HARVARD Kennedy School
JOHN F. KENNEDY SCHOOL OF GOVERNMENT

Harvard Environmental Economics Program

Discussion Paper 10-16

Reducing the impact of price shocks in energy-intensive economies*

Andrew Philip Matheny
MPA/ID Harvard Kennedy School 2010

*This paper won the Harvard Environmental Economics Program's 2010 The Enel Endowment Prize for the Best Paper by a Masters Student

Email: heep@harvard.edu Website: www.hks.harvard.edu/m-rcbg/heep/

The Harvard Environmental Economics Program

The Harvard Environmental Economics Program develops innovative answers to today's complex environmental issues, by providing a venue to bring together faculty and graduate students from across the University engaged in research, teaching, and outreach in environmental and natural resources economics and related public policy. The program sponsors research projects, develops curricula, and convenes conferences to further understanding of critical issues in environmental and resource economics and policy around the world.

Acknowledgements

The Enel Endowment for Environmental Economics, at Harvard University, provides major support for HEEP. The endowment was established in February 2007 by a generous capital gift of $5 million from Enel, SpA, a progressive Italian corporation involved in energy production worldwide. HEEP enjoys an institutional home in and support from the Mossavar-Rahmani Center for Business and Government at Harvard Kennedy School. As its name suggests, the Center is concerned with the interaction of the public and private sectors, including with regard to environmental issues.

HEEP is grateful for additional support from: Shell, Christopher P. Kaneb (Harvard AB 1990); the James M. and Cathleen D. Stone Foundation; Paul Josefowitz (Harvard AB 1974, MBA 1977) and Nicholas Josefowitz (Harvard AB 2005); and the Belfer Center for Science and International Affairs at the Harvard Kennedy School. The Harvard Project on International Climate Agreements, co-directed by Robert N. Stavins and closely affiliated with HEEP, is funded primarily by a grant from the Doris Duke Charitable Foundation.

HEEP—along with many other Harvard organizations and individuals concerned with the environment—collaborates closely with the Harvard University Center for the Environment (HUCE). A number of HUCE's Environmental Fellows and Visiting Scholars have made intellectual contributions to HEEP.

Matheny, Andrew Philip, "Reducing the impact of price shocks in energy-intensive economies." Discussion Paper 2009-16, Cambridge, Mass.: Harvard Environmental Economics Program, May, 2010.

The views expressed in the Harvard Environmental Economics Program Discussion Paper Series are those of the author(s) and do not necessarily reflect those of the John F. Kennedy School of Government or of Harvard University. Discussion Papers have not undergone formal review and approval. Such papers are included in this series to elicit feedback and to encourage debate on important public policy challenges. Copyright belongs to the author(s). Papers may be downloaded for personal use only.

SECOND YEAR POLICY ANALYSIS

Reducing the impact of price shocks in energy-intensive economies

In fulfillment of the requirements for the degree of Master in Public Administration in International Development, John F. Kennedy School of Government, Harvard University

Adviser: Filipe Campante
Seminar leader: Lant Pritchett

Andrew Philip Matheny

March 15, 2010

TABLE OF CONTENTS

EXECUTIVE SUMMARY 1

INTRODUCTION 3

Overview of energy intensity 3

Energy intensity in developing countries 7

Price signals, subsidization and effects on energy efficiency 7

CHAPTER I: LITERATURE REVIEW 9

CHAPTER II: OVERVIEW OF HYPOTHESES 11

Relationship between energy intensity and economic crises 12

Effects of price shocks on energy intensity and on the business cycle 12

Correlations between energy price subsidization and energy intensity 12

CHAPTER III: EMPIRICAL EVIDENCE AND ANALYSIS 14

Description of data set and methodological considerations 14

Regression of energy intensity on price and subsidization variables 17

Regression of cyclical component of GDP on macroeconomic price and energy variables 18

