gender equality, high acceptance of homosexuality, and high acceptability of abortion. It is also low in devoutness, religiousness of individuals and importance of religion. As highlighted in the third column, the values that separate these regions most strongly, with over three standard deviations of difference, are their emphasis on political and educational gender equality, as well as their emphasis on devoutness. Slightly less strong, with around two or more standard deviations between them, are their differences in views on abortion, homosexuality and divorce, as well as the importance of religion, and their emphasis on voice. Voice refers to the importance placed by respondents on individual economic and political participation. Lastly, with a difference of around one to two standard deviations, are their views on how to raise children. Regions 1 and 2 do not separate much on views on conformism, or trust in the justice system in general. Component 1 thus separates countries most on their views on gender equality and their emphasis on familial hierarchies. These regions also differ on their emphasis on free choice, participation in democracy and the importance of religion. At a greater level, these values overlap slightly with the emancipative index, which separates an emphasis on the traditional nuclear family, which values economic survival over freedom, with the more emancipative values of free choice, political and economic participation and gender equality. Where this differs from the WVS data is on how children are raised and the importance of religion. Component 1 here, separates regions based on their emphasis between choice, voice, gender equality and religion, rather than the emancipative index, which separates the choice, voice, gender equality autonomy values. Here, countries that are high in Component 1 are characterised by high emphasis on choice, voice and gender equality, and vice versa for low Component 1.

The values with the highest scores in Region 3 are Voice 1 and Voice 3, as well as the emphasis placed on obedience in children. Region 3 is also lower in trust in the courts, the police, and the army. In contrast, Region 4 is much higher in trust in the courts and the police, and places emphasis on independence in children. Region 4 is low in religiousness, as well as respect for authority. Component 2 separates out less than Component 1, with at most 2 standard deviations of difference in the values emphasised by the two regions. The biggest differences are seen in the trust in courts and police variables, as well as the importance of religious practise value. In these regions, the emphasis on respect for authority also differs. It should be noted that the respect for authority variable is derived from a survey question that asks respondents whether they believe more respect for authority in the future is a good thing, which may be relative to average respect for authority

prevailing in the country. In addition, the emphasis on practise of religion, as well as trust in the army, and the importance of obedience and independence in children. Component 2 seems to mostly separate on respect for authority, and trust in the justice system, however, the regions differ in their approaches to raising children. Component 2 thus separates less symmetrically than component one, with low component 2 being associated with much lower-than-average trust in the justice system, but high component 2 being characterised by only slightly higher than average trust in the justice system. Similarly, the difference in religiousness is driven by region four (i.e., high Component 2) being much more secular than average, whereas Region 2 is only slightly more religious than average. Thus, it may be worthwhile to rather interpret low Component 2 as being low in trust in the justice system, and high Component 2 as being low in respect for authority, and low religiousness. The values that are symmetric in separation are the values regarding raising children, with Region 4 emphasising independence more than average, and Region 3 emphasising it less than average.

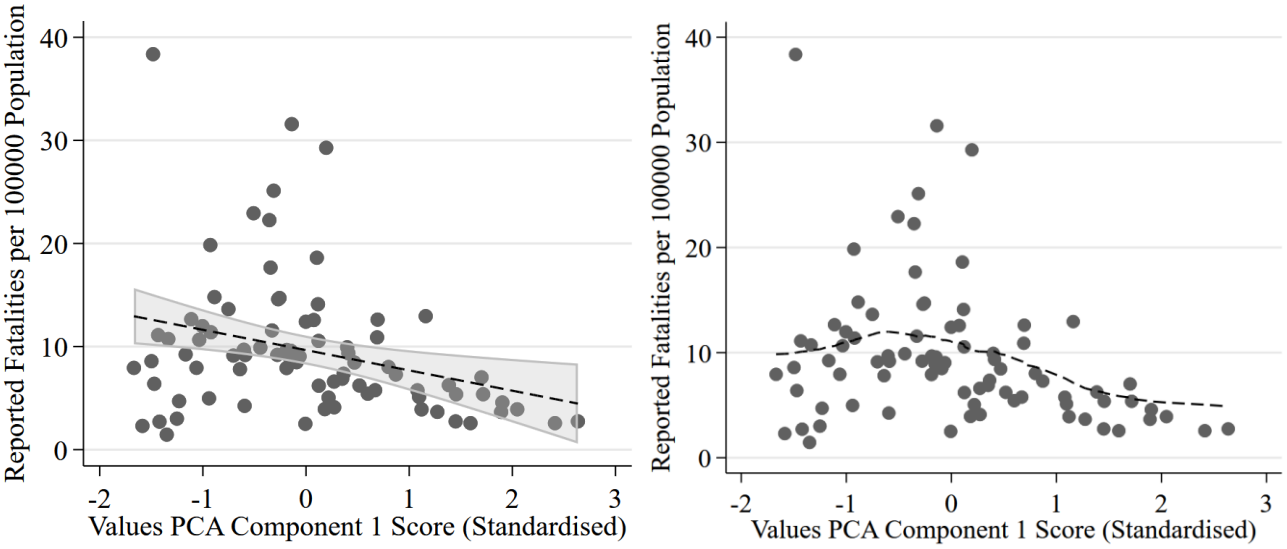
To summarise, Component 1 principally describes differences in emphasis on economic and political freedom, with low Component 1 scores being characteristic of regions in which a traditional, religious, nuclear family is emphasised, for the purposes of economic stability. In these regions, economic and political participation is not emphasised. Instead, respecting your elders, religion and conformism are valued. In contrast, countries with high Component 1 scores emphasise social, economic and political freedom.

It seems that what drives these separations is an emphasis on democracy and freedom; that is every individual not only has freedom of choice, but a responsibility to participate in economics and politics (as is shown by the emphasis placed on the gender equality and voice variables). As an additional layer, regions with high Component 1 scores are socially liberal, as shown by their emphasis on acceptance of abortion, homosexuality and divorce.

Not much can be said about whether Component 1 separates political liberalism from political conservatism, as the emphasis is merely on democratic participation rather than specific political policies supported. Similarly, Component 2 describes two different value groupings: the scepticism in the justice system grouping, and the relationships with parents and authority grouping, with low Component 2 representing low respect in the justice system and an emphasis on low independence in children, and high Component 2 representing more secular societies, with emphasis on independence and obedience in children.

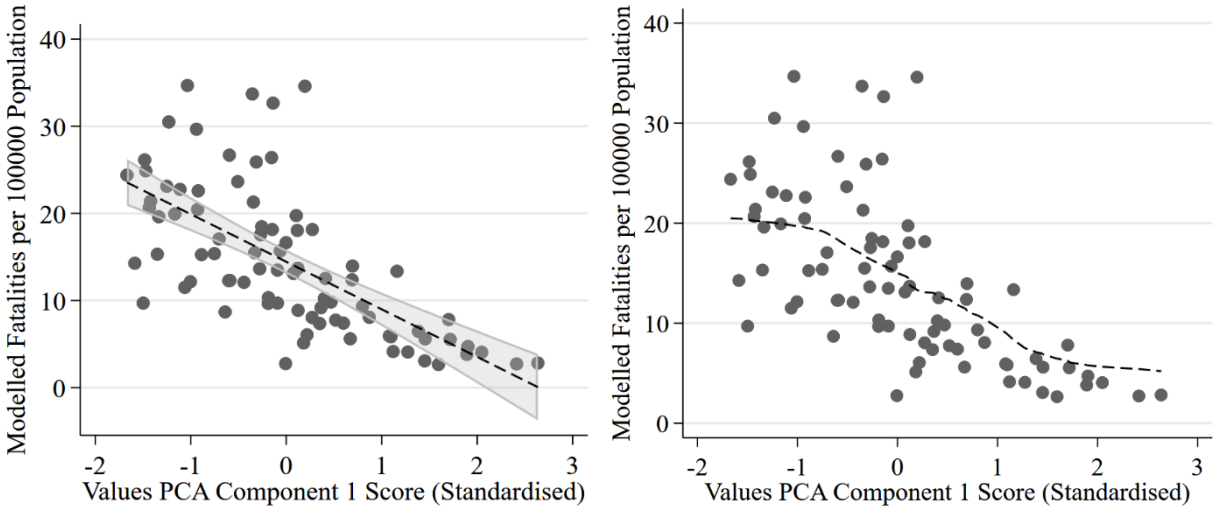
Figures 21, 22, 23 and 24 that follow present the values PCA results alongside reported and modelled fatalities.

Figure 21 Reported Fatalities by Values Component 1 Score



Source: Own Calculations from Inglehart et al. (2021) and WHO (2018)

Figure 22 Modelled Fatalities by Values Component 1 Score

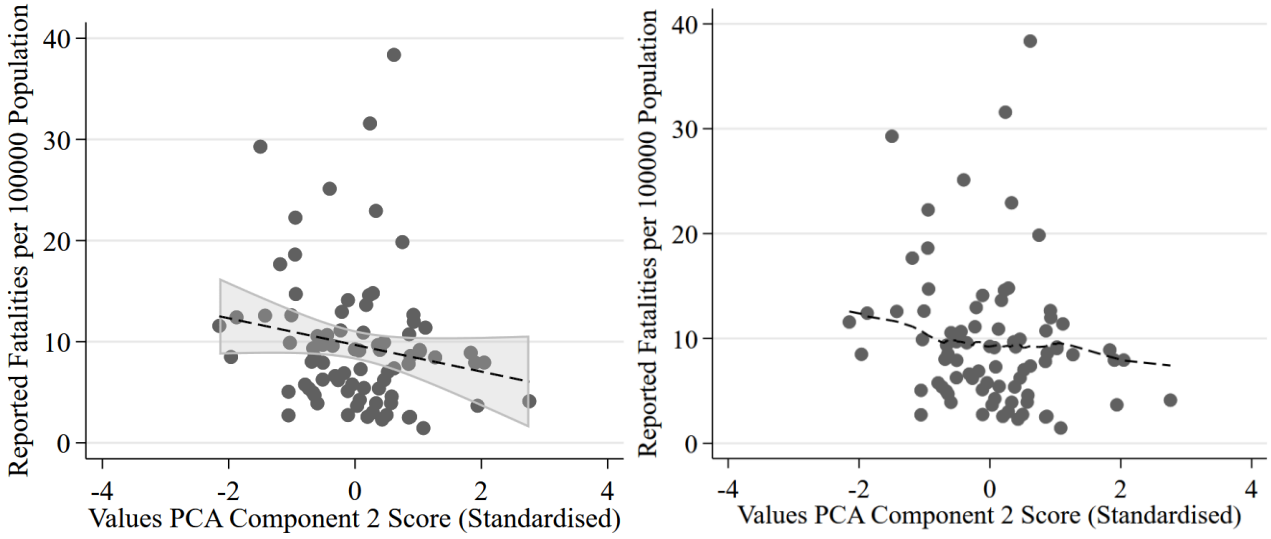


Source: Own Calculations from Inglehart et al. (2021) and WHO (2018)

Figures 21 and 22 show the relationship between reported fatalities, modelled fatalities and Values Component 1 scores respectively. Both linear graphs show a negative relationship between Component 1 and fatalities, with low fatalities being associated with high Component 1 scores; and high fatalities being associated with low Component 1 scores. The use of modelled fatalities strengthens the result. When non-linear relationships are considered, the result remains that low Component 1 scores are associated with high fatalities and vice versa. However, the reported fatalities graph suggests that there may be slightly higher fatalities where average Component 1 scores are concerned. However, when modelled fatalities are considered, this relationship disappears. This may simply be due to underreporting in countries with low Component 1 scores. As these countries are

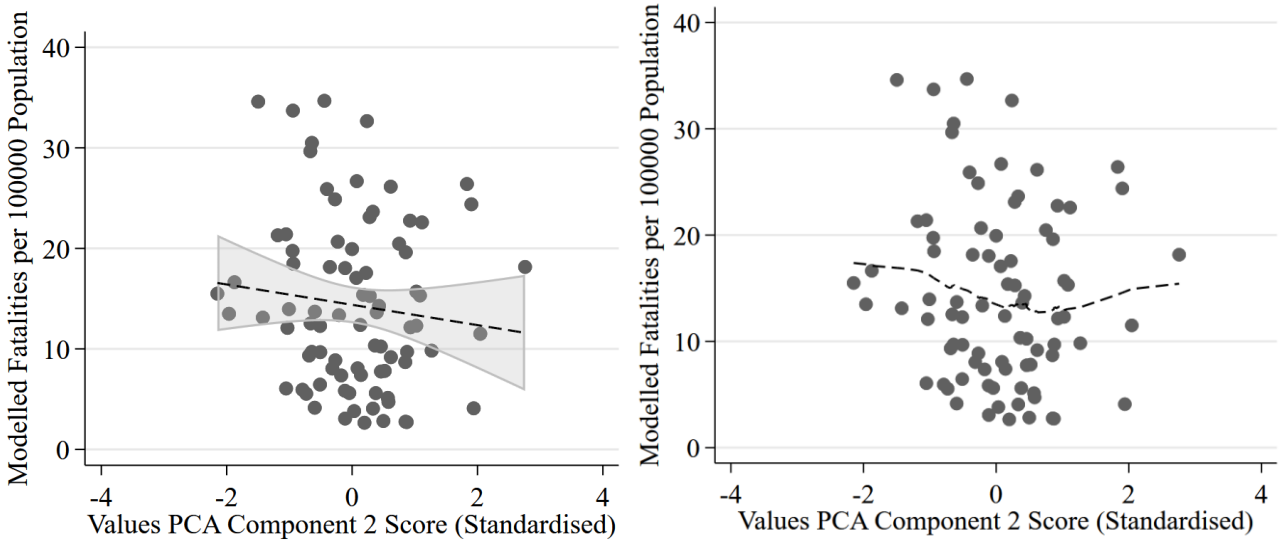
characterised by a greater emphasis on economic stability, the value placed on economic stability may be derived from years of unstable economic conditions, and consequently poor record keeping may occur on the part of their government.

Figure 23 Reported Fatalities by Values Component 2 Score



Source: Own Calculations from Inglehart et al. (2021) and WHO (2018)

Figure 24 Modelled Fatalities by Values Component 2 Score



Source: Own Calculations from Inglehart et al. (2021) and WHO (2018)

Similarly, Figures 23 and 24 suggest a negative relationship between fatalities and Component 2 scores. The graphs with the linear line of best fit show a weak negative relationship between fatalities and Component 2. The LOWESS lines of best fit seem to imply some negative relationship exists. However, when modelled fatalities are considered there seems to be a suggestion that average

Component 2 values are related to lower fatalities, and any deviation from this results in higher fatalities. These graphs, however, have a lot of noise, and no clear interpretation pattern exists.

3.2.1.4 Summary and Discussion

Table 7 and 8 summarise the bivariate linear best fit results presented in section 3.2.2, showing the slope of the line, the significance of the best fit line, the number of observations, and the R-squared values. All PCA and MCA results here are standardised variables, with a mean of 0 and a standard deviation of 1.

