



The Lead Education and Abatement Design Group
Working to eliminate lead poisoning globally and to protect
the environment from lead in all its uses: past, current and new uses
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Leaded Vehicular Fuel and the Global Effort to Eliminate Lead Poisoning: Factors constraining the global endeavour to eliminate lead additives from vehicular fuel

**Summary of Research for Nairobi presentation handout by Danielle Cooper, UTS,
for The LEAD Group Inc.**

Background

As you're only too aware, exposure to lead has extremely harmful health impacts, which I don't need to go into here. Research has demonstrated that the highly dispersive nature of leaded petrol use means that '[l]eaded gasoline causes more widespread human exposure to lead than any other single source' (Alliance to End Childhood Lead Poisoning 1999: 2). Consequently, '[t]he phasing out of lead from gasoline is considered to be a critical step in reducing population blood lead concentrations' (Wilson and Horrocks 2008: 1).

As of January 2011, the United Nations Environment Programme's Partnership for Clean Fuels and Vehicles (UNEP PCFV) reported that lead has been eliminated from vehicular fuel in all but six countries (Algeria, Afghanistan, Myanmar, North Korea, Iraq and Yemen). Of these countries, only Algeria has set a target phase-out date (2013) for the elimination of leaded vehicular fuel in its markets (UNEP PCFV 2011: 7).

In order to contribute to an understanding of which factors are acting as barriers to the global effort to eliminate lead additives from vehicular fuel, this paper considers the effect of a range of potential determinants of environmental policymaking and implementation across a large number of countries with specific reference to the global effort to eliminate lead additives from vehicular fuel.

The aim of this project was to clarify which factors are constraining change in the global effort to eliminate lead additives from vehicular fuel.

This study does not attempt to quantify the impact of identified determinants on a country's capacity to eliminate lead additive from its vehicular fuel. Rather, this study aims to identify whether or not relationships exist between the proposed determinants of social change and a country's status in relation to the elimination of lead additives from their vehicular fuel.

Methodology

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Phase One: foundational literature review into the mechanics of change, focusing on environmental reform on national scales. This research was undertaken with a view to the development of a list of factors which have been shown to either encourage or inhibit environmental reform in domestic contexts, considering both domestic and international factors.

Phase Two: cross-referencing political, cultural, social, economic and civil society characteristics of each of the countries still reliant on leaded fuel in an attempt to extrapolate potential determinants of lead status

Phase Three: compilation of data. Due to resource limitations, this study did not involve firsthand data collection, but relied upon the following datasets from reputable international organizations:

1. The 'Corruptions Perceptions Index' compiled by Transparency International;
2. The 'Index of Democracy' compiled by the Economic Intelligence Unit;
3. The 'Press Freedom Index' compiled by Reporters Without Borders
4. Per Capita Gross Domestic Product data compiled by the International Monetary Fund;
5. The 'Index of Economic Freedom' compiled by The Heritage Foundation with the Wall Street Journal;
6. The 'Human Development Indicators' compiled by the United Nations Development Programme; and
7. The 'Global Peace Index' compiled by the Institute for Economics and Peace

Data was collected for 2006 and 2010 for most of the factors, although peacefulness datasets were from 2008 and 2010, and HDI datasets relied on 2005 and 2010 data

Phase Four: non-parametric comparative data analysis (to facilitate non-normal datasets generated by the small sample size associated with the unleaded datasets for 2006). This phase consisted of five steps:

1. Histogram: to facilitate visual comparative analysis, and to identify potential trends;
2. Numerical comparison of the median values of the leaded and unleaded datasets for each year: to ascertain, prima facie, whether a difference existed between the leaded and unleaded countries with respect to the isolated determinant (corruption, democracy, press freedom, per capita gross domestic product, economic freedom, human development and peacefulness).
3. Mann-Whitney test of statistical significance: to determine whether the relationship between lead status and the isolated determinant had emerged by chance or was

indicative of a direct relationship between the two variables, assigning a conventional α risk of 0.05;

4. Probability distribution diagnosis performed on the leaded dataset in order to determine the best fit;
5. Cumulative probability function of the distribution: performed up to and including the median of the unleaded dataset. If the cumulative probability distribution indicated that a country in the leaded dataset was found to be four times more likely (or more than four times more likely) to return a value less than or equal to the median value of the unleaded countries, the practical difference in the leaded and unleaded countries in relation to the independent variable was considered substantial.