CHAPTER IV: OVERVIEW OF POLICY ALTERNATIVES 21

Reduction of energy price subsidization 21

Incentivization of investments in energy efficiency 22

Status quo 22

CHAPTER V: TECHNICAL AND POLITICAL CONSIDERATIONS 24

Cost/benefit analysis 24

Administrative feasibility and implementability 25

Political considerations 26

Institutional environment 27

CHAPTER VI: CONCLUSIONS AND POLICY RECOMMENDATIONS 32

REFERENCES 33

APPENDIX 35

EXECUTIVE SUMMARY

This paper argues that countries which have higher energy intensity – those that require more energy per unit of economic output – tend to suffer from deeper recessions and are more susceptible to price shocks. In addition, price rises, which cause demand to decrease in the short run and induce investments in efficiency in the longer run, are the major channel for causing reductions in energy intensity. Moreover, energy price subsidization dampens price signals and the pressure that they put on energy intensity, and is therefore associated with higher energy intensity. Price subsidization also involves significant fiscal costs, which have effects on the business cycle, amplifying the magnitude of downturns.

It follows that it is in the interest of countries to use energy less intensively and, thus, more efficiently: if it is possible to produce the same amount of economic output using fewer inputs, in this case using less energy, this increases profits and net economic output. Additionally, as energy use tends to be associated with greenhouse gas emissions, there may be environmental reasons for wanting to reduce energy intensity. Insofar as countries want to reduce the severity of recessions and want to promote macroeconomic stability, they should pursue policies that reduce their energy intensity. Finally, since energy price subsidization is associated with higher energy intensity and exacerbates the effects of economic downturns, reducing subsidization should also be a policy priority. Evidence and analysis suggest that a one standard deviation decrease in retail fuel price subsidization (corresponding to USD 0.34/liter) would induce a 0.04 ktoe/USD decrease in energy intensity (13% of average energy intensity in 2007) and a 0.9 percentage point increase in cyclical GDP.

This paper analyzes three policy alternatives that approach the issue of decreasing economy-wide energy intensity and finds that reducing price subsidies – while often politically difficult – is the most attractive option. For this reason, this paper advocates for reducing net subsidies to energy prices to the extent that it is politically-feasible, if necessary in an incremental or partial way. Additionally, this paper proposes an institutional approach to analyzing the political constraints to passing subsidy reforms that suggests that it is easier to implement these reforms in more

democratic and competitive political systems. Beyond this, implementing measures that incentivize investments in energy efficiency is also desirable, although this is more administratively-complex and potentially costlier as well.

INTRODUCTION

This paper posits a relationship between energy intensity, price subsidization, and the behavior of the business cycle in the macroeconomy, and draws policy conclusions that follow from this. It lays out a theoretical framework for explaining the interactions between these macroeconomic variables, then attempts to establish these results empirically, using historical data from 1971-2008. Finally, following from theoretical and empirical research, this paper analyzes policy approaches – identifying their costs and benefits and taking into account political and institutional considerations – to mitigate the effects of energy price subsidization and high energy intensity on movements in the business cycle, and makes targeted policy recommendations.

Overview of energy intensity

Energy intensity measures energy supply per unit of economic output in a given economy. For the purposes of this analysis, we will use annual total primary energy supply (TPES) in an economy (which includes net exports and stock changes), as measured in millions of tons of oil equivalent (Mtoe), and GDP, as measured in millions of 2000 U.S. dollars. By convention, we will measure energy intensity, TPES per unit of GDP, in kilotons of oil equivalent (ktoe) per 2000 U.S. dollars, which is equivalent to tons of oil equivalent (toe) per thousand 2000 U.S. dollars[1]. Energy intensity in 2007 ranged from 0.058 ktoe/USD in Hong Kong to 3.086 ktoe/USD in the Democratic Republic of Congo, with a world average of 0.305 ktoe/USD and an OECD average of 0.183 ktoe/USD. As such, Hong Kong is six times more energy efficient than the world average, and the DRC is 10 times more energy intensive (see appendix graph of energy intensity by country in 2007).