Table 7 Summary of Linear Best Fit Results: Reported Fatalities

	Laws MCA Dimension 1 (Standardised)	Standards MCA Dimension 1 (Standardised)	Mean Enforcement	Values PCA Component 1 (Standardised)	Values PCA Component 2 (Standardised)
Slope	0.478	-1.238	0.0442	-1.969	-1.318
P-Value	0.339	0.0126	0.86	0.00586	0.104
Observations	175[15]	175	170	83	83
R-Squared	0.005	0.035	0	0.09	0.032

Source: Own Calculations from Inglehart et al. (2021) and WHO (2018)

Table 8 Summary of Linear Best Fit Results: Modelled Fatalities

	Laws MCA Dimension 1 (Standardised)	Standards MCA Dimension 1 (Standardised)	Mean Enforcement	Values PCA Component 1 (Standardised)	Values PCA Component 2 (Standardised)
Slope	-2.19	-5.38	-2.394	-5.46	-1.011
P Value	0.002	0.000	0.000	0.000	0.322
Observations	175	175	170	83	83
R-Squared	0.056	0.337	0.281	0.441	0.012

Source: Own Calculations from Inglehart et al. (2021) and WHO (2018)

The bivariate OLS results suggest if linear relationships are considered, laws and enforcement have no bearing on reported fatalities, whereas Values Component 1 and Standards Dimension 1 do. The correlations suggest that the better a countries suite of standards, the lower the country's fatalities. This result is both intuitive, and well founded in the literature: standards make vehicles safer, thus, if a crash occurs, it is less likely that the crash will be fatal. The results also suggest that Values Component 1, which is associated with democratic participation, is also significant, with countries that place emphasis on political and economic participation and freedom, as well as social liberalism

[15] The attrition in observations can be accounted for as follows: information on laws and standards is available for all 175 observations in the GRSSR portion of the data set. 5 countries are lost when enforcement is included, as detailed in section 3.1.3.3. 9 of the 92 variables in the WVS portion of the data set have missing data, so they are not included in the MCA and MCA algorithms, and hence only 83 observations are seen when the values PCA scores are considered. For further detail see Appendix C

experiencing better road traffic outcomes. Conversely, those that place an emphasis on survival experience worse outcomes.

When modelled fatalities are considered, the laws variable and mean enforcement become significant, and the effect of standards and Values Component 1 becomes stronger. As discussed, enforcement may become significant when modelled fatalities are considered due to poor enforcement and poor monitoring of fatalities being associated with each other. This may mean that enforcement is not insignificant, but rather that any lack of significant is driven by underreporting. The significance of the law's variable suggests that improving laws may be beneficial, but due to a lack of data for countries without laws, it is difficult to draw strong conclusions with this data set.

If tentative conclusions are to be drawn at this stage, before any multivariate analysis is undertaken, it appears as though standards and values are very important for road traffic outcomes, with better standards being linked to lower fatalities, and democratic participation being linked to lower fatalities. It is likely that the relationship between standards and fatalities is simple and causal, as described by the literature: cars that adhere to the prescribed standards are safer, and if individuals do engage in risky road traffic behaviour and crashes do occur, safer vehicles result in less fatal crashes.

The relationship between Values Component 2 and fatalities, however, is unclear, The lack of significance of Values Component 2 may be driven by the small sample size, as when both modelled fatalities and reported fatalities are compared to Component 2, economic significance is seen (that is, a higher score on Values Component 2 is associated with lower fatalities), however, statistical significance is not observed. As it is observed that most countries do have legislation that addresses all the areas prescribed by the WHO, it is plausible that lower trust in the justice system may be driving the economic significance of this result, with individuals choosing to disregard the law due to a lack of trust in the motives of the law makers, however, this result is neither clear nor strong in this data set.

If Values Component 1 is considered, however, a very strong correlation between values and fatalities is observed, with the countries that are socially liberal and democratic experiencing better outcomes than their more socially conservative counterparts. The causal mechanism driving this relationship likely requires additional investigation. To speculate, it may be that what separates these two regions is their priorities. As discussed by Welzel (2013), what separates regions that are more emancipative from those that are less emancipative is the freedom to focus on economic prosperity and growth. It is plausible that regions with low Values Component 1 scores (such as Yemen, Libya, and Iraq) have poor economic conditions, and thus their priority is survival. Where survival is a priority, it is difficult to simultaneously prioritise democratic participation, and hence social responsibility. Conversely, in

countries with high Component 1 scores (such as Sweden, Switzerland, and Australia), social responsibility and democratic participation is a much higher priority. There may thus be both greater respect for the law, as well as greater feelings of social responsibility. This may result in better adherence to road traffic code, as the law is respected, and individuals feel a responsibility to follow the law, as they know that following the law results in safer roads for all. For countries with low Component 1 scores, citizens may not respect their governments, whether as a result of corruption, poor economic and political outcomes, or for whatever other reason. With the added emphasis in these countries on survival, individuals do not have the capacity to simultaneously value social responsibility. As a result, they may choose not to follow road legislation due to scepticism surrounding the motives of the law makers, and a lack of capacity to prioritise social responsibility. Further research in this area is imperative.

The effect of enforcement here is still somewhat unclear. It appears that enforcement does matter for outcomes, but only up to a certain point (as was shown in the scatter plots), and the result is only significant when the modelled fatalities is considered. As before, this is likely to be linked to improved enforcement and improved record keeping.

Lastly, due to the lack of variation within the laws variable, little can be said about the relationship between laws and fatalities. There is some suggestion that better laws are linked to better outcomes. However, considering the scatterplots shows that there are countries that address all 7 of the WHO's priority areas that have very good outcomes, but simultaneously, there are countries with very poor outcomes. It may be worth noting that the laws variable only emphasises the presence of laws addressing the priority areas, however, countries may be able to improve outcomes by improving the functional forms of these laws, that is, simply having a law that regulates speeding, or drink driving is insufficient, the law may need to be in line with the 'best practise' legislation.

This section has, however, only considered the bivariate relationships between these variables. Section 3.2.3 considers linear multivariate relationships between the variables, and section 3.2.4 considers non-linear relationships multivariate relationships.

3.2.2 OLS

3.2.2.1 Results

In order to investigate how modelled fatalities vary when laws, standards, enforcement and values are considered simultaneously, Table 9 is presented.

Table 9 Regressions 1-5

	1	2	3	4	5
VARIABLES	**Modelled Fatalities**	**Modelled Fatalities**	**Modelled Fatalities**	**Modelled Fatalities**	**Modelled Fatalities**
Laws MCA Dimension 1 (Standardised)	0.199				0.170
	(0.860)				(0.880)
Standards MCA Dimension 1 (Standardised)	-1.513*	-1.492*	-1.589*		-1.608*
	(0.0910)	(0.0905)	(0.0673)		(0.0687)
Mean Enforcement	-0.989**	-0.987**	-1.095**		-1.097**
	(0.0432)	(0.0421)	(0.0175)		(0.0181)
Values PCA Component 1 (Standardised)	-3.706***	-3.678***	-3.485***	-5.543***	-3.508***
	(0.000383)	(0.000328)	(0.000368)	(0)	(0.000431)
Values PCA Component 2 (Standardised)	-0.564	-0.558		-1.419*	
	(0.483)	(0.483)		(0.0630)	
Constant	21.18***	21.23***	21.92***	14.51***	21.89***
	(1.23e-09)	(8.11e-10)	(0)	(0)	(6.25e-11)
Observations	81[16]	81	81	83	81
R-squared	0.511	0.511	0.508	0.465	0.508
P-Values in parentheses					
***** p<0.01, ** p<0.05, * p<0.1**					

Source: Own Calculations from Inglehart et al. (2021) and WHO (2018)

Table 9 displays the OLS results obtained when the relationship between modelled fatalities and laws, standards, enforcement, and values are considered simultaneously. Regression 1 employs all five covariates (Laws Dimension 1, Standards Dimension 1, mean enforcement perception, Values Component 1 and Values Component 2). It is observed that standards, enforcement, and Values Component 1 are all statistically significant, with better standards, more enforcement, and a higher Values Component 1 scores being related to better outcomes. The directions of the co-efficients on each of these variables is in line with the bivariate results, however, the magnitudes on each of them is slightly smaller. The laws variable, and Values Component 2 are insignificant when all five variables are considered simultaneously.

Standards, enforcement, and Values Component 1 remain significant when Laws Dimension 1 and Values Component 2 are removed in regressions 2 and 3 respectively. Values Component 2 only becomes significant when considered alongside Values Component 1, as is shown in Regression 4. Regression 5 considers whether laws becomes significant when the Values Component 2 is dropped first. The results show that laws remains insignificant here as well. These regressions thus show that

[16] The precise breakdown of which countries are included in the regressions may be found in the appendix. Here, when the GRSSR and WVS data sets are considered alongside each other (92 matches), 9 observations are lost due to missing data in the values, and an additional 2 variables are lost due to missing data for enforcement.

when considered simultaneously, Laws Dimension 1 and Values Component 2 become insignificant, and that only Standards Dimension 1, mean enforcement perception and Values Component 1 are significant. These results corroborate the results found in section 3.2.1, in that the effect of legislation on fatalities is not strong, but rather standards, enforcement and Values Component 1 are.

Notably, the standards variable has the lowest significance, with a p-value 0.0673. The economic significance, however, shows that a one standard deviation increase in standards is associated with a drop in fatalities of 1.589 per 100000 population. Enforcement is the next most significant variable, with a p-value of 0.0175, and a coefficient of -1.095, implying that countries with higher levels of enforcement experience lower fatalities. Lastly, Values Component 1 is the most significant variable, with a one standard deviation difference in component one scores being associated with a drop in fatalities of around 3.485 deaths per 100000 population. Gross National Income (GNI) is not considered in these regressions as a control, as GNI is used directly in the estimation process to obtain the modelled fatalities variable. Regressions 1-5 suggest that when considered jointly, only standards, enforcement and Values Component 1 are significantly related to fatalities.

The results for reported fatalities are weaker than those of modelled fatalities. It is plausible that much of this is attributable to underreporting, however, the regression results are still reported in Table 10 and 11.

Table 10 Regressions 6-10

	6	7	8	9	10
VARIABLES	**Reported Fatalities**	**Reported Fatalities**	**Reported Fatalities**	**Reported Fatalities**	**Reported Fatalities**
Laws MCA Dimension 1 (Standardised)	0.674				0.611
	(0.577)				(0.615)
Standards MCA Dimension 1 (Standardised)	-0.290	-0.218	-0.424		-0.492
	(0.760)	(0.816)	(0.648)		(0.602)
Mean Enforcement	-0.408	-0.405	-0.633		-0.640
	(0.428)	(0.430)	(0.197)		(0.195)
Values PCA Component 1 (Standardised)	-1.660	-1.565	-1.156	-2.055***	-1.236
	(0.123)	(0.138)	(0.256)	(0.00364)	(0.232)
Values PCA Component 2 (Standardised)	-1.205	-1.187		-1.469*	
	(0.161)	(0.165)		(0.0589)	
Constant	12.17***	12.32***	13.79***	9.726***	13.67***
	(0.000363)	(0.000279)	(2.54e-05)	(0)	(3.35e-05)
Observations	81	81	81	83	81
R-squared	0.137	0.133	0.111	0.130	0.113
P-Values in parentheses					
***** p<0.01, ** p<0.05, * p<0.1**					

Source: Own Calculations from Inglehart et al. (2021) and WHO (2018)

Table 10 shows that no meaningful results are found when laws, standards, enforcement and values are considered jointly. When Laws Dimension 1 and Values Component 2 are removed in regressions 7 and 8, this result does not change. Whilst the signs mirror those found in the modelled fatalities regressions, the variables remain statistically insignificant. Some significance is seen when Values Component 1 and 2 are considered jointly, and without the other variables, however, when additional variables are present in the regression, their significance disappears. This may suggest that the second values component is only important when considered along-side the first dimension. In addition, regression 10 shows that even when Values Component 2 is left out of the regression (that is, the variable without any significance in the bivariate correlations), the result remains unchanged.

Table 11 Regressions 11-16

	11	12	13	14	15	16
VARIABLES	**Reported Fatalities**	**Reported Fatalities**	**Reported Fatalities**	**Reported Fatalities**	**Reported Fatalities**	**Reported Fatalities**
Laws MCA Dimension 1 (Standardised)			0.621			
			(0.604)			
Standards MCA Dimension 1 (Standardised)			-0.218	-0.151	-0.282	-0.280
			(0.816)	(0.870)	(0.758)	(0.775)
Mean Enforcement			-0.310	-0.306	-0.447	-0.447
			(0.547)	(0.550)	(0.364)	(0.368)
Values PCA Component 1 (Standardised)			-0.216	-0.115	0.385	0.387
			(0.878)	(0.934)	(0.767)	(0.780)
Values PCA Component 2 (Standardised)			-0.880	-0.861		
			(0.315)	(0.323)		
GNI Per Capita	-7.69e-05***	3.41e-05	-0.000110	-0.000111	-0.000127*	-0.000128
	(0.00473)	(0.678)	(0.125)	(0.120)	(0.0658)	(0.480)
GNI Per Capita Squared		-1.81e-09				0
		(0.154)				(0.996)
Constant	9.952***	9.402***	13.15***	13.30***	14.45***	14.45***
	(0)	(0)	(0.000150)	(0.000112)	(9.80e-06)	(2.97e-05)
Observations	173[17]	173	81	81	81	81
R-squared	0.046	0.057	0.164	0.161	0.150	0.150
P-Values in parentheses						
***** p<0.01, ** p<0.05, * p<0.1**						

Source: Own Calculations from Inglehart et al. (2021) and WHO (2018)

Table 11 considers the use of GNI as a control, to ascertain whether economic development is driving any results. Regression 11 shows that GNI per capita is significantly correlated with fatalities, with lower fatalities being observed at higher levels of per capita income. Specifically, this relationship is not non-linear, as is shown in regression 12. Regression 12 employs a Kuznets type specification, with GNI per capita, and GNI per capita squared, to rest if a quadratic relationship exists. It is found, however, that when this specification is used, both variables become insignificant. Regression 13 presents the regression with Laws Dimension 1, Standards Dimension 1, mean enforcement, Values Component 1 and GNI per capita, and no statistical significance is found. Some significance is seen in GNI at the 10% level in Regression 15, where Standards Dimension 1, mean enforcement and

[17] As before, the precise countries included in the regressions may be found in the Appendix C. Here, where the observations equal 173, two observations from the 175 observations in the GRSSR portion of the data set are lost due to missing data on GNI.

Values Component 1 are considered alongside GNI. As in Regression 12, this significance disappears when GNI per capita squared is introduced. There are few meaningful results captured in Tables 10 and 11, with some suggestion that GNI has a bearing on fatalities, however the relationship is weak.

As a robustness check, Tables 12 and 13 below present model specifications that include interactions, so as to determine if certain variables are only jointly significant. Only the most important results are shown here, however the full reduction is presented in Appendix C.