Phase Five: the findings of this study were then contextualised through reference to generalised theories of environmental reform.

Results

Corruption: it can be confidently asserted that the likelihood that a country is leaded is related to its level of corruption, and that the relationship between corruption levels and the elimination of leaded petrol operated throughout the period 2006 to 2010. It is clear that leaded countries are substantially more likely to be corrupt than unleaded countries, and as time has progressed this trend has become even more pronounced. While in the absence of comparable time series data no definitive statement can be made as to whether the relationship between high levels of corruption and an increased tendency towards reliance on leaded fuel is causative in nature, the strength of the relationship provides considerable support for the proposition that failures to address high corruption levels in countries that continue to rely on leaded petrol may be inhibiting the global effort to eliminate lead additives from vehicular fuel. As the correlation between high corruption levels and reliance on leaded petrol became more pronounced in 2010 than it was in 2006, it can be asserted that the need to address the high levels of corruption present in leaded countries in order to further the global effort to eliminate lead additives from vehicular fuel was more compelling in 2010 than it was in 2006.

Democracy: it can be confidently asserted that the likelihood that a country is leaded is related to its level of democracy, and that the relationship between democracy levels and the elimination of leaded petrol operated throughout the period 2006 to 2010. It is clear that leaded countries are substantially less likely to be democratic than unleaded countries, and that as time has progressed this trend has become even more pronounced.

While in the absence of comparable time series data no definitive statement can be made as to whether the relationship between low levels of democracy and an increased tendency towards reliance on leaded vehicular fuel is causative in nature, the strength of the relationship provides considerable support for the proposition that failures to address low

democracy levels in countries that continue to rely on leaded petrol may be inhibiting the global effort to eliminate lead additives from vehicular fuel. As the correlation between low democracy levels and reliance on leaded petrol became more pronounced in 2010 than it was in 2006, it can be asserted that the need to address the low levels of democracy present in leaded countries in order to further the global effort to eliminate lead additives from vehicular fuel was more compelling in 2010 than it was in 2006.

Press Freedom: it can be confidently asserted that the likelihood that a country is leaded is related to its level of press freedom, and that this relationship between press freedom levels and the elimination of leaded vehicular fuel operated throughout the period 2006 to 2010. It is clear that leaded countries are substantially less likely to exhibit press freedom than unleaded countries, and that as time has progressed this trend has become even more pronounced.

While in the absence of comparable time series data no definitive statement can be made as to whether the relationship between low levels of press freedom and an increased tendency towards reliance on leaded fuel is causative in nature, the strength of the relationship provides considerable support for the proposition that failures to address low press freedom levels in countries that continue to rely on leaded petrol may be inhibiting the global effort to eliminate lead additives from vehicular fuel. As the correlation between low press freedom levels and reliance on leaded petrol became more pronounced in 2010 than it was in 2006, it can be asserted that the need to address the low levels of press freedom present in leaded countries in order to further the global effort to eliminate lead additives from vehicular fuel was more compelling in 2010 than it was in 2006.

Per Capita GDP: the absence of a correlation between a country's per capita GDP levels and its status in relation to the elimination of leaded fuel denies the possibility of a causal relationship between the factors. Consequently, it is possible to conclude that, as in 2006, the lower levels of per capita GDP observable in leaded countries as compared with their unleaded counterparts (in the histogram and box plot generated by the data) was not acting as a barrier to the elimination of lead additives from vehicular fuel in 2010. It can be concluded with confidence that there is no causative relationship between per capita GDP levels and the elimination of lead additives from vehicular fuel, and that the per capita GDP values present in countries still reliant on leaded fuel today is not acting as a barrier to the global effort to eliminate lead additives from vehicular fuel.

Economic Freedom: it can be confidently asserted that the likelihood that a country is leaded is related to its level of economic freedom, and that the relationship between economic freedom levels and the elimination of leaded petrol operated throughout the period 2006 to 2010. It is clear that leaded countries are substantially less likely to exhibit higher levels of economic freedom than unleaded countries.

While in the absence of comparable time series data no definitive statement can be made as to whether the relationship between low levels of economic freedom and an increased tendency towards reliance on leaded fuel is causative in nature, the strength of the relationship provides considerable support for the proposition that failures to address low economic freedom levels in countries that continue to rely on leaded petrol may be inhibiting the global effort to eliminate lead additives from vehicular fuel.