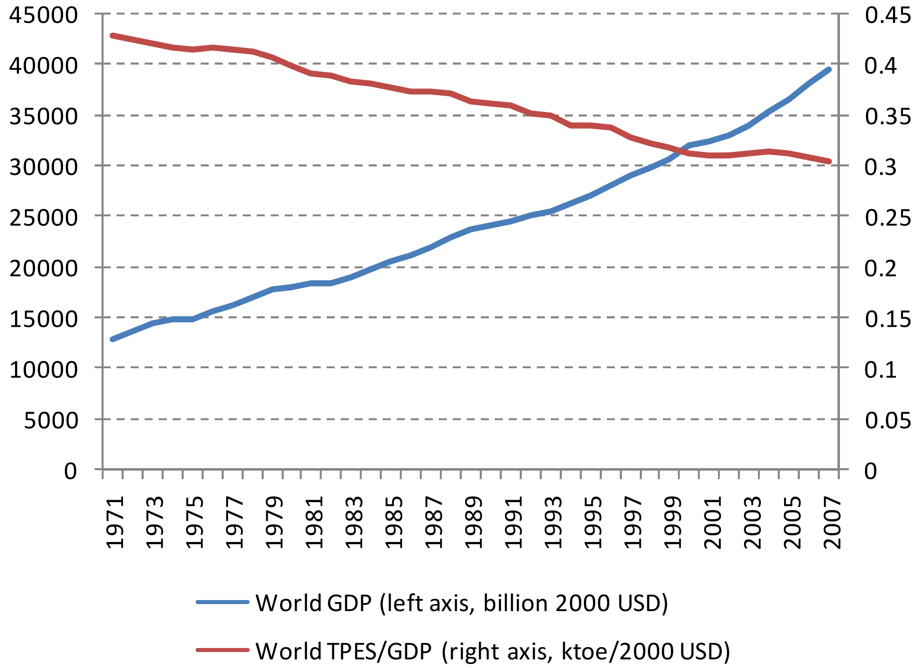
Energy intensity in a given country depends on a number of factors, related to structure of the country's economy, to the technology it employs, and, over time, to certain policies in place in

[1] According to the convention used by the International Energy Agency (OECD)

the country. It also may depend on factors exogenous to the country, such as world energy prices. Economic activities such as mining, steel production and other heavy industry tend to be more energy-intensive than manufacturing, which, in turn, tends to be more energy-intensive than service-based activities. Similarly, within a given sector or specific activity, different technologies can have differing levels of energy intensity. More modern and advanced technologies are usually more energy-efficient than older ones. For instance, coal-fired thermal power plants built in the second half of the twentieth century tend to be more energy-intensive than coal-fired cogeneration plants built in the past decade, and modern steel mills use energy more efficiently than those built 100 years ago.

There has been a clear downward trend in world energy intensity levels in the period from 1971 to 2007. This has been the case in most countries, with the notable exception of several middle-income, energy-exporting countries (notably ex-Soviet republics and countries that grow natural resource extraction rapidly). Worldwide average energy intensity has declined over this period by 28.7%, from 0.428 ktoe/USD to 0.305 ktoe/USD. In OECD countries, the decline – of 41% – was even greater, from 0.31 ktoe/USD to 0.183 ktoe/USD. The following figure illustrates the evolution of world GDP and TPES/GDP from 1971 to 2007.