Table 12 Regressions 17-24

	17	18	19	20	21	22	23	24
VARIABLES	**Modelled Fatalities**	**Modelled Fatalities**	**Modelled Fatalities**	**Modelled Fatalities**	**Modelled Fatalities**	**Modelled Fatalities**	**Modelled Fatalities**	**Modelled Fatalities**
Laws MCA Dimension 1 (Standardised)	0.170	14.51**	14.49**	14.48**	14.88***	15.87***	15.65***	13.63***
	(0.880)	(0.0238)	(0.0217)	(0.0209)	(0.00552)	(0.00065)	(0.00079)	(0.00243)
Standards MCA Dimension 1 (Standardised)	-1.608*	-1.632	-1.627	-1.205	-1.419	-1.472*	-1.389	-1.433*
	(0.0687)	(0.657)	(0.655)	(0.529)	(0.102)	(0.0842)	(0.103)	(0.0962)
Mean Enforcement	-1.097**	-0.233	-0.233	-0.219	-0.206			
	(0.0181)	(0.686)	(0.684)	(0.695)	(0.706)			
Values PCA Component 1 (Standardised)	-3.508***	-7.853*	-7.857*	-8.168**	-8.303**	-8.910***	-7.703***	-3.357***
	(0.00043)	(0.0710)	(0.0687)	(0.0251)	(0.0164)	(0.00357)	(0.00765)	(0.00054)
Laws MCA Dimension 1 (Standardised)# Values PCA Component 1 (Standardised)		0.0518						
		(0.979)						
Standards MCA Dimension 1 (Standardised)# Values PCA Component 1 (Standardised)		-0.926	-0.921	-0.954	-1.031	-1.145		
		(0.445)	(0.439)	(0.410)	(0.289)	(0.213)		
Mean Enforcement # Values PCA Component 1 (Standardised)		0.811	0.814	0.868	0.894	0.993**	0.667	
		(0.268)	(0.258)	(0.147)	(0.109)	(0.0429)	(0.106)	
Laws MCA Dimension 1 (Standardised)# Standards MCA Dimension 1 (Standardised)		-0.606	-0.570	-0.434				
		(0.877)	(0.875)	(0.900)				
Laws MCA Dimension 1 (Standardised)# Mean Enforcement		-2.653**	-2.649***	-2.637***	-2.679***	-2.862***	-2.806***	-2.455***
		(0.0111)	(0.00995)	(0.00948)	(0.00496)	(0.00048)	(0.00062)	(0.00191)
Standards MCA Dimension 1 (Standardised)# Mean Enforcement		0.0810	0.0778					
		(0.890)	(0.891)					
Constant	21.89***	17.78***	17.78***	17.70***	17.55***	16.37***	15.67***	16.06***
	(6.25e-11)	(4.98e-06)	(4.24e-06)	(2.97e-06)	(8.67e-07)	(0)	(0)	(0)
Observations	81	81	81	81	81	81	81	81
R-squared	0.508	0.560	0.560	0.560	0.560	0.559	0.550	0.534
pval in parentheses								
*** p<0.01, ** p<0.05, * p<0.1								

Source: Own Calculations from Inglehart et al. (2021) and WHO (2018)

Table 12 presents models with modelled fatalities as the dependent variable. Regression 21 presents a base specification with fatalities considered alongside Laws Dimension 1, Standards Dimension 1, mean enforcement and Values Component 1. Component 2 is left out at this stage as it has been seen to be mostly insignificant in all results up to this stage. When all the interactions are employed, laws, values and the interaction between laws and values are significant. Whilst standards and enforcement are not statistically significant, the directions of the signs on these variables still suggest the same relationship seen in previous sections.

Regressions 23 to 27 sequentially remove the most insignificant variable in each column, so as to uncover what the optimal specification is. Regression 28 presents the final result of this process. When interactions are considered, laws, standards, values, and the interaction between laws and enforcement are the only significant variables found. Specifically, laws become significant (in comparison to previous sections), when considered alongside enforcement. The signs on this interaction are notable. The coefficient on laws represents a hypothetical country with no laws and no enforcement. Holding all else constant, as expected, this country would have high fatalities. However, as laws and enforcement increase together (as indicated by the interaction term), fatalities decrease. Thus, a country with strong laws and good enforcement will have significantly lower fatalities than this hypothetical country with no enforcement and no legislation. Standards are significant in this final model specification; however, this variable only becomes significant in the final regression, and at the 10% level. The results of the interactions-based specifications therefore suggest the following: unlike regressions 1-5, laws do have an impact on fatalities, however, laws only become significant when they are accompanied by an appropriate level of enforcement. Furthermore, it is plausible that fatalities may be reduced by improving the enforcement of existing road safety legislation. As before, values remain a strongly significant, with higher Component 1 scores being related to significantly lower fatalities than lower Component 1 scores. Similarly, better standards are related to lower fatalities.

Table 13 repeats the above process with reported fatalities as the dependent variable. Appendix C shows the full reduction process, however, here, only the base specification, the full interactions specification, and the most reduced model are shown.

Table 13 Regressions 25-28

	25	26	27	28
VARIABLES	**Reported Fatalities**	**Reported Fatalities**	**Reported Fatalities**	**Reported Fatalities**
Laws MCA Dimension 1 (Standardised)	0.611	-1.394		
	(0.615)	(0.460)		
Standards MCA Dimension 1 (Standardised)	-0.492	1.839		
	(0.602)	(0.631)		
Mean Enforcement	-0.640	-0.568		
	(0.195)	(0.283)		
Values PCA Component 1 (Standardised)	-1.236	1.902		
	(0.232)	(0.661)		
Laws MCA Dimension 1 (Standardised)# Values PCA Component 1 (Standardised)		-1.486		
		(0.478)		
Standards MCA Dimension 1 (Standardised)# Values PCA Component 1 (Standardised)		-1.184	-2.336***	-1.750**
		(0.332)	(0.000126)	(0.0398)
Mean Enforcement # Values PCA Component 1 (Standardised)		-0.198		
		(0.786)		
Laws MCA Dimension 1 (Standardised)# Standards MCA Dimension 1 (Standardised)		-3.239		
		(0.426)		
Laws MCA Dimension 1 (Standardised)# Mean Enforcement				
Standards MCA Dimension 1 (Standardised)# Mean Enforcement		-0.121		
		(0.846)		
GNI Per Capita				-5.18e-05
				(0.334)
Constant	13.67***	15.84***	11.43***	11.78***
	(3.35e-05)	(1.24e-05)	(0)	(0)
Observations	81	81	83	83
R-squared	0.113	0.212	0.167	0.177
P-Values in parentheses				
***** p<0.01, ** p<0.05, * p<0.1**				

Source: Own Calculations from Inglehart et al. (2021) and WHO (2018)

When reported fatalities are considered, few meaningful results are obtained. The final regression suggests that only the interaction between Standards Dimension 1 and Values Component 1 is significant, with fatalities decreasing as standards and values are jointly increased. Regression 28 introduces GNI as a control, and it is found to be insignificant.

3.2.2.2 Discussion

This section has shown that when reported fatalities are considered, it is slightly more difficult to find significant relationships between fatalities and the investigated variables. It is plausible that this is due to underreporting of fatalities resulting in countries that may actually be high in fatalities, being counted as mid-level or low fatality countries, thus obscuring the results. The modelled fatalities data suggests that standards and values, specifically values PCA component one, are strongly correlated with fatalities, with both variables displaying negative correlations. Enforcement is also seen to be significant, with better enforcement being associated with lower fatalities. Laws are mostly seen to be insignificant, however, it is difficult to draw conclusions from this data set; as there are so few countries without laws, it may simply be there are not enough observations of poor laws to find statistical significance. To this end, it may be more useful to consider standards as being more representative of a country's formal institutions. A country with a more complete suite of vehicle standards (and given that most countries do have good laws, these standards are considered alongside a strong suite of traffic laws), can be regarded as a country with a strong traffic institutions, and it has been shown here that this does have an impact on fatalities. In addition, as shown in Regression 24, enforcing these laws is of paramount importance. The result it quite intuitive: it is not simply enough to impose good laws on citizens, they must also be enforced. However, the most significant variable in almost all of the above regressions is Values Component 1. Values have a very strong effect on fatalities, with countries with higher component one scores having significantly lower fatalities than countries with low component one scores. As discussed in section 0, the mechanism through which values impacts fatalities is unclear at this stage, however, it is undoubtedly worth further research to determine if a causal link exists.

However, this section has presented only linear relationships. Section 3.2.3 employs cluster analysis, so as to investigate these phenomena further.

3.2.3 Cluster Analysis

3.2.3.1 Theoretical Basis

Cluster Analysis is a set of algorithms and tools that classifies objects into groups based on their similarity. Objects that are very similar are grouped together, and objects that are further apart are placed in different groups. This thesis employs k-means clustering, which attempts to split data into a predetermined number of clusters (k clusters) in such a way that data in the same cluster are similar, and the data points in different clusters are dissimilar (Yildirim, 2020).

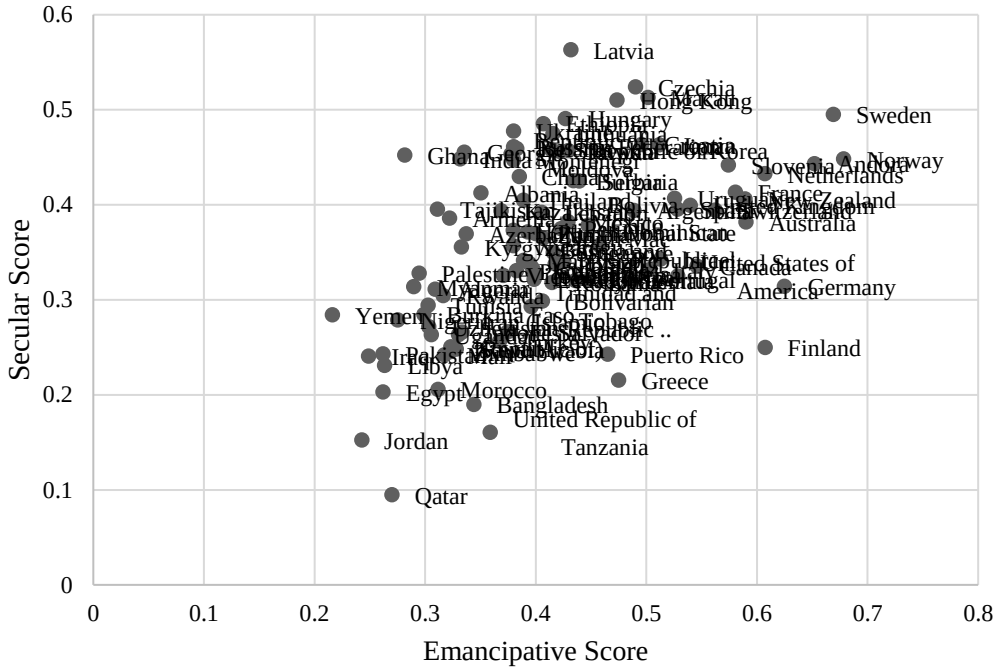
The similarity between two points is determined by how far apart they are. If the points are plotted on a Cartesian plane, the distance between them can be measured and calculated. Typically, the Euclidian distance is used:

$$Distance(a, b) = \sqrt{(a_1 - b_1)^2 + (a_2 - b_2)^2}$$

Where a and b denote different points, and the subscripts refer to the dimension of their Cartesian co-ordinate. The algorithm that determines these clusters attempts to minimise distances within clusters and maximises distances between clusters.

Consider the below scatter plot, which shows the emancipative and secular scores for each country:

Figure 25 Secular and Emancipative Scores by Country



Source: Own Calculations from Inglehart et al. (2021)

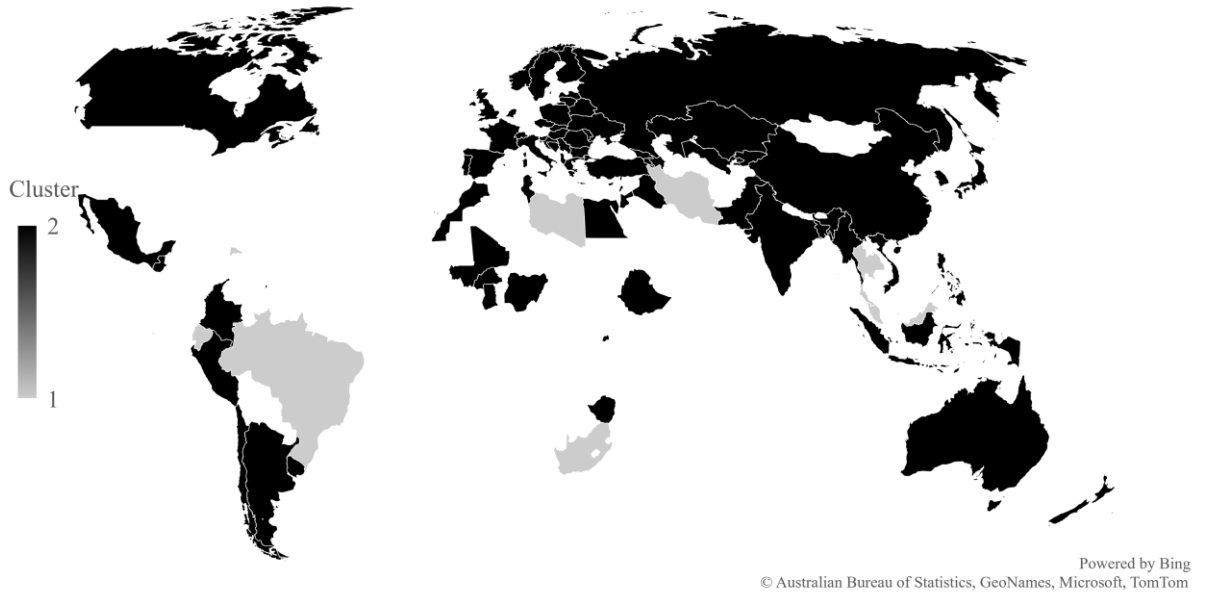
The algorithm would thus separate countries into clusters as per the geometric distance between them, grouping like countries together. Whilst this simple example only considers a two-dimensional problem, this can be done with more variables and in higher dimensions. The k-means algorithm begins by randomly selects centres ('centroids') of clusters. It then calculates the distance of all the data points in the data set to the given cluster. Thereafter it assigns data points to the closest cluster. These groupings determine the new centroids of each cluster by taking the average of all the data points in the cluster. This process is then repeated until convergence is reached, and centroids no longer shift.

3.2.3.2 Clusters of Values

The rest of this section proceeds as follows. K-means clustering is employed, and is performed with fatalities, mean enforcement, Laws Dimension 1, Standards Dimension 1 and both Values Component 1 and 2. Reported fatalities and modelled fatalities are presented separately, with two means clustering and three means clustering presented sequentially. Four (or greater) means clustering was not employed as there is no additional explanatory power found in these results.

Figure 26 and 27, as well as Table 14 shows the results obtained when two means clustering is performed with reported fatalities.