Human Development Indicators: it was possible to conclude with confidence that any relationship which may have been observed between human development values and a failure to eliminate leaded petrol in 2010 (e.g. in the histograms or box plots generated by the data) emerged by chance. The absence of a correlation between a country's human development levels and status in relation to the elimination of leaded fuel denies the possibility of a causal relationship between the factors. Consequently, it is possible to conclude that, as in 2006, the lower levels of human development observable in leaded countries as compared with their unleaded counterparts (illustrated in the histogram and box plot generated by the data) were not acting as a barrier to the elimination of lead additives from vehicular fuel in 2010. We can conclude with confidence that there is no causative relationship between human development levels and the elimination of lead additives from vehicular fuel, and therefore that the human development levels present in countries reliant on leaded petrol is not acting as a barrier to the global effort to eliminate lead additives from vehicular fuel.

Peacefulness: it can be confidently asserted that the likelihood that a country is leaded is related to its level of peacefulness, and that the relationship between peacefulness levels and the elimination of leaded petrol operated throughout the period 2008 to 2010. It is clear that leaded countries are substantially less likely to be peaceful than unleaded countries, and as time has progressed this trend has become even more pronounced.

While in the absence of comparable time series data no definitive statement can be made as to whether the relationship between low levels of peacefulness and an increased tendency towards reliance on leaded fuel is causative in nature, the strength of the relationship provides considerable support for the proposition that failures to address low peacefulness levels in countries that continue to rely on leaded petrol may be inhibiting the global effort to eliminate lead additives from vehicular fuel. As the correlation between low peacefulness levels and reliance on leaded petrol became more pronounced in 2010 than it was in 2008, it can be asserted that the need to address the low levels of peacefulness present in leaded countries in order to further the global effort to eliminate lead additives from vehicular fuel was more compelling in 2010 than it was in 2008.

Contextualisation of Results

Corruption and Democracy

This study was consistent with the existing body of literature in that it confirmed that both low levels of democracy and high levels of corruption make it substantially more likely that a country will continue to be reliant on leaded vehicular fuel, and provides support for the proposition that failures to address the low levels of democracy and high levels of corruption present in leaded countries may be inhibiting the global effort to eliminate lead additives from vehicular fuel. The relationships between low levels of democracy, high levels of corruption and a failure to eliminate lead additives from vehicular fuel was shown to have been operative in both 2006 and 2010.

The results of this study, supported by the wider body of environmental reform literature and read in light of the damning body of anecdotal evidence implicating Innospec (the world's sole supplier of TEL) as taking advantage of corruption in countries still reliant on leaded petrol in order to ensure that their product continued to be imported and added to vehicular fuel, make it possible to conclude that the relationship between high levels of corruption and failures to institute environmental reform which has been observed in the wider body of literature holds true in relation to the specific issue of the global effort to eliminate lead additives from vehicular fuel.

Freedom of Information

Environmental reform literature provides support for the proposition that countries with higher levels of freedom of information are more likely to have the capacity to introduce and implement reforms directed at environmental protection, holding that higher levels of freedom of information are conducive to increased public participation and civil society involvement, which in turn has positive effects on environmental protection outcomes (Martens 2006: 211). This body of literature was considered to qualify freedom of information as a potential determinant of environmental policy for consideration in this study. While no comprehensive datasets measuring the relative levels of freedom of information available in countries across the world was available, the Press Freedom Index compiled by *Reporters Without Borders* was analysed as a proxy for freedom of information levels across the world.

Results indicated high levels of correlation between press freedom levels and the likelihood that a country had eliminated lead additives from petrol, and provided strong support for the proposition that the lower press freedom levels observable in countries that continued to utilise leaded petrol was acting as a barrier to the global effort to eliminate lead additives from vehicular fuel. Although press freedom can only be considered a proxy for freedom of information, in the context of the wider body of literature supporting the hypothesis that high levels of freedom of information are conducive to the introduction and implementation of environmental reforms, it is reasonable to theorise that the relationship between press freedom and the elimination of leaded petrol is indicative of the broader effect of freedom of information (which will frequently coincide with high levels of press freedom). In this context, the results of this study provides a level of support for the proposition that

theorised lower levels of freedom of information in countries that continue to utilise leaded vehicular fuel may be acting as a barrier to the global effort to eliminate leaded petrol.