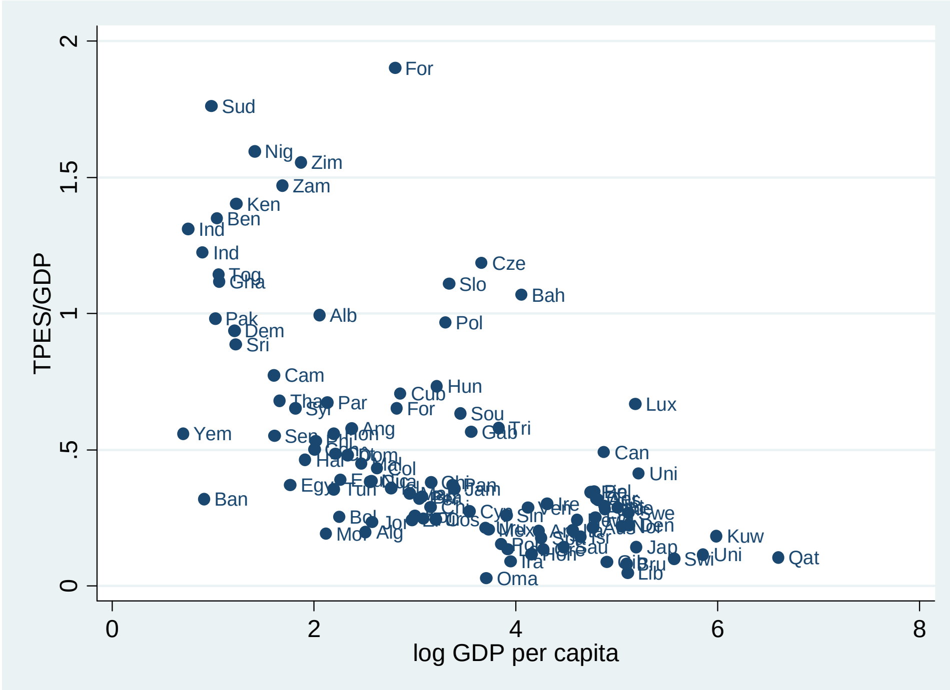
Figure 1. World GDP and TPES/GDP, 1971-2007



Source: IEA

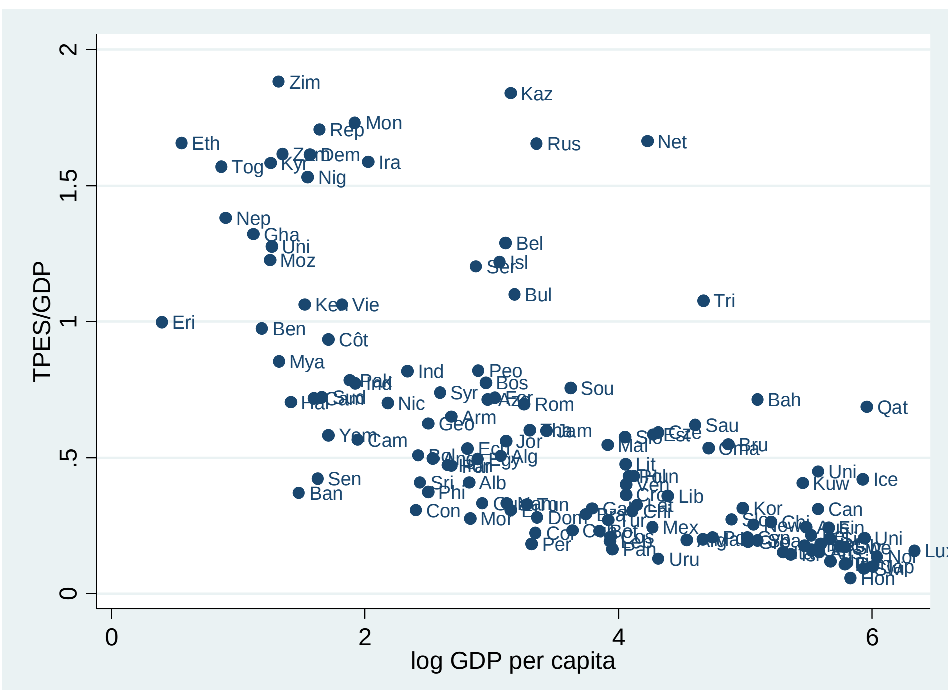
There also seems to exist a negative correlation between a country's level of income per capita and its energy intensity: the wealthier a country is, as measured by its level of per capita income, the less energy-intensive it tends to be. The following scatter plots illustrate this relationship using 1971 and 2007 data.