Figure 26 Means Clustering with Reported Fatalities



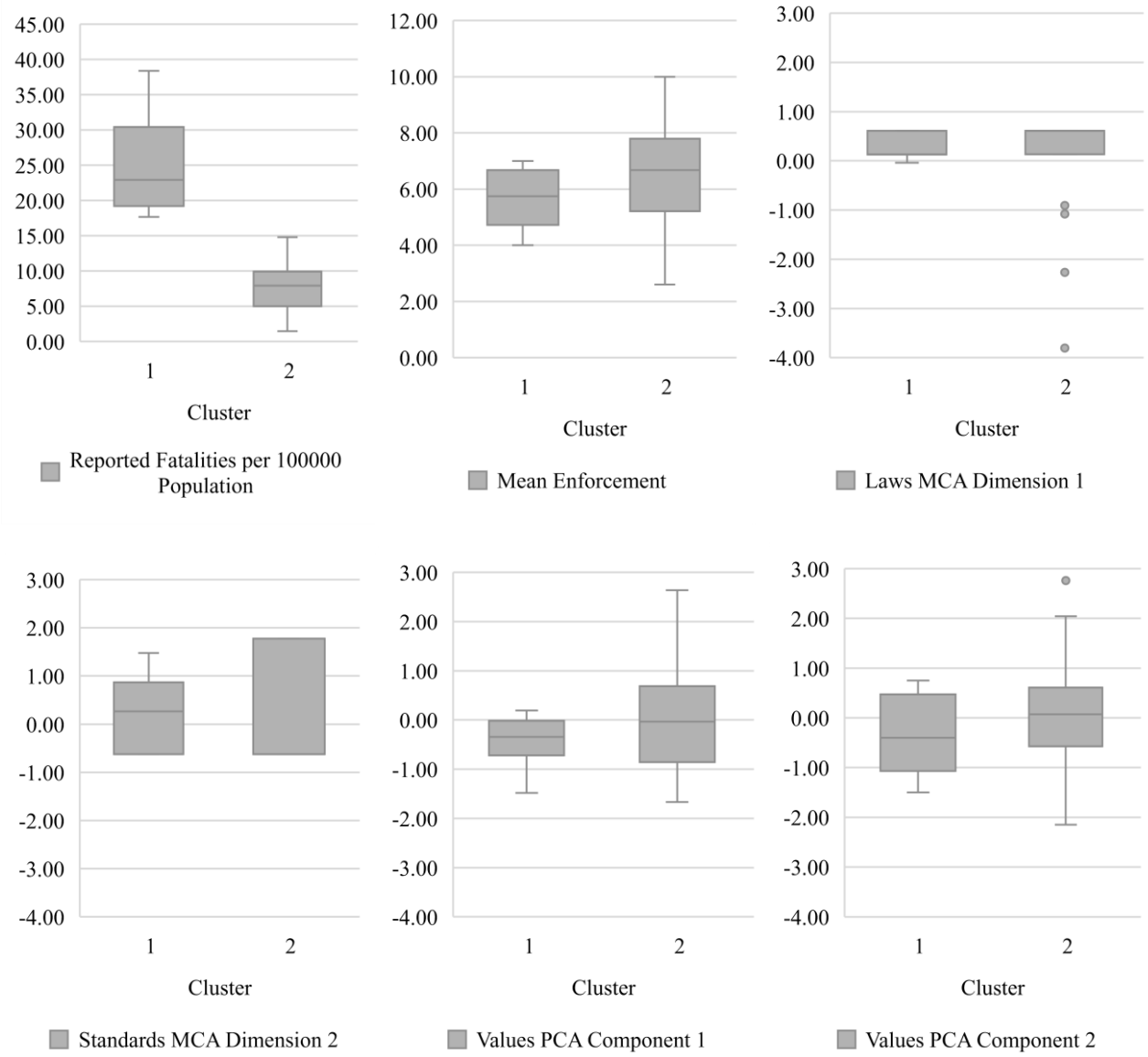
Source: Own Calculations from Inglehart et al. (2021) and WHO (2018)

Table 14 Cluster Characteristics for 2 Means Clustering with Reported Fatalities: Means

	Cluster 1 (9 Countries)	**Cluster 2 (72 Countries)**
Reported Fatalities per 100000 Population	25.07	7.75
Mean Enforcement	5.65	6.34
Laws MCA Dimension 1	0.33	0.29
Standards MCA Dimension 2	0.17	0.42
Values PCA Component 1	-0.42	0.04
Values PCA Component 2	-0.34	0.09

Source: Own Calculations from Inglehart et al. (2021) and WHO (2018)

Figure 27 Cluster Characteristics for 2 Means Clustering with Reported Fatalities: Box Plots



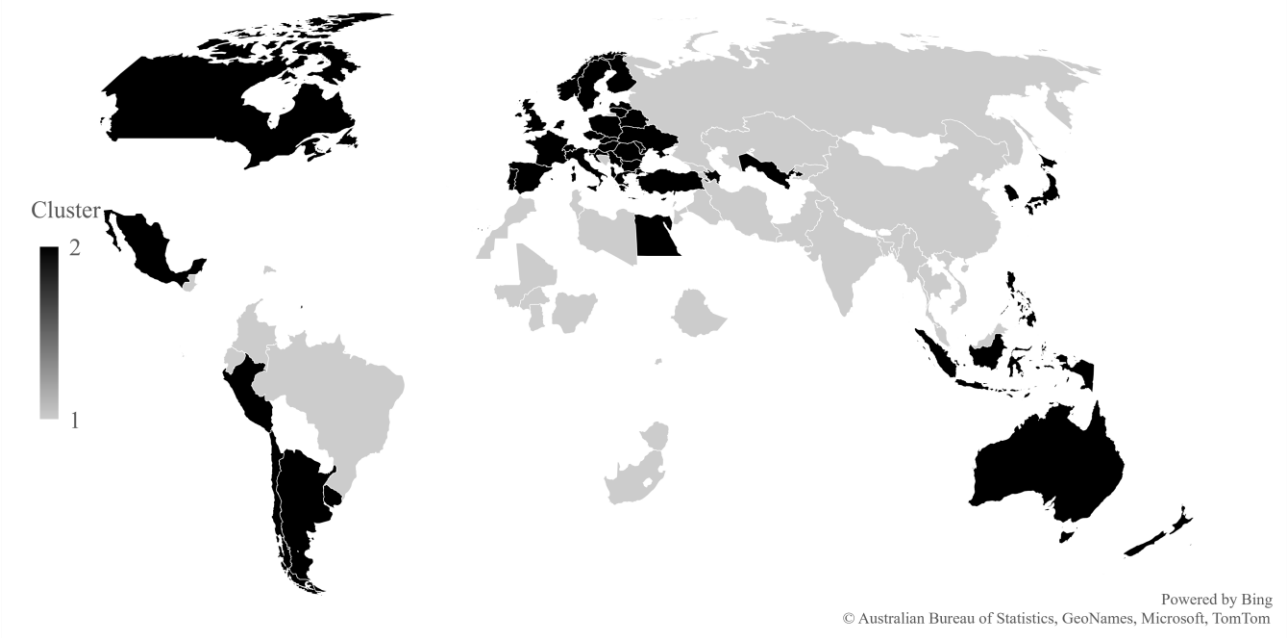
Source: Own Calculations from Inglehart et al. (2021) and WHO (2018)

Cluster 1 contains 9 countries, as is displayed in figure 26. In contrast, Cluster 2 is made up of the 72 other countries employed in this analysis. Fatalities are significantly different within these clusters, with Cluster 1 exhibiting much higher reported fatalities than Cluster 2. Enforcement, however, is not very different, due to the overlap in distributions. Cluster 1 has slightly worse mean and median enforcement, with a narrower distribution than Cluster 2, however, both poor and excellent enforcement are seen in Cluster 2. Thus, enforcement, whilst slightly better in Cluster 2 is not what separates these two clusters. Similarly, whilst it is not immediately clear on the standards graph (the median and the first quartile are both -0.63), standards are not very different between clusters. Cluster 1 has a slightly higher median, but a lower quartile 3, and range, as well as a lower mean. In contrast,

the median is lower in Cluster 3, however, the range is greater, as is the mean. All things considered, standards may be slightly worse in Cluster 1, however, there is also significant overlap in this variable, so this cannot be said conclusively. This pattern is also seen in the values variables, with Cluster 1 skewing to slightly lower Values Component 1 scores. Cluster 2 overlaps slightly with Cluster 1, but has a slightly wider distribution, with the presence of higher Component 1 scores. With Values Component 2, an overlap in is also observed, however, Cluster 2 seems to have a wider distribution of Component 2 scores. The two means clustering with reported fatalities results seem to mirror the results seen in the regressions: there is little that truly separates high fatality groups from low fatality groups when reported fatalities are considered.

Consider Figures 28 and 29 below, as well as Table 15, which present the results when 2-means clustering is performed using modelled fatalities.

Figure 28 2 Means Clustering with Modelled Fatalities



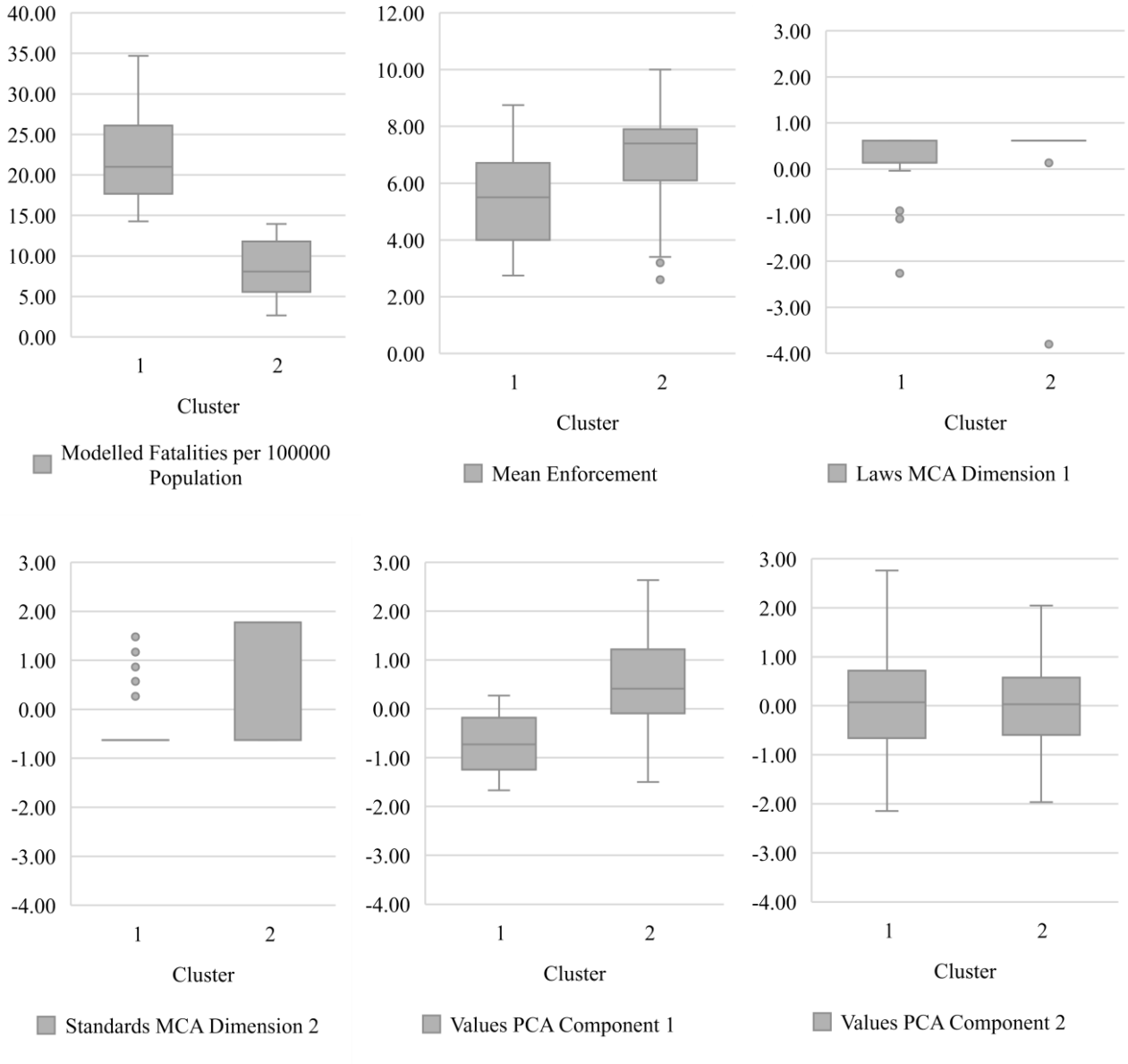
Source: Own Calculations from Inglehart et al. (2021) and WHO (2018)

Table 15 Cluster Characteristics for 2 Means Clustering with Modelled Fatalities: Means

	Cluster 1 (36 Countries)	Cluster 2 (45 Countries)
Modelled Fatalities per 100000 Population	22.25	8.29
Mean Enforcement	5.38	6.97
Laws MCA Dimension 1	0.10	0.45
Standards MCA Dimension 2	-0.28	0.93
Values PCA Component 1	-0.71	0.54
Values PCA Component 2	0.04	0.04

Source: Own Calculations from Inglehart et al. (2021) and WHO (2018)

Figure 29 Cluster Characteristics for 2 Means Clustering with Modelled Fatalities: Box Plots



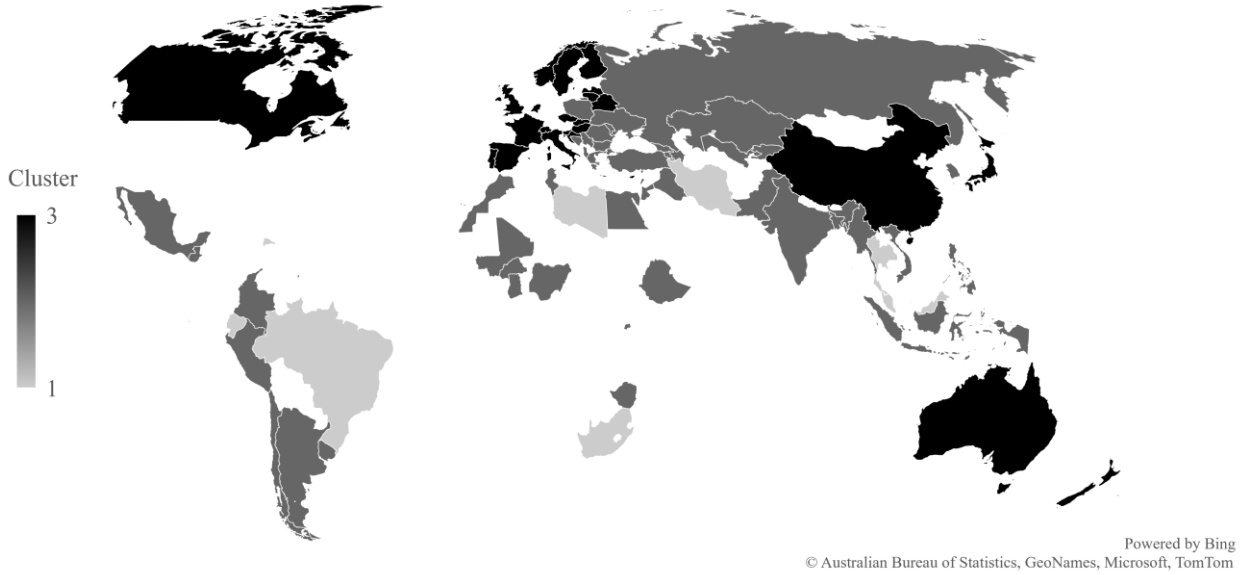
Source: Own Calculations from Inglehart et al. (2021) and WHO (2018)

Like the results from reported fatalities, Cluster 1 has higher fatalities than Cluster 2, with no overlap in the distributions. When enforcement is considered, the overlap is much smaller than in the reported fatalities case, with only most of the overlap observed occurring with the first and fourth quartiles. Median enforcement is significantly lower in the high fatality group, at around 5.5, in comparison to 7.4 in the low fatalities group. Laws, however, differ slightly but not substantially, with the high fatality group exhibiting good laws on average, with some instances of sub-par laws (as indicated by the outliers and the first and second quartiles), and the lower fatality group exhibiting fewer deviations from good laws (with almost all countries exhibiting a score of 0.61, and only two outliers). Standards

also differ between clusters, with the high fatalities group exhibiting a low standards score, and few outliers deviating from this. Whilst it is not clear on the graph, the median score for standards in the second cluster is 1.78. The second cluster thus has significantly better standards on average than the first. When values are considered, the first component seems to differ between countries, with the only observed overlap occurring at the tails of the box plot, however, Component 2 does not differ substantially between clusters. As was observed in the reported fatalities case, these results mirror the results found in the OLS section: laws are not a good predictor of fatalities, nor is the second values component. It is found, however, that Standards Dimension 1, mean enforcement and Values Component 1 are associated with fatalities, with good standards, good enforcement and higher component one scores being associated with low fatalities.