Economic Factors, Poverty, Human Development and the Elimination of Leaded Vehicular fuel

The disparity in findings between the effects of per capita gross domestic product (confirmed not to act as a determinant) and economic freedom (confirmed to potentially act as a determinant) on the effort to eliminate lead additives from vehicular fuel indicates that the relationship between economic factors and the elimination of leaded fuel is not explicable solely by reference to national income.

This study demonstrates a close correlation between economic freedom levels and the elimination of lead additives from vehicular fuel. In both 2006 and 2010, countries which continued to add lead to their vehicular fuel exhibited substantially lower levels of economic freedom as compared with their unleaded counterparts. Statistical analysis indicated that this relationship did not emerge by chance, and that the difference in levels of economic freedom between the two datasets was sufficiently substantial to have a practical effect. Although the lack of comparable time series data precluded a definitive determination of whether the relationship between economic freedom levels was causative or merely correlative, the strength of the relationship between economic freedom levels and status in relation to the elimination of leaded vehicular fuel provided considerable support for the proposition that failures to address low levels of economic freedom in countries still reliant on leaded petrol may have been acting as a barrier to the global effort to eliminate lead additives from vehicular fuel. This finding is consistent with the existing consensus within the body of literature that economic factors act as a significant determinant of a country's ability to implement environmental protection reforms.

The results of this research determine that there is no relationship between a country's level of human development and its status in relation to the elimination of lead additives from its vehicular fuel. From this finding, it can be stated with confidence that the low levels of human development present in countries still reliant on leaded petrol is not acting as a barrier to the global effort to eliminate lead additives from vehicular fuel. Perhaps the absence in the literature of studies considering the effect of human development levels on national environmental reform and protection policies indicates that no connection has been made between human development levels and environmental policymaking and implementation. Were this the case, this study would then be viewed as consistent with the silence of the literature on this issue. Although this study found no relationship between lead status and human development levels, the absence of literature exploring the relationship between human development levels and environmental reform policymaking more generally suggests that this may be an area for future research.

Conflict and Peacefulness

The results of this study indicate a strong relationship between levels of peacefulness and efforts to eliminate lead additives from vehicular fuel. In 2008, it was possible to conclude that the higher levels of conflict in countries which had failed to eliminate lead was acting as a barrier to change in these countries. The results of this study indicate a strong relationship between levels of peacefulness and efforts to eliminate lead additives from vehicular fuel. In 2008, it was possible to conclude that the failure to address the higher levels of conflict in countries which had failed to eliminate lead may be acting as a barrier to change, and by 2010 the relationship between low levels of peacefulness and a propensity for continued reliance on leaded vehicular fuel was even more pronounced.

These findings are consistent with the analogous and anecdotal evidence of a connection between high levels of conflict and an institutional incapacity to introduce and implement reforms directed at environmental protection. However, in the absence of a stronger body of wider literature exploring the relationship between environmental reform and conflict levels, it is difficult to contextualise the results of this research. Consequently, further research into this area is required.

Directions for future research

The inability of this study to definitively characterise the relationships between determinants and the global effort to eliminate lead additives from vehicular fuel as causative or merely correlative is a serious limitation of this paper. A study that was able to produce comparable time series data in order to develop a definitive test of causality would have considerable value in further illuminating existing barriers to the global effort to eliminate lead additives from vehicular fuel. An analytical framework built on multiple regression analysis would aid in this endeavour, and would also enable a comparison of the relative influence of each potential determinant as a barrier to environmental reform in the area of the elimination of leaded vehicular fuel.

Further study could consider the effect of a number of potential determinants which were unable to be investigated in this study due to a lack of available data. These potential determinants include the presence and activity of environmental NGOs (see Tosun 2007), regulatory structures, technology levels (especially in relation to refining technologies and the numbers of vehicles fitted with catalytic converters – see Hestler and Spilling 2010) and cultural dimensions (see Husted 2005). Each of these factors emerged in the first phase of research of this study as potential barriers to the global effort to eliminate lead additives from vehicular fuel, but due to an inability to access appropriate datasets were excluded from the scope of this paper. Further research addressing these factors would advance our understanding of the factors constraining change in relation to the global effort to eliminate lead additives from vehicular fuel.