Figure 2. GDP per capita (log scale) versus TPES/GDP, 1971



Source: IEA

Figure 3. GDP per capita (log scale) versus TPES/GDP, 2007



Source: IEA

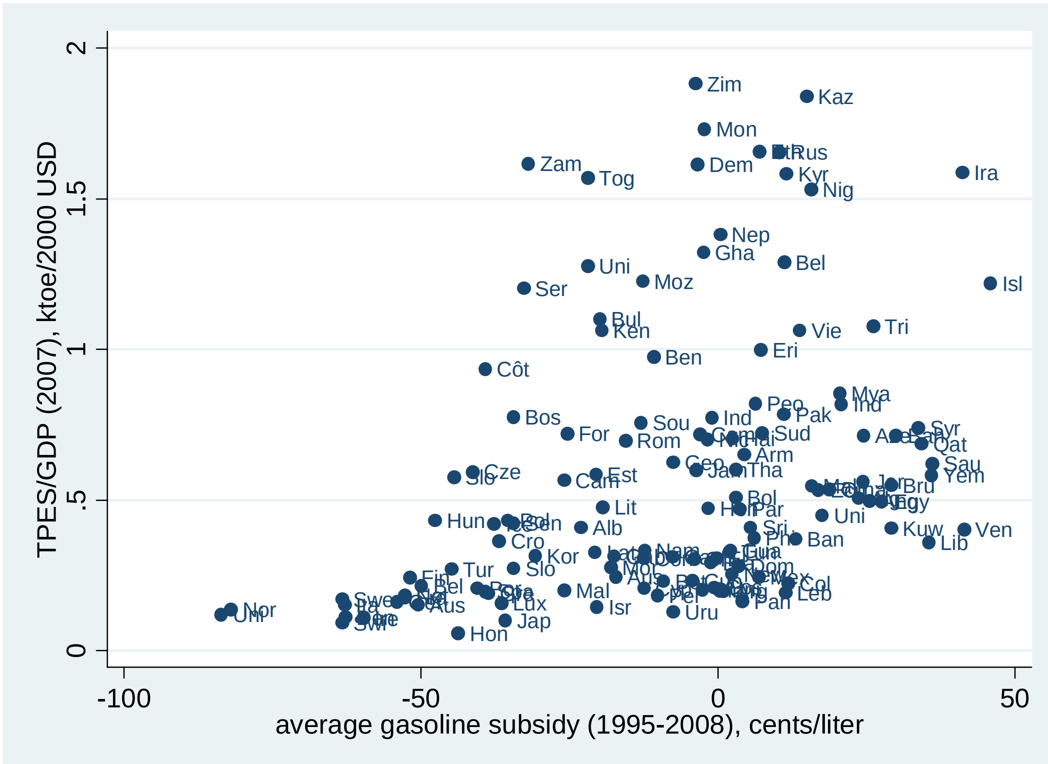
Energy intensity in developing countries

Developing and transition countries tend to produce, transmit, and use energy less efficiently relative to economic output than their developed counterparts, as measured by energy use per unit of economic output (TPES/GDP). This is a result both of technology and of policies (or a lack of policies). From the standpoint of technology, developing countries tend to use technologies that are cheaper, older, and that are therefore less efficient. This is the case in the energy sector both upstream and downstream, spanning from production to end-use. It pertains to production/generation, transmission, and distribution systems. There are also environmental factors that make it such that energy intensity is often higher in developing countries. Cheaper technology is often used because it has lower fixed or variable costs (not necessarily both at once). This could be a result of an unwillingness to invest in high fixed cost technologies due to limitations relating to access to credit or a generally smaller appetite for large-scale investments on the part of domestic or foreign investors. This could also be a consequence of a lack of relevant technical expertise to operate and maintain more advanced technologies (which are more efficient). All of these factors could be influenced by policy intervention.

Price signals, subsidization and effects on energy efficiency

From the standpoint of policy, price signals are the primary means of incentivizing investments in efficiency. Developing countries tend to have more price controls, regulations, and subsidies than their developed counterparts, which can make it such that price signals are not fully effective in bringing about improvements in efficiency. Other market imperfections such as imperfect information can also contribute to a lack of investment in energy efficiency. The following figure shows energy intensity in 2007 as compared to retail gasoline price subsidization (average level from 1995-2008). It is clear from this figure that the greater the extent to which countries subsidize, the more energy-intensive they tend to be.