As a robustness check, this analysis is performed with three clusters. The reported fatalities results are shown first in Figures 30 and 31, as well as Table 16.

Figure 30 3 Means Clustering with Reported Fatalities



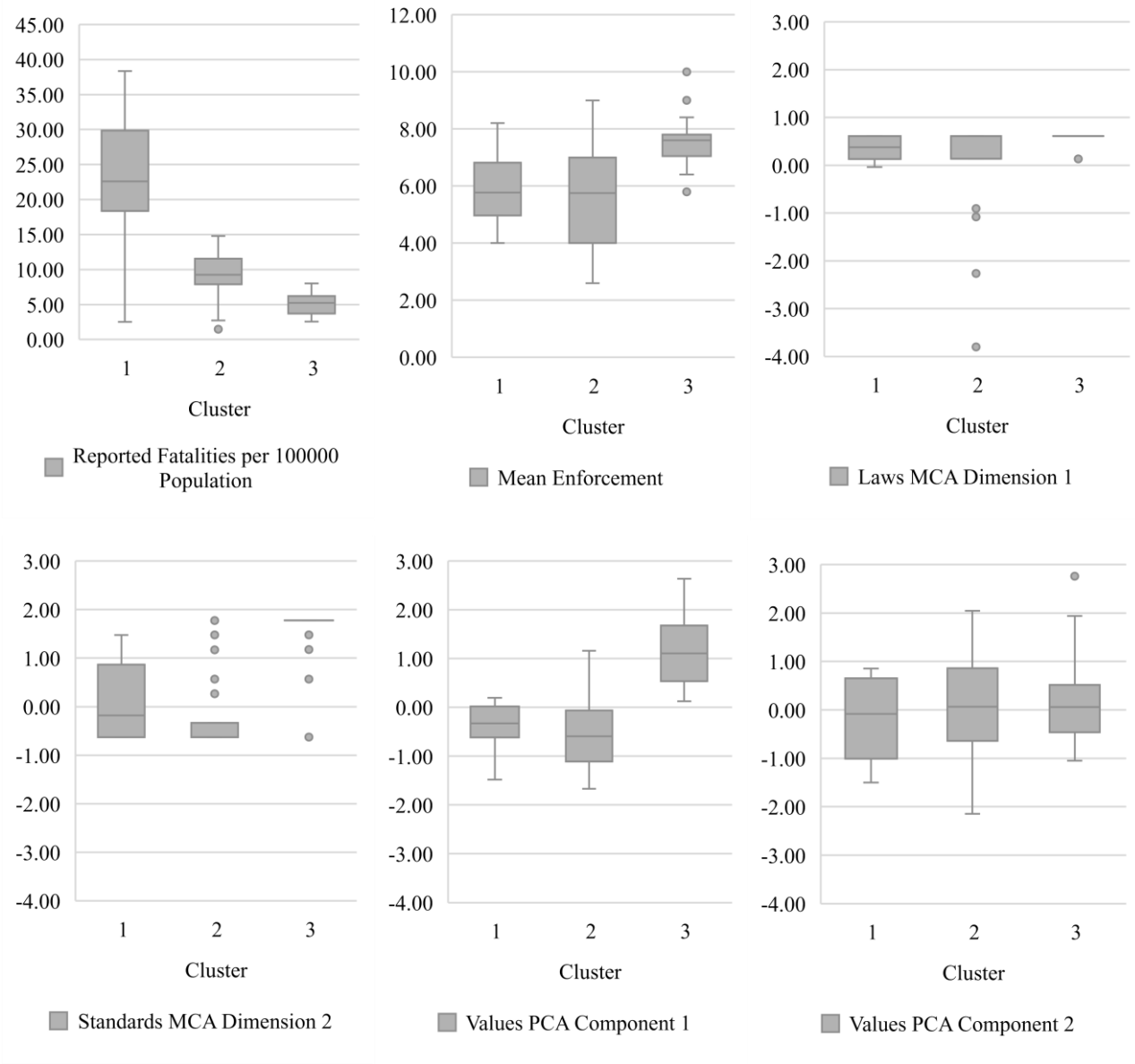
Source: Own Calculations from Inglehart et al. (2021) and WHO (2018)

Table 16 Cluster Characteristics for 3 Means Clustering with Reported Fatalities: Means

	Cluster 1 (10 Countries)	Cluster 2 (47 Countries)	Cluster 3 (24 Countries)
Reported Fatalities per 100000 Population	22.82	9.27	5.00
Mean Enforcement	5.90	5.66	7.59
Laws MCA Dimension 1	0.35	0.13	0.59
Standards MCA Dimension 2	0.09	-0.15	1.58
Values PCA Component 1	-0.38	-0.52	1.14
Values PCA Component 2	-0.22	0.04	0.16

Source: Own Calculations from Inglehart et al. (2021) and WHO (2018)

Figure 31 Cluster Characteristics for 3 Means Clustering with Reported Fatalities: Box Plots



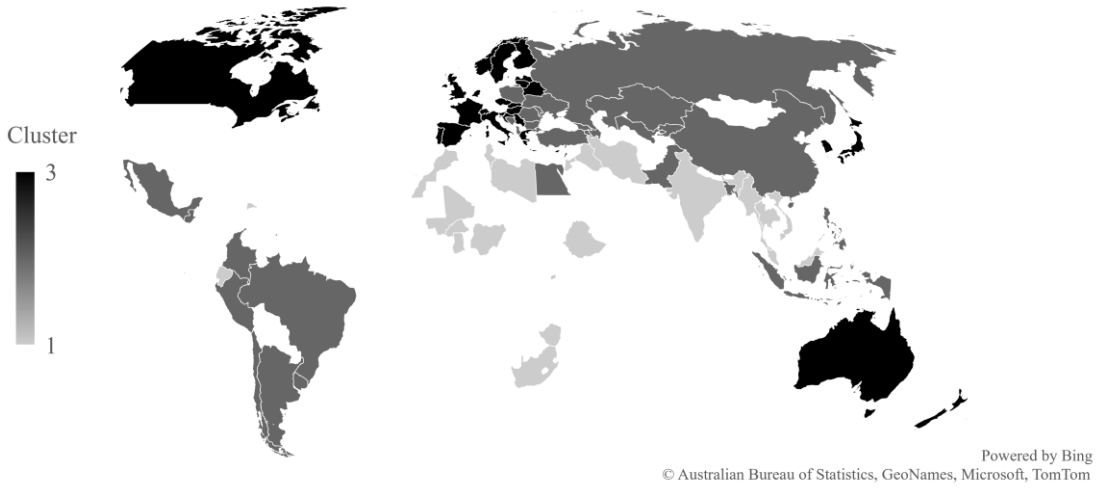
Source: Own Calculations from Inglehart et al. (2021) and WHO (2018)

Three cluster groupings are found, with high, mid and low fatalities respectively. Enforcement does not differ substantially between the mid and high fatalities clusters; however, the low fatalities cluster exhibits higher enforcement. There is also some overlap with the laws box plots, but there do seem to be slightly better laws overall in the low fatality cluster, with the low and mid fatalities clusters exhibiting very similar distributions, with more presence of countries with sub-par laws. When standards are considered, there seems to be better standards in Cluster 3 than in Clusters 1 and 2. It is difficult to conclude that Cluster 1 is different to Cluster 2, as Cluster 1 is significantly smaller than Cluster 2, so what does appear as better standards than Cluster 2, may be more or less the same distribution, with Cluster 2 simply having more observations available, however, considering the

medians (-0.18 and -0.63 respectively) and the means (0.09 and -0.15 respectively), there does seem to be some suggestion that the higher fatalities cluster has better standards than the mid fatalities cluster. However, this may be to underreporting in some of the mid-fatality countries. When values are considered, the high and mid fatalities clusters appear to have lower Values Component 1 scores, with slightly Component 1 one scores being observed in Cluster 2. The low fatalities cluster appears to have high Values Component 1 scores. Values Component 2, however, does not appear to differ substantially between these clusters.

These results suggest a similar pattern to the previous analyses, with high fatalities being associated with worse standards, worse enforcement, and lower Values Component 1 scores, however, mid-level fatalities seem to have unexpected results, with lower values scores and worse standards. It is plausible that this is attributable to underreporting, and that the mid-fatality countries are actually high fatality countries. As such, a robustness check employing modelled fatalities is presented in Figures 32 and 33, as well as Table 18.

Figure 32 3 Means Clustering with Modelled Fatalities



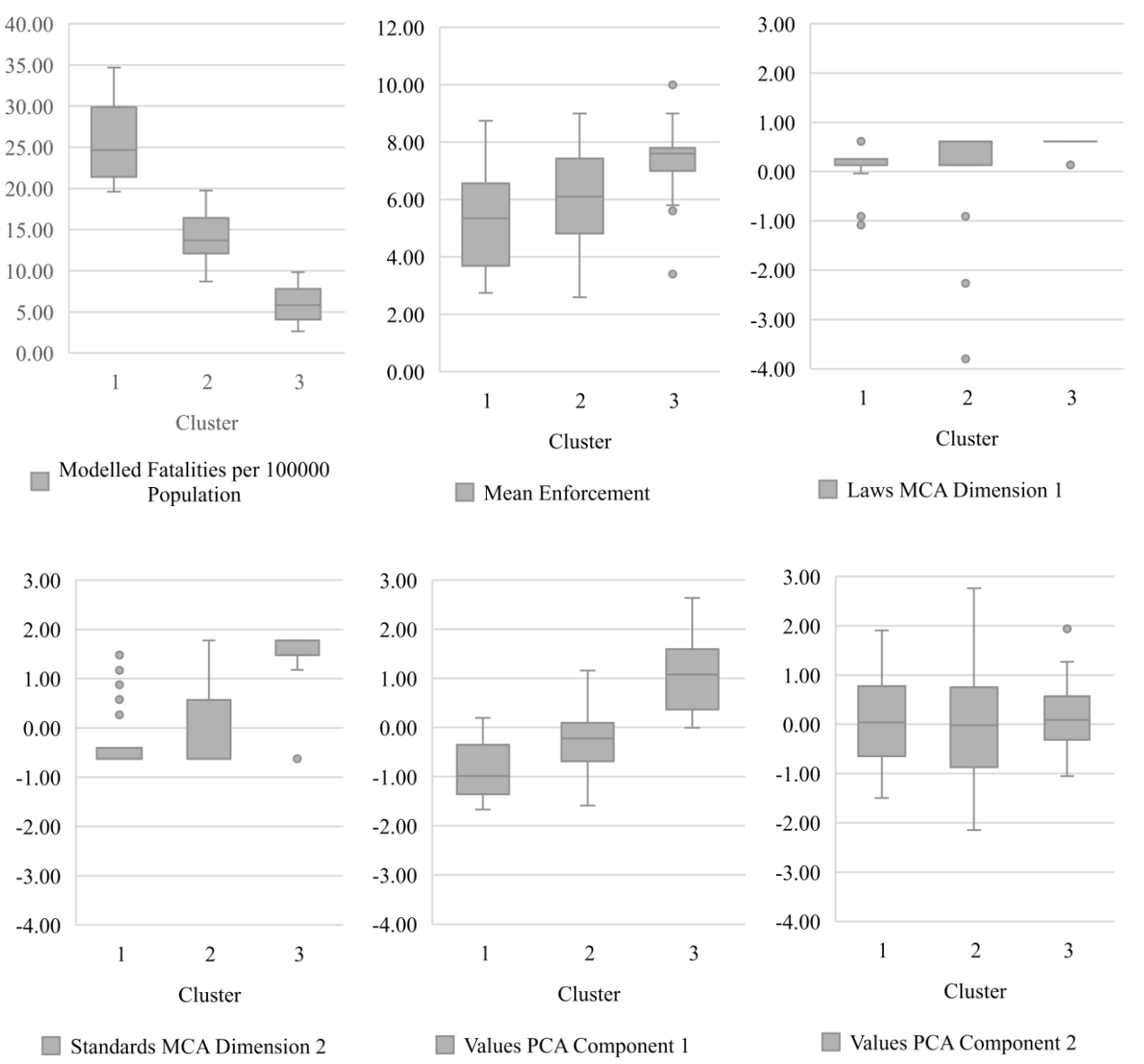
Source: Own Calculations from Inglehart et al. (2021) and WHO (2018)

Table 17 Cluster Characteristics for 3 Means Clustering with Modelled Fatalities: Means

	Cluster 1 (22 Countries)	Cluster 2 (32 Countries)	Cluster 3 (27 Countries)
Modelled Fatalities per 100000 Population	25.71	13.99	5.95
Mean Enforcement	5.25	6.02	7.37
Laws MCA Dimension 1	0.13	0.16	0.60
Standards MCA Dimension 2	-0.29	-0.05	1.45
Values PCA Component 1	-0.89	-0.30	1.04
Values PCA Component 2	0.07	-0.06	0.13

Source: Own Calculations from Inglehart et al. (2021) and WHO (2018)

Figure 33 Cluster Characteristics for 3 Means Clustering with Modelled Fatalities: Box Plots



Source: Own Calculations from Inglehart et al. (2021) and WHO (2018)

As was found before, three cluster groupings with high, mid-level and low fatalities are found. The result for the low fatalities group remains unchanged, with high enforcement, good laws, good standards and high Values Component 1 scores being observed. The results for the mid and high fatalities groups seem to align more with the previous analyses here; more enforcement, better laws and standards, and slightly higher values component one scores are associated with lower fatalities. Notably, the laws result becomes slightly stronger in this graph; laws in the high fatalities group are slightly worse on average than the mid-level fatalities group.

The results in the clustering section mirror those in the OLS section. When reported fatalities are considered, it is difficult to pick up strong results, however, when the far ends of the fatalities

distribution are considered, that is, for very high fatality countries and low fatality countries, it is found that Standards Dimension 1, mean enforcement and Values Component 1 are predictors of fatalities, with strong standards, good enforcement and high Component 1 scores being associated with lower fatalities. When modelled fatalities are considered, this result strengthens, with the separations of the characteristics of the low, mid-level, and high fatalities groups becoming more pronounced.

3.2.4 Discussion

This section has found that laws do not differ significantly between areas, with most countries exhibiting laws that address most or all of the areas outlined by the WHO (2018). As has been shown throughout this thesis, it is likely that this is the result of two aspects of the laws variable: most countries have laws addressing at least 5, 6 of the 7 areas prescribed; and the functional forms of the laws is what is most relevant. Consider speeding laws to illustrate. Simply having a law addressing speeding is not sufficient. As described in section 2.1.3, the speeding law needs to be appropriate for the context; different road types and different circumstances require different speed limits. As such, it cannot be concluded that laws are completely irrelevant and that countries need not address legislative changes; however, simply introducing a law will not be sufficient.

Similarly, the second values component, which emphasises a split between countries with low trust in their police, courts and army, as well as preferences for raising children, has not been found to be strongly associated with fatalities. It appears that trust in the justice system is not driving road behaviour, and hence fatalities.