Figure 4. Average gasoline subsidies (1995-2008) versus TPES/GDP, 2007



Source: IEA, GTZ

CHAPTER I: LITERATURE REVIEW

Although there is little in the economics literature that has been written specifically on the subject of energy intensity, especially examined as a dependent variable, the above-defined problem fits into academic literature on emerging market crises induced by price shocks and on energy (notably oil prices) and macroeconomics more generally. Additionally, there are academic discussions on the effects of subsidization on the macroeconomy, which have some relevance. The International Energy Agency (OECD) and the International Monetary Fund have published numerous research pieces and position papers relating to the topics of energy intensity and the relationship between price shocks and crises. GTZ, Germany's state-sponsored foreign aid organization, also publishes a semi-annual survey of retail fuel prices, which includes a discussion of the effects and incidence of subsidization policies across countries. Finally, the second portion of this paper draws on literature in political economic on the influence of political institutions on fiscal and tax policy.

Guillermo Calvo (Calvo 2005) has written about balance sheet effects and the ways in which capital flows and movements in the current account relate to emerging market crises. This sheds light on mechanisms through which price subsidization can have effects on fiscal and macroeconomic variables. Hausmann and Rigobon (Hausmann and Rigobon 2003) reassess the natural resource "curse" in the context of financial market imperfections, examining the relationship between the tradable and non-tradable sectors and the impact on macroeconomic volatility. They find some support for second-best, interventionist trade and financial policies, which may inform this paper's research on subsidization policy.

Jorgenson, Gordon, Killian, and Hamilton have all written extensively on the relationship between oil prices and the macroeconomic. Jorgenson has framed the energy sector in neoclassical long-run models of the economy, emphasizing the relationship between energy prices and productivity growth (Jorgenson 1981, Jorgenson 1984, Jorgenson 1999), while Gordon has incorporated oil into an analysis of inflation, crises, and the Phillips curve (Gordon 1999, Gordon 2009). Killian and Hamilton have examined oil prices as an explanatory factor of crises, studying the effects of price shocks on the real economy and their transmission mechanisms (Killian 2007, Killian 2008, Killian 2009, Hamilton 2005). The work of these authors has informed the views and hypotheses that this paper has taken on the relationship between energy intensity, the business cycle, and price subsidization.

Additionally, the IMF, World Bank, IEA, and GTZ have published numerous policy and research papers on the subject of oil prices and price subsidization. This literature has contributed to the understanding of price shocks and crises, and their transmission mechanisms (IEA 2004, IMF 2008b), and to the impact of subsidization on efficiency and macroeconomic volatility (IMF 2007, IEA 2002, GTZ 2009).