It has however been found that standards are associated with fatalities, and that countries with better vehicle standards have fewer fatalities. It is not likely that safer cars result in drivers undertaking less risky behaviour and that this is driving the reduction in fatalities. As is suggested by the WHO (2018), vehicle standards make vehicles safer, and make it less likely that a crash will be fatal if it does occur. It seems that this is the result that is being picked up in the data; better standards have found to be associated with lower fatalities, and as such it may be useful for standards to be integrated into the institutional framework.

Enforcement has also been found to be associated with fatalities, with more enforcement being associated with better results. This result is promising, as the differences in enforcement between clusters with low and high fatalities are not substantial, but in general, countries with lower fatalities have enforcement perceptions of around 7-8, whereas countries with high fatalities have enforcement perceptions that are around 4-6. It is difficult to conclude that these results may be transferrable between countries without a panel type specification; or an experimental approach, however, it may

be that enforcement need not be improved dramatically, and that some results may be achieved with small improvements in enforcement. However, as discussed in 3.2.2, enforcement and laws go hand in hand. In order to obtain results, better laws and better enforcement work in tandem to produce lower fatalities.

It is important to consider the work of Mecuro and Medema (2006) once again; who suggest that using formal institutions to induce change is inherently negative in nature; as behavioural change is only observed due to individuals conforming to the law to avoid negative sanctions, such as fines or imprisonment. Similarly, as outlined by Stigler (1974); enforcement is costly, and that it may be infeasible to achieve perfect enforcement without substantial costs being incurred. This sentiment is echoed by Du Plessis et al (2020b) who suggest that whilst improved enforcement may be beneficial in the South African context, it would clog up the courts system with (relatively) menial offences. Aligning the informal institutions and the law, as prescribed by Pejovich (1999) reduces transaction costs, and as such requires less enforcement. As has been shown in this thesis, informal institutions are *strongly* related to fatalities. A consistent result that the split between countries that value economic and political participation and those that focus on economic survival has been found. This brings out three possible routes for reductions in fatalities using informal institutions: either appealing to the pre-existing informal institutions, attempting to change the factors underlying the development of these institutions, or attempting to change informal institutions altogether. Further research is needed to understand the causal mechanism underlying this relationship between values and traffic fatalities, however, once found, it may lay the framework for using informal institutions to attempt to change the issue of traffic fatalities.

The first mechanism is by far the simplest. Once the prevailing informal institutions in a country are understood, it is easier to target campaigns that appeal to common values. For example, if citizens do not respect the law, as they are uncertain of the motives of the law makers, they may choose to not follow traffic laws, not because they do not care about road fatalities, but simply because they do not value the law in general. However, if it is observed that a value is their emphasis placed on family and community, then presenting safe road behaviour not as requiring that they follow the law, but rather as a tool to keep their families and communities safer may bring about changes in road behaviour and thus road fatalities. Thus, if the emphasis is placed rather on following the law because of its benefits to the individual (as determined by their values), rather than following the law for the sake of following the law, some improvements may be observed.

The second mechanism is slightly more difficult and more costly but may fall outside of the scope of a road safety lead agency, however, doing so may have further reaching positive consequences. Once the prevailing informal institutions as well as their origins are understood, these origins may be used

to improve fatalities. For example, as before, if the citizens do not respect the law and thus do not follow it because they do not trust the motives of their law makers, it would be useful to first attempt to understand why this is the case. If citizens have lost faith in their government because of rampant corruption, and corruption is reduced, citizens may have a greater willingness to follow the law, as, the law is no longer seen as an opportunity for corrupt police and courts to accept bribes, or for corrupt governments to serve their own interests, but rather as a government's attempt to protect their citizens. If the underlying forces are changed, greater compliance may be observed.

Lastly, the final mechanism by which informal institutions may be used to improve outcomes is by changing the informal institutions themselves. This is an undesirable option, as changing the culture of an entire population is both difficult may border on unethical and does not address the mechanism through which this culture impacts behaviour (and thus outcomes). Changing the culture itself is undesirable, however, understanding how culture impacts behaviour and decision-making may allow for creative solutions to be devised to align informal institutions and formal institutions, to best address road fatalities, as well as other economic outcomes.

4 Developing a Better Road Safety Framework in South Africa

4.1 The State of South African Road Safety and Road Safety Policies

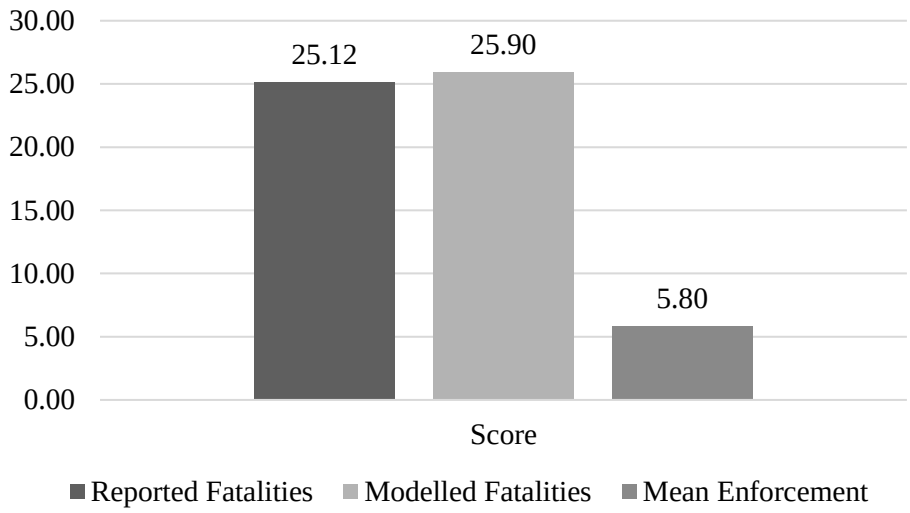
Given that this thesis was grounded in issues of road safety in South Africa, this section discusses the South African institutional context. The Road Traffic Management Corporation (RTMC) is the lead agency tasked with managing road safety in South Africa. The RTMC (2020) identified that the following causes of crashes, injuries and fatalities on the roads: reckless driving by the youth, alcohol abuse, poor road user attitudes towards road safety, and fraud and corruption at Driving Licence Testing Centres (DLTCs)[18]. In response, efforts in the past decade have been concentrated on developing the RTMC's National Road Safety Strategy (NRSS) (2016-2030), which is well founded in the principles outlined by the WHO (RTMC, 2020). The WHO spearheaded the United Nations Decade of Action (UNDA) for Road Safety (2011-2020), as motivated in the 2009 Global Road Safety Status Report (RTMC, 2017). South Africa endorsed this plan, and consequently, has had a renewed focus on road safety in the past decade.

South Africa's road safety strategy is founded on the principles outlined by the UNDA: road safety management, safer roads and mobility, safer vehicles, safer road users and adequate post-crash response. In addition, South Africa places an emphasis on the 'Safe Systems' approach, which requires that road safety policy is designed to both expect and accommodate human error (RMTC 2017). Similarly, the RTMC, over and above the recommendations of the WHO, places an emphasis on legislation[19] as well as youth, as factors that are especially pertinent in South Africa.

Some improvements have been made since the drafting of the NRSS. The GRSSR (2018) reports that, in 2016, fatalities in South Africa amounted to 14 071 (25.12 per 100000 population). The RTMC reports that, in 2020, road fatalities have since stabilised and started to decline, with 12 503 fatalities occurring in the 2019/2020 calendar year. This represents 21.08 fatalities per 100000 population in 2020[20] population figures. In aiming to reduce fatalities further, the 2020 Annual Report lays plans for better enforcement, better training of traffic officers, improving the National Traffic Information System (NaTIS), better crash reporting, stabilising of finances, and tackling fraud and corruption at DLTCs. The 2020 Annual Report aims to radically transform enforcement, and the road safety landscape in the upcoming 5 years.

[18] Whilst a mechanism for how fraud and corruption at DLTCs was not explicitly discussed, it may be that people are not safe drivers, and who would otherwise have failed their driving tests, were able to purchase a driver's license from a corrupt official.
[19] Legislation did not feature as heavily in the UNDA's pillars in 2011, albeit featuring more strongly in later work by the WHO (RTMC, 2017; WHO 2018; WHO 2009; WHO 2011).
[20] 2020 Population figures used are estimated by the World Bank (2021).

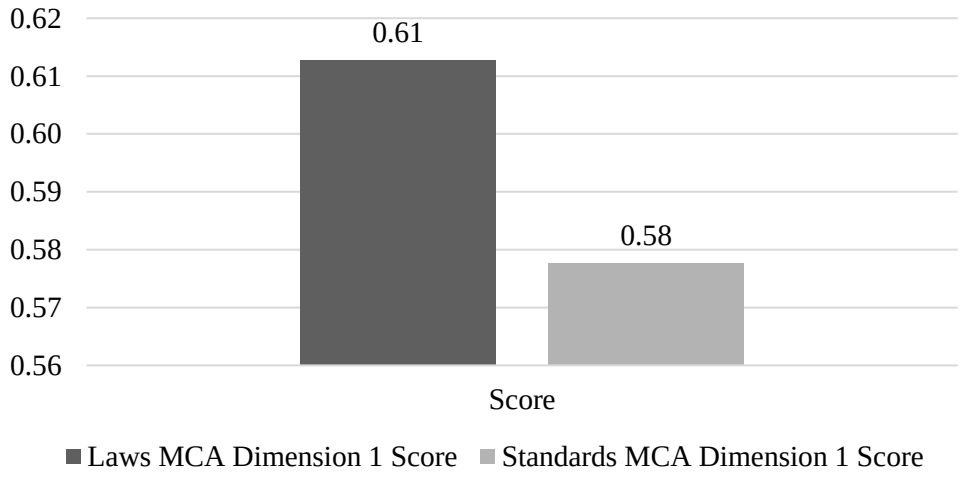
Figure 34 Fatalities and Enforcement in South Africa



Source: Own Calculations from WHO (2018)

Figure 34 shows the state of fatalities and enforcement as investigated in this thesis. A reassuring factor is that South African road safety reporting is seen as accurate as per the WHO, and very little underreporting is estimated. In addition, the RMTC's 2020 report has shown that fatalities are significant. Similarly, enforcement is perceived to be fair, with an average score of 5.8. The GRSSR (WHO, 2018, p.235) posits that helmet wearing is enforced well, with an enforcement perception score of 8. Speeding enforcement is perceived to be fair, with a score of 6, as are drinking and driving, child restraints and seatbelts, with scores of 5. Given the results shown in this thesis, the improved enforcement prioritised by the RTMC (2017;2020) may assist in reducing fatalities.

Figure 35 Laws and Standards in South Africa



Source: Own Calculations from WHO (2018)

Figure 35 shows the formal institutional landscape, as investigated in this thesis. South Africa has a strong suite of laws, with laws in every area prescribed by the WHO. Standards are better than average in South Africa, with the country displaying 4 out of the 8 best practise standards prescribed by the WHO. There is still some scope for improvements here, and the use of vehicle standards, which are shown to have a significant impact on fatalities, is not emphasised by the RTMC (2017;2020). This would be in line with their 'Safe Systems' approach, which emphasises that road systems should be designed to both expect and accommodate human error. Their approach emphasises speed management, and notes that the limits of the human body ought to be taken into account when designing and maintaining roads and vehicles (RTMC, 2017). However, employing safe standards may help ensure that crashes themselves are less fatal. As such, integrating improved standards in South Africa may be able to improve outcomes.

4.2 Norms and Values in the South African Road Safety Context

Returning to the work of Du Plessis et al. (2020a), this thesis casts its focus to the state of informal institutions in South Africa. Du Plessis et al. (2020a) hypothesise that high fatalities are probably driven by inappropriate norms, values and behaviours amongst drivers. In addition, they outline the role played by enforcement. Most infringements are difficult to detect and punish, and the legal and administrative systems that are responsible for this ought to do this do not function well. Citizens do not want to follow the law, and due to shortcomings in the administrative system, citizens are able to avoid compliance with few consequences[21].

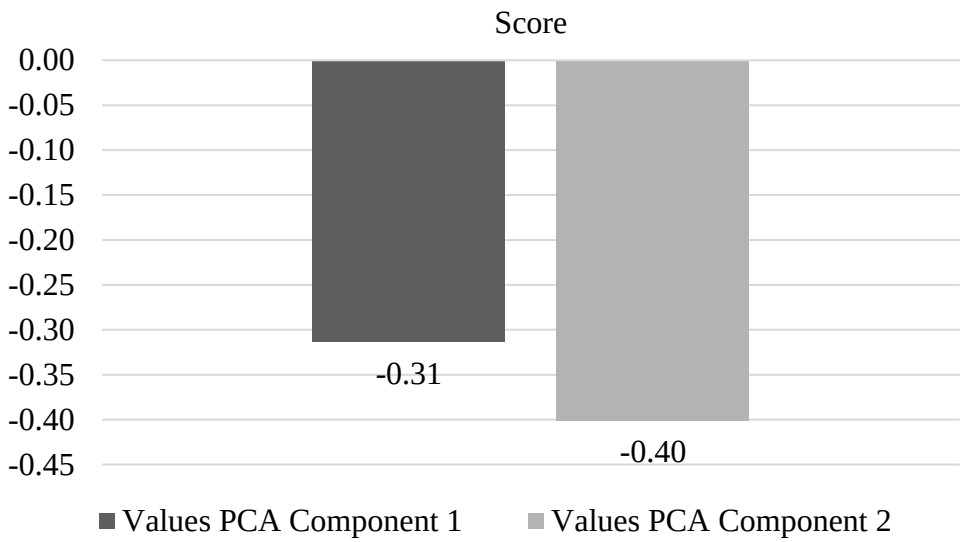
Sinclair (2013), similarly, investigates attitudes, norms and driving behaviour among young drivers in South Africa and Sweden. Sinclair (2013) considers whether the background of South African youth, which is characterised by tumultuous social change, as well as high levels of aggression and violence has any impact on driving standards and behaviour. She finds that, whilst South African youth are aware of issues surrounding road safety, and recognise dangers of poor driving, that there is insufficient acknowledgment of their personal responsibility for this situation. This is in line with the theory of compliance outlined by Feldman and Kaplan (2021) in section 2.4.2, in that individuals may act in self-blindedly or self-justifiably unethical ways. Crucially, Sinclair (2013) finds that young South African drivers perceive the behaviour of other drivers to be poor, and that other South Africans are not law abiding, whereas their perception of their own behaviour is that they are law abiding. This may reflect the principal of non-compliance through self-justification of unethicality discussed in

[21] A periphery issue is that the legal framework which may align the incentives of drivers with the informal institutions exists but is not in use. The Administrative Adjudication of Road Traffic Offenses (AARTO) Act (No 46 of 1998) would establish a streamlined fine and demerit system, that would suspend or cancel the licences of consistent offenders. Implementing AARTO would assist in making the consequences of poor driving and not complying with the law more salient to drivers. However, the implementation of AARTO has been delayed. (Du Plessis et al., 2020a)

section 2.4.2. Lastly, respondents perceived traffic officials in general (not simply DLTC officials) to be corrupt, and as such, this lack of respect for the government undermines traffic laws further.

Figure 36, below, shows the Values Component 1 and Component 2 scores.