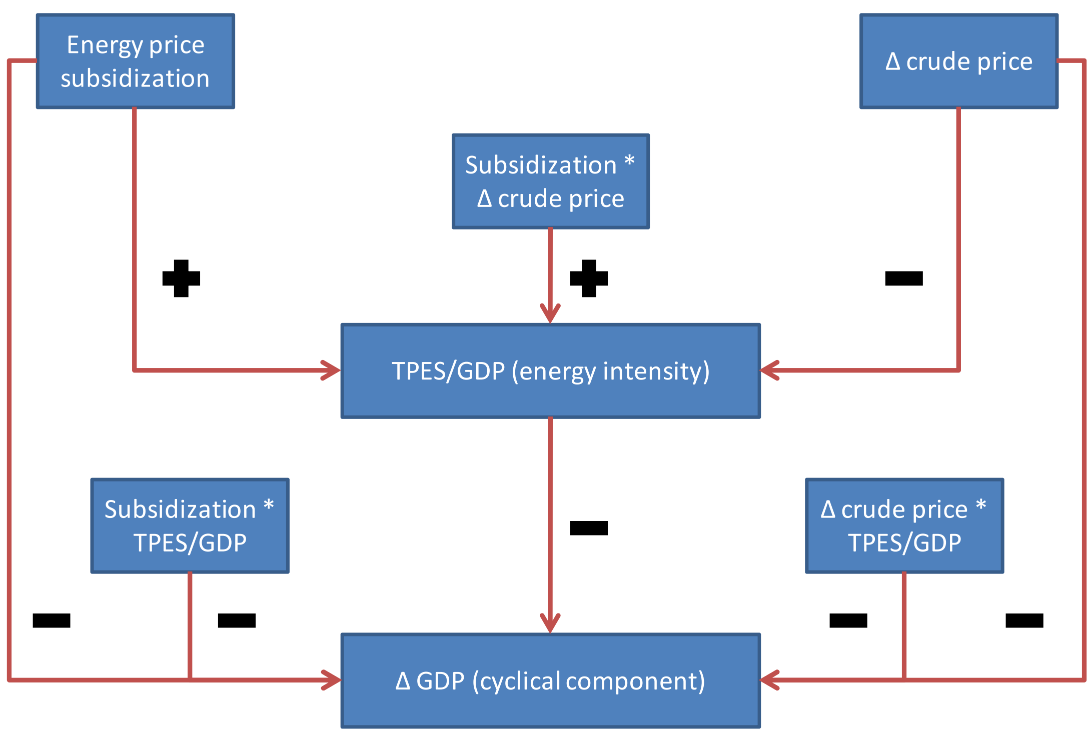
The second portion of this paper considers the political feasibility of various proposed policy alternatives. There appears to be relatively little that has been written in the political economy literature on the subject of comparative energy price subsidization across countries. Frederiksson and Millimet have examined environmental taxation from the perspective of comparative politics and conclude that presidential-congressional regimes set pollution taxes on retail fuel prices lower than do parliamentary systems (Frederiksson and Millimet 2004). Their hypothesis builds on a framework established by Persson, Roland, and Tabellini, which contrasts taxation policy in presidential and in parliamentary systems, predicting lower tax rates under presidential regimes (Persson, Roland, and Tabellini 2000). Using a micro-founded theoretical political economy model that endogenizes policy preferences, Persson, Roland, and Tabellini argue that presidential systems have more checks and balances, while greater legislative cohesion is achieved under parliamentary systems, and this induces resultant differences in tax systems.

CHAPTER II: OVERVIEW OF HYPOTHESES

Following from classical economic theory on competitive pricing and aggregate supply shocks, this paper posits that there is a positive relationship between both an economy's energy intensity level and energy subsidization, and between both of these variables and the development of price shock related emerging market crises (as seen in drops in the cyclical component of GDP). The hypothesized mechanism is that, controlling for other factors, countries that subsidize tend to invest less in energy efficiency and therefore see fewer improvements in energy efficiency than countries that do not subsidize. Insofar as energy intensity is related to the severity of price shock induced crises, price subsidization interacts both with the degree of energy intensity and with price shocks, and thereby both directly and indirectly exacerbates these and their effects on downturns in economic activity.

The following figure summarizes the hypothesized relationships between the above-mentioned macroeconomic variables.

Figure 5. Hypothesized relationships between subsidization, TPES/GDP, GDP and crude price



Source: Author's analysis

Relationship between energy intensity and economic crises

In the context of energy price shocks, lower energy efficiency is a liability for a country, as it intensifies the economic effects of these shocks. When comparing two countries, one with high energy intensity and the other with low energy intensity, in the presence of a price shock, the one with high intensity will see a proportionately greater rise in its input costs, holding output constant. This price shock could put energy-intensive firms out of business. It also would translate into a price increase for any goods produced in the economy requiring energy as an input. Moreover, if these energy inputs are imported, this would have an adverse effect on the current account and, potentially, on the real exchange rate (depending on the exchange rate regime, the severity of the price shock, the level of energy intensity, and the energy demand elasticity). This mechanism and this reasoning follows from the literature on emerging market crises, notably the work of Calvo (Calvo 2005).

Effects of price shocks on energy intensity and on the business cycle

As discussed above, price signals are one mechanism for inducing investment in improving energy efficiency. A well-known instance in which a price shock induced major investments in energy efficiency was the case of the oil shocks of the 1970s and their effects on accelerating turnover of the capital stock in all sectors of the United States (both industry and consumer sectors). More recently, with record-high oil prices in the summer of 2008, high wholesale fossil fuel prices induced greater investment in alternative and renewable energy sources and high retail fuel prices caused consumers to purchase more fuel-efficient vehicles. Therefore, positive price shocks should tend to put downward pressure on energy intensity, while also causing decreases in GDP (at least among net importing countries).