Figure 36 Informal Institutions in South Africa



Source: Own Calculations from Inglehart et al. (2021)

Figure 36 shows that South Africa skews towards lower Component 1 and Component 2 scores. This indicates that South African place slightly less emphasis on economic and political participation and are somewhat less socially liberal than the rest of the world. The low Component 2 scores suggest that the country might skew towards less trust in the justice system and higher respect for authority. However, both of these scores are quite moderate. Table 18 breaks down these scores, by showing the standardised scores for each of the 24 values outlined by the WVS.

Table 18 Informal Institutions in South Africa

		Number	Value	Standardised Score
Secular	**Defiance**	1	Nationalism	0.34
		2	Respect for authority	0.56
		3	Devoutness	0.44
	Disbelief	4	Practise of religion	0.6
		5	Religiousness of person	0.86
		6	Religion important	0.64
	Relativism	7	Conformative 1	-0.33
		8	Conformative 2	-0.43
		9	Conformative 3	-0.74
	Scepticism	10	Trust in courts	0.47
		11	Trust in police	0.27
		12	Trust in army	-0.33
Emancipative	**Autonomy**	13	Independence valued in kid	-0.07
		14	Obedience valued in kid	0.22
		15	Imagination valued in kid	-0.47
	Gender Equality	16	Political	0.03
		17	Education	0.2
		18	Jobs	0.35
	Choice	19	Homosexuality Acceptable	-0.05
		20	Divorce Acceptable	-0.44
		21	Abortion Acceptable	-0.25
	Voice	22	Voice 1	-0.35
		23	Voice 2	0.34
		24	Voice 3	0.06

Source: Own Calculations from Inglehart et al. (2021)

Here, it is seen that South Africa has lower than average scores in defiance and disbelief variables, symbolising that South Africans place an emphasis on respect for authority and respect for elders and are also quite religious. However, South Africans are less conformative than other countries. In addition, trust in the courts system is higher than average, suggesting that there may not be a perception of corrupt judges, but none of the scepticism (or trust in the justice system variables) are particularly strong. Notably, trust in the police is fairly average, suggesting that whilst there may not be outright disdain for law enforcement, there is certainly a degree of scepticism. Lastly, South Africa skews somewhat socially conservative, slightly lower than average importance placed on imagination being valued in children, as well as lower than average approval of homosexuality, divorce and abortion. Additionally, the scores that emphasise voice and gender equality are also average.

These scores may either reflect three underlying types of South Africans; these may be the 'true' average values in South Africa, with most South Africans reflecting very moderate views in comparison to the rest of the world. These differences may also be driven by two separate groupings of values in South Africa. As is well established, South Africa has high inequality, with a small population of very rich South Africans, and a much larger population of poorer South Africans. As

such, two distinct value groupings may also exist, due to differing economic conditions. However, these may also reflect a country in transition from lower emancipative and secular values to higher emancipative and secular values. Without further research, it is impossible to speculate more deeply about this, however, these values do provide a strong basis for further consideration of the interactions between formal and informal institutions.

4.3 Institutions and Enforcement in SA; Proposed Amendments to the National Road Safety Strategy

Given the discussions in the preceding sections, two distinct findings are worth noting for improved road safety in South Africa. First, the NRSS proposed by the RTMC (2017) is well aligned with the prescriptions of the WHO and is likely to bring about significant changes in road safety outcomes. However, it is worth noting, as per the findings of this thesis, that some additional considerations around standards and informal institutions may be of value. First, as South Africa only has 4 of the 8 standards considered in this thesis, some additional regulations regarding the use of standards may improve road safety outcomes. This may feature as part of a long-term plan, and all newly manufactured or imported cars could be required to be subjected to all the required regulations.

Secondly, as the values distribution is moderate, that is, South Africans are not strongly against political and economic participation, they do not strongly distrust the police and courts, and they do have respect for authority, improved enforcement may in fact work to reduce fatalities. However, there may still be some resistance. As outlined by Sinclair (2013); there are perceptions of corruption in the government, and specifically in the traffic management system, that are present. Reducing corrupt behaviour and improving the perception and functioning of the road management systems may result in greater willingness to comply with the law. Lastly, the work of Feldman and Kaplan (2021) in relation to the findings of Sinclair (2013) is especially pertinent: nudges may assist in ensuring that better decisions around road safety are made, and may ensure that citizens comply with the law, even when it is not actively being enforced.

5 Conclusion

This thesis has presented an institutional analysis of road safety outcomes. Du Plessis et al. (2020a), which posits that inappropriate norms, values and behaviours, as well as poor enforcement, are drivers of high fatalities in South Africa was taken as a starting point. The WHO (2018) outlines that road safety may be improved by focusing on safer roads, safer vehicles, improved institutions and institutional management, and post-crash care. As such, an institutional lens is employed to analyse this problem. First, the theory surrounding institutions was presented. Institutions have been linked to economic outcomes successfully in the literature, with laws and values being linked to economic

outcomes. As such, changes in the law are able to bring about changes in economic outcomes. The literature, however, cautions against simply transposing laws from one economy to another, and emphasises that in order for changes in legislation to be successful, the laws must be in line with the prevailing informal institutions (Pejovich, 1999; Chang, 2011). The literature also emphasises the role played by enforcement. Enforcement helps ensure that citizens follow the law, however, it is a costly endeavour, and significant forethought into the most appropriate type of enforcement for a given situation is needed. Enforcement is envisioned as acting both as a deterrent of behaviour, in the case of traditional enforcement, however, nudges, reminders and informal institutions may be less costly forms of enforcement relied on to ensure citizens comply.

The literature on road safety and institutions is sparse, and as such, this thesis has aimed to fill a gap in the literature by investigating how formal institutions, informal institutions and enforcement interact to influence road fatalities. This study synthesises two data sources: the 2018 Global Road Safety Status Report (GRSSR) (WHO, 2018), as well as the first six waves of the World Values Survey (WVS) (Inglehart et al. 2020) to investigate road safety outcomes. Multiple Correspondence Analysis (MCA) and Principal Component Analysis (PCA) were employed as dimensionality reduction tools, as the sample size is small, and higher degrees of freedom are necessary to perform inference. OLS and Cluster Analysis were employed to find linear and non-linear relationships between formal institutions, informal institutions, and enforcement.

Specifically, it is found that the presence of a law in a country cannot conclusively be linked to road fatalities. On its own, the law is an insufficient tool for reducing road fatalities. However, OLS results find that when considered alongside enforcement, the law is not irrelevant. Well enforced laws are found to have a significant effect on road fatalities. In addition, vehicle standards, as a form of formal institutions, are found to have a positive effect on road fatalities. As is outlined in the literature, vehicle standards make vehicles safer, so that if individuals are involved in a crash, it is less likely to be fatal.

Lastly, informal institutions are found to be strongly correlated with road fatalities, with countries exhibiting preferences for political and economic participation, as well as social liberalism, experiencing lower road fatalities. Notably, values linked to trust in the courts and the police, were not significantly linked to lower fatalities. Whilst no causal mechanism has been identified, it is hypothesised that for countries with more emphasis on economic and political participation, there is more respect for the law. Even if individuals do not agree with the law, as it has come into the fore as part of a democratic process, they are more willing to follow it. Similarly, the values found to be significantly related to fatalities resemble the emancipative index, as described by the Welzel (2013). This index separates countries that are concerned with economic stability from countries that are

concerned with economic freedom. Countries with low emancipative scores are termed to be concerned with economic 'survival'. Individuals in these countries may be faced by corrupt or untrustworthy governments, and as such, they may be less inclined to follow the law. In addition, a focus on survival may reflect economic circumstances that do not allow individuals to be concerned with social responsibility and as such, these countries may be more prone to self-justified unethicality, that is, a tendency to justify unethical behaviour if it is in an individual's self-interest to do so. Individuals concerned with economic survival in their day to day lives may not have the space for consideration of responsibility towards others.

The South African case has also been considered. South Africa has good laws, but high fatalities. The literature hypothesises that this is due to poor enforcement of laws, perceptions of corruption, and inappropriate driver behaviour. This thesis finds that some scope for improved standards in South Africa exists, which may result in less fatal crashes in spite of poor driver behaviour. Lastly, as enforcement in South Africa is one of the areas prioritised by the RTMC, this thesis cautions that values in South Africa may result in this not being as effective as is hoped. Whilst South Africans were not found to have extremely high distrust in the justice system, nor a lack of emphasis on political and economic participation, values fall in the middle ground on most metrics, suggesting that compliance is not a given. It is hypothesised that respect for the law still needs to be earned in South Africa, as perceptions of corruption have clouded willingness to comply with the law. As such, the strong legislative framework in South Africa may be irrelevant in solving the issue of high road fatalities, and actions need to be taken to align formal and informal institutions first.

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Appendix A WHO Estimation Strategies

In estimating road traffic fatalities, the WHO classifies countries in four groups based on criteria. A different estimation strategy is used in each group. The WHO gathers data from Ministries of Health from around the world (WHO 2018, p.289). Deaths that follow from a road traffic crash are counted as fatalities, regardless of when they occur. Where countries did not have good data, estimates based on covariates (including measures of road transport factors and legislation, road use, governance, enforcement and economic development) were generated. Table A1 that follows summarises this.

Table A1 Estimation Strategy Used by WHO

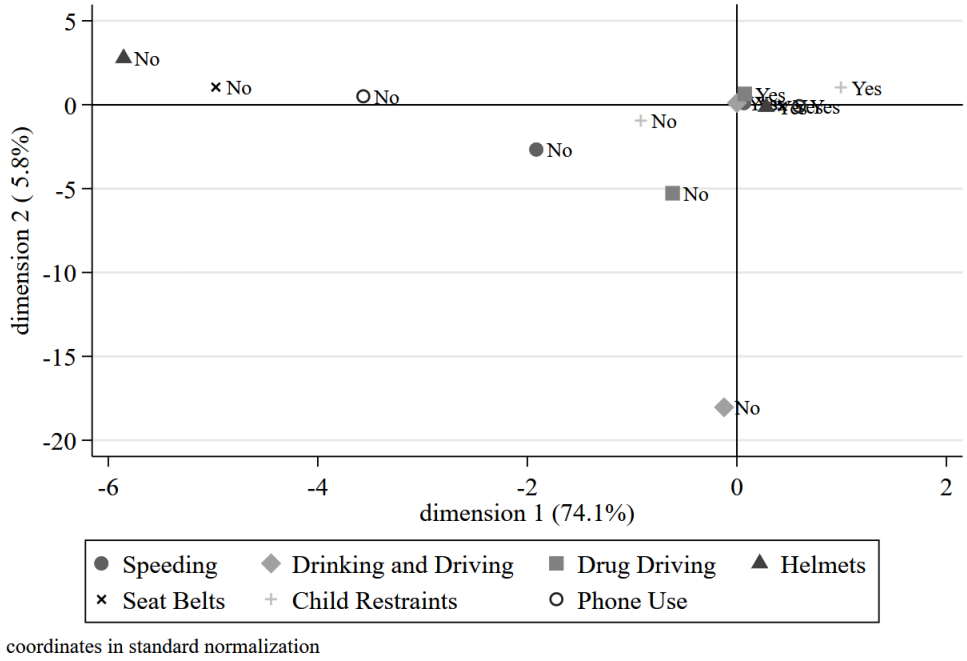
Group	Criteria	Estimation Strategy
Group 1	Countries with Death Registration data 86 countries Completeness for the year (2016) is estimated to be 80% or more Average Completeness for the decade estimated to be 80% or more	Calculated based on data reported to the WHO Adjusted as per completeness estimation (i.e., if completeness was estimated to be 80%, the death rate was adjusted by multiplying by 100/80) If death registration data, where the estimated fatalities exceeded the number of reported fatalities, the death registration-based estimate was used (9 countries). If death registration data for 2007-2015 exists, deaths in 2016 were estimated based on a projection of the trends in surveillance data (54 countries). If the reported number of Road traffic deaths adjusted to unlimited time exceeded the estimate based on death registration data, the reported deaths were used (23 countries)
Group 2	Countries with other sources of information on total deaths by cause were available for a single year or only few earlier years.	Regression estimate. (3 countries) The method uses a negative binomial regression, including the following covariates: log GDP, vehicles per capita, road density, speed limits on rural and urban roads, health system access, alcohol apparent consumption, working age population, percentage motorbikes, corruption index, national policies for walking and cycling, and population.
Group 3	Countries with a population of 150000 or less.	Reported deaths were used directly without adjustment.
Group 4	Countries without eligible death registration data/data less than 80% complete.	Regression estimate, as in Group 2. (77 countries)

Source: Summarised from WHO (2018, p. 288)

Appendix B MCA and PCA Results

Figure A1 below shows the loading plot for MCA performed on laws. The axes indicate the percentage of variation explained by the relevant dimension.

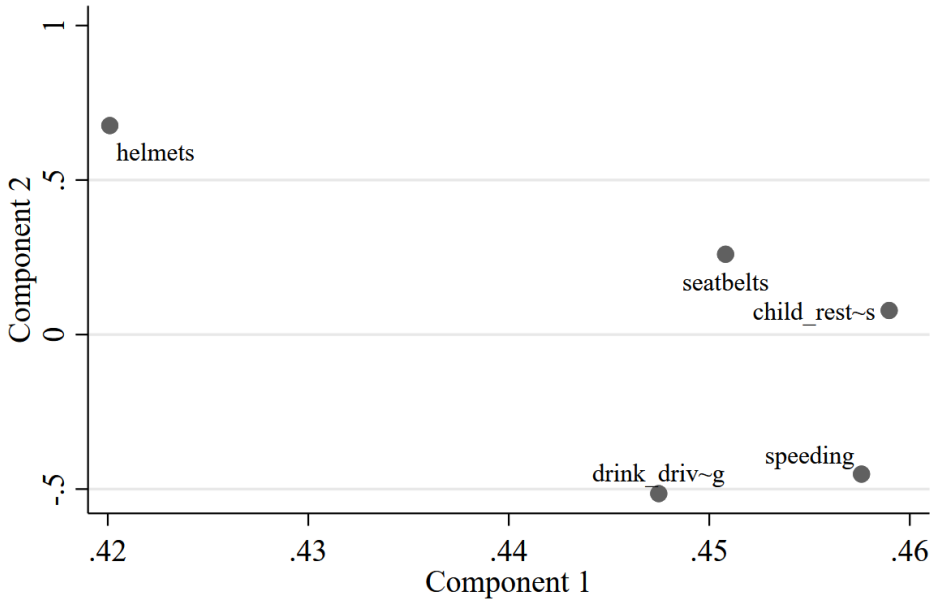
Figure A1 Multiple Correspondence Analysis: Laws



Source: Own Calculations from WHO (2018)

Figure A2, below, shows the PCA loading plot for enforcement perception.

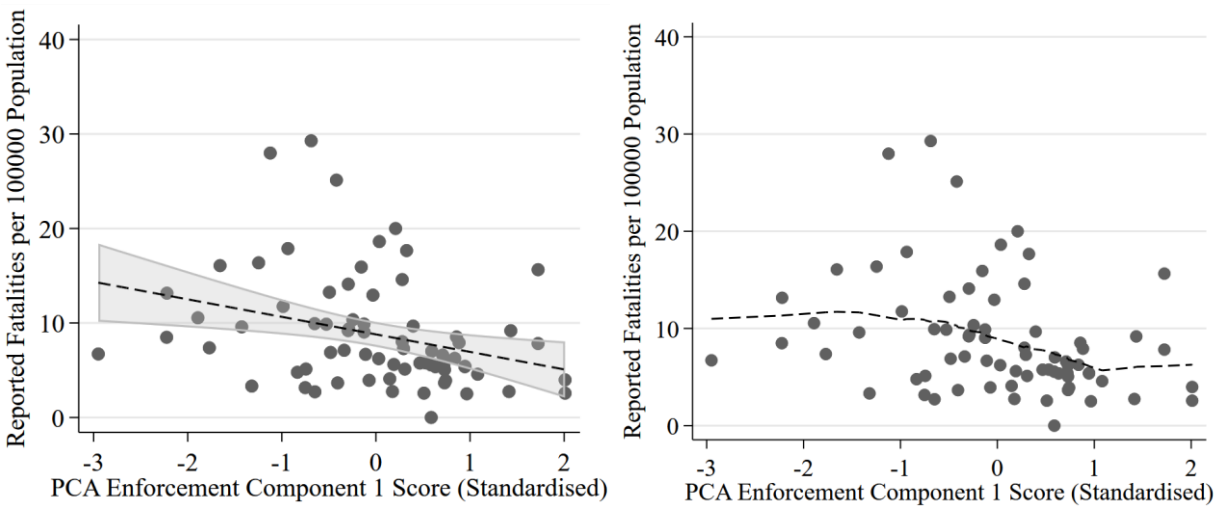
Figure A2 Principal Component Analysis: Enforcement Loading Plot



Source: Own Calculations from WHO (2018)

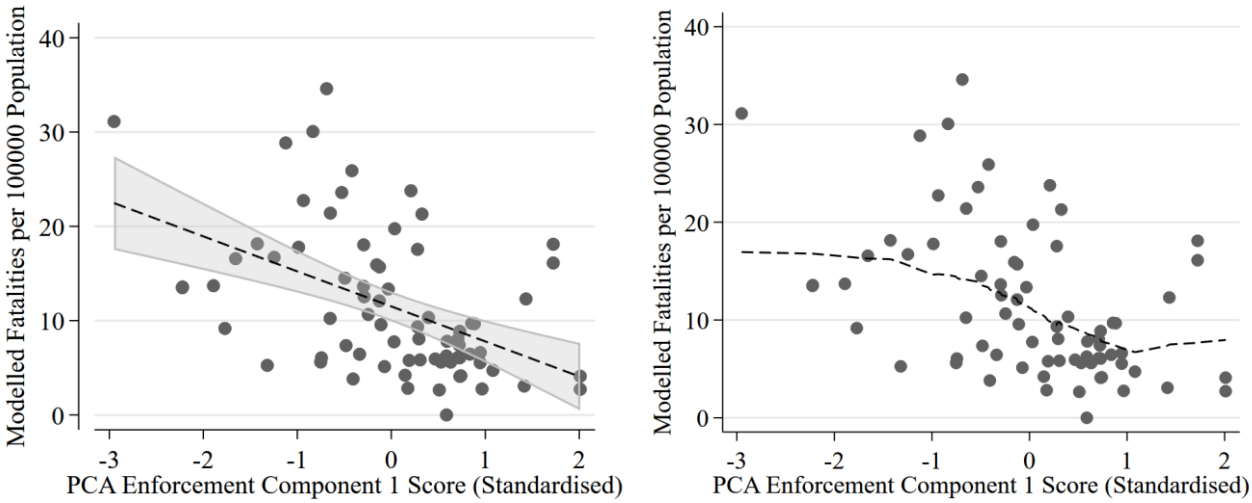
Figures A3 and A4 show scatterplots with OLS and LOWESS lines of best fit, for reported fatalities and modelled fatalities respectively, showing a weakly negative relationship in all four graphs. A high component one score here is related to a high level of enforcement. If the line of best fit is considered, both modelled and reported fatalities show a negative relationship between enforcement and fatalities, with better enforcement being linked to lower fatalities. However, considering the scatter plot only, there is a lot of noise in the data, as is also shown by the LOWESS line of best fit.

Figure A3 Reported Deaths by Enforcement Perception PCA Scores



Source: Own Calculations from WHO (2018)

Figure A4 Modelled Deaths by Enforcement Perception PCA Scores



Source: Own Calculations from WHO (2018)

The co-efficients, significance, observations and R^2 scores are shown in Table A2 below.

Table A2 Summary of Linear Best Fit Results

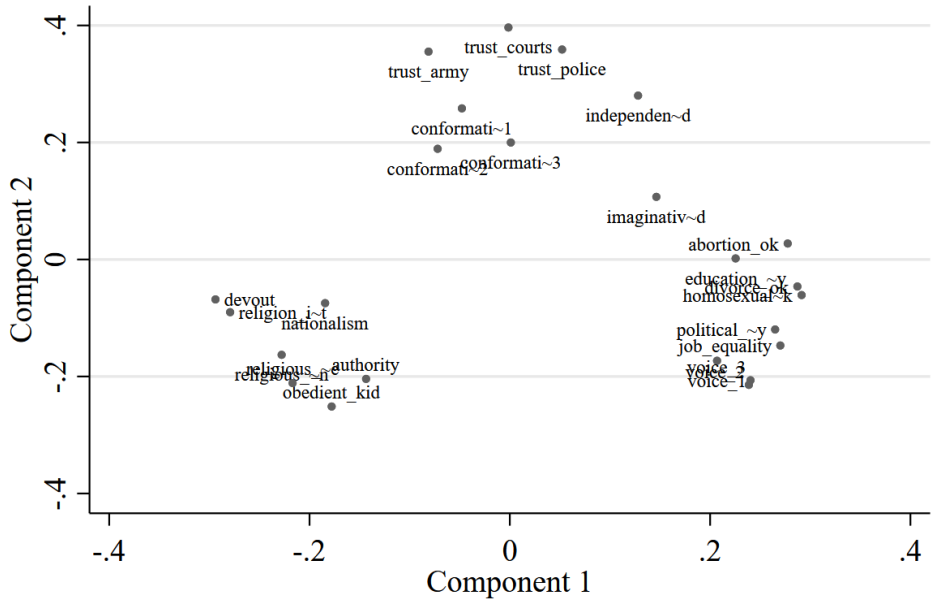
	PCA Enforcement Dimension 1 (Standardised) (Reported Fatalities)	PCA Enforcement Dimension 1 (Modelled Fatalities)
Co-efficient	-1.853	-3.713
P Value	0.007	0.000
Observations	73	73
R-Squared	0.098	0.233

Source: Own Calculations from Inglehart et al. (2021) and WHO (2018)

A high component one score here is related to a high level of enforcement. If the line of best fit is considered, both modelled and reported fatalities show a negative relationship between enforcement and fatalities, with better enforcement being linked to lower fatalities. However, considering the scatter plot only, there is a lot of noise in the data, as is also shown by the LOWESS line of best fit.

Figure A5 shows the loading plot obtained when PCA is performed on the 24 values in the WVS data set. 3 groupings are observed, with trust in the justice system, conformism and valuing independence in children clustered together, loading highly on dimension 2. Similarly, devout, nationalism, authority, obedience valued in children and all the religious variables cluster together. Lastly, imagination is valued in children, as well as all three voice, choice and gender equality variables cluster together.

Figure A5 Principal Component Analysis: Values Loading Plot



Source: Own Calculations from Inglehart et al. (2021) and WHO (2018)

Appendix C OLS

Table A3 shows the reduction from the full interactions specification, to the narrowest interactions specification. Regression A1 shows only the base specification, whereas A2 shows the full interactions specification. In each subsequent row, the least significant variable is removed. A10 shows the final regression in which only the interaction between standards and Values Component 1 remain significant.

Thereafter, Table A4 shows the list of observations, followed by a discussion of the attrition in observations in the regressions in section 3.2.2.

Table A3 Regressions A1-A10

	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10
VARIABLES	**Reported Fatalities**	**Reported Fatalities**	**Reported Fatalities**	**Reported Fatalities**	**Reported Fatalities**	**Reported Fatalities**	**Reported Fatalities**	**Reported Fatalities**	**Reported Fatalities**	**Reported Fatalities**
Laws MCA Dimension 1 (Standardised)	0.611	-1.394	-1.484	-1.342	-0.811					
	(0.615)	(0.460)	(0.414)	(0.452)	(0.550)					
Standards MCA Dimension 1 (Standardised)	-0.492	1.839	1.216	0.910						
	(0.602)	(0.631)	(0.557)	(0.645)						
Mean Enforcement	-0.640	-0.568	-0.597	-0.514	-0.505	-0.541	-0.471	-0.458		
	(0.195)	(0.283)	(0.238)	(0.282)	(0.287)	(0.249)	(0.298)	(0.309)		
Values PCA Component 1 (Standardised)	-1.236	1.902	2.411	0.754	0.983	0.646				
	(0.232)	(0.661)	(0.482)	(0.562)	(0.411)	(0.538)				
Laws MCA Dimension 1 (Standardised)# Values PCA Component 1 (Standardised)		-1.486	-1.406	-1.521	-1.761	-1.331	-1.154			
		(0.478)	(0.491)	(0.451)	(0.365)	(0.458)	(0.513)			
Standards MCA Dimension 1 (Standardised)# Values PCA Component 1 (Standardised)		-1.184	-1.133	-1.486	-1.627*	-1.695*	-1.470*	-1.729**	-1.828***	-2.336***
		(0.332)	(0.338)	(0.126)	(0.0765)	(0.0619)	(0.0748)	(0.0171)	(0.00796)	(0.000126)
Mean Enforcement # Values PCA Component 1 (Standardised)		-0.198	-0.290							
		(0.786)	(0.601)							
Laws MCA Dimension 1 (Standardised)# Standards MCA Dimension 1 (Standardised)		-3.239	-3.526	-3.049	-1.566	-1.313	-1.087	-1.551	-1.926	
		(0.426)	(0.350)	(0.402)	(0.352)	(0.418)	(0.489)	(0.268)	(0.146)	
Laws MCA Dimension 1 (Standardised)# Mean Enforcement										
Standards MCA Dimension 1 (Standardised)# Mean Enforcement		-0.121								
		(0.846)								
Constant	13.67***	15.84***	16.00***	15.47***	15.24***	15.08***	14.35***	14.38***	11.75***	11.43***
	(3.35e-05)	(1.24e-05)	(4.89e-06)	(3.07e-06)	(2.79e-06)	(2.85e-06)	(1.23e-06)	(1.07e-06)	(0)	(0)
Observations	81	81	81	81	81	81	81	81	83	83
R-squared	0.113	0.212	0.211	0.208	0.206	0.202	0.198	0.193	0.189	0.167
P-Values in Parentheses										
***** p<0.01, ** p<0.05, * p<0.1**										

Source: Own Calculations from Inglehart et al. (2021) and WHO (2018)

Table A4 List of Observations

Features in Both Data Sets	Features in GRSSR Data Only	Features in WVS Data Only
Albania	Afghanistan	Algeria
Argentina	Angola	Andorra
Armenia	Antigua and Barbuda	Haiti
Australia	Austria	Hong Kong
Azerbaijan	Barbados	Macau
Bangladesh	Belgium	Montenegr0
Belarus	Belize	Nicaragua
Bolivia (Plurinational State of)	Benin	North Mac
Bosnia and Herzegovina	Bhutan	Palestine
Brazil	Botswana	Puerto Rico
Bulgaria	Burundi	Taiwan
Burkina Faso	Cabo Verde	Yemen
Canada	Cambodia	Zambia
Chile	Cameroon	
China	Central African Republic	
Colombia	Chad	
Croatia	Comoros	
Cyprus	Congo	
Czechia	Cook Islands	
Dominican Republic	Costa Rica	
Ecuador	Côte d'Ivoire	
Egypt	Cuba	
El Salvador	Democratic Republic of the Congo	
Estonia	Denmark	
Ethiopia	Dominica	
Finland	Equatorial Guinea	
France	Eritrea	
Georgia	Eswatini	
Germany	Fiji	
Ghana	Gabon	
Greece	Gambia	
Guatemala	Grenada	
Hungary	Guinea	
India	Guinea-Bissau	
Indonesia	Guyana	
Iran (Islamic Republic of)	Honduras	
Iraq	Iceland	
Israel	Ireland	
Italy	Jamaica	
Japan	Kenya	
Jordan	Kiribati	

Features in Both Data Sets	Features in GRSSR Data Only	Features in WVS Data Only
Kazakhstan	Lao People's Democratic Republic	
Kuwait	Lesotho	
Kyrgyzstan	Liberia	
Latvia	Luxembourg	
Lebanon	Madagascar	
Libya	Malawi	
Lithuania	Maldives	
Malaysia	Malta	
Mali	Mauritania	
Mexico	Mauritius	
Morocco	Micronesia (Federated States of)	
Myanmar	Mongolia	
Netherlands	Montenegro	
New Zealand	Mozambique	
Nigeria	Namibia	
Norway	Nepal	
Pakistan	Niger	
Peru	Oman	
Philippines	Panama	
Poland	Papua New Guinea	
Portugal	Paraguay	
Qatar	Saint Lucia	
Republic of Korea	Samoa	
Republic of Moldova	San Marino	
Romania	Sao Tome and Principe	
Russian Federation	Senegal	
Rwanda	Seychelles	
Saudi Arabia	Solomon Islands	
Serbia	Somalia	
Singapore	South Sudan	
Slovakia	Sri Lanka	
Slovenia	Sudan	
South Africa	Suriname	
Spain	Syrian Arab Republic	
Sweden	The former Yugoslav Republic of Macedonia	
Switzerland	Timor-Leste	
Tajikistan	Togo	
Thailand	Tonga	
Trinidad and Tobago	Turkmenistan	
Tunisia	United Arab Emirates	
Turkey	Vanuatu	
Uganda	West Bank and Gaza Strip	
Ukraine		

Features in Both Data Sets	Features in GRSSR Data Only	Features in WVS Data Only
United Kingdom		
United Republic of Tanzania		
United States of America		
Uruguay		
Uzbekistan		
Venezuela (Bolivarian Republic of)		
Viet Nam		
Zimbabwe		

Source: Own Calculations from Inglehart et al. (2021) and WHO (2018)

The attrition in observations in the regressions may be accounted for as follows: where 173 observations are shown, this attrition is due to missing data on GNI for the Cook Islands and Somalia. In these regressions, only the data from the GRSSR data set have been considered. Similarly, where there are 170 observations, data has been lost due to the inclusion of enforcement, which is missing for Austria, Denmark, Papua New Guinea, Germany and the USA. Where 95 observations are shown, only the WVS data has been considered, and 10 of the 105 observations in the WVS portion of the data have been lost due to missing data in one of the 24 values, resulting in the observation being left out of the PCA algorithm. These countries are: Andorra, El Salvador, Estonia, Israel, Kuwait, Qatar, Saudi Arabia, Tajikistan, Uganda, and the United Republic of Tanzania.

When the data sets are combined, 92 observations are seen, as listed in column one of table A4 above. Regressions with 83 observations occur when 9 of the 92 variables are lost due to missing data in one of the 24 values, similar to the above attrition from 105 observations to 95 observations. The observations lost are: El Salvador, Estonia, Israel, Kuwait, Qatar, Saudi Arabia, Tajikistan, Uganda and the Republic of Tanzania. When 81 observations are seen, these occur due to an additional 2 variables being lost due to missing data in enforcement in Germany and the USA.