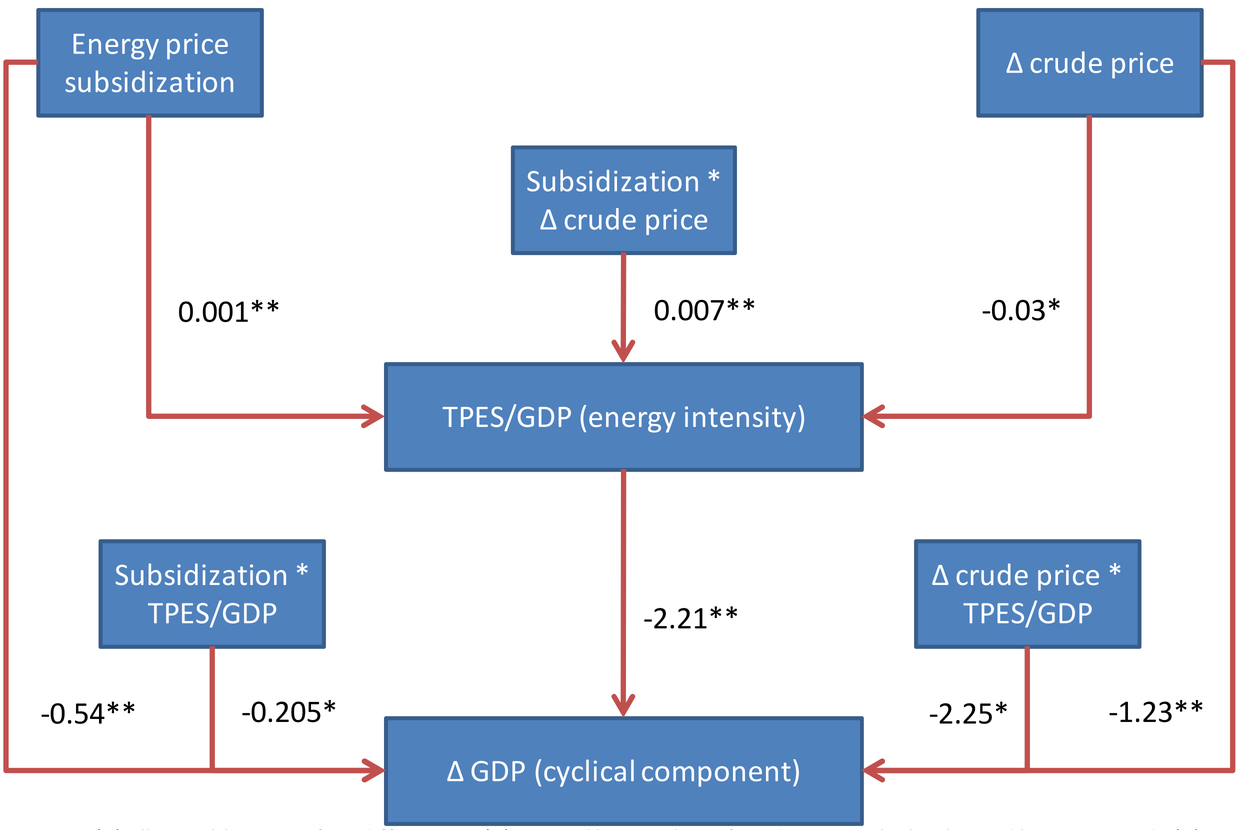
Correlations between energy price subsidization and energy intensity

Moreover, many countries – particularly developing countries – subsidize energy prices, and these subsidies reduce the effectiveness of the price signal, as the government often absorbs the subsidy in its budget, often causing the government's budget to go into deficit. By not passing this price increase on to consumers, these consumers do not alter their behavior as a result of the price shock in the short run, and do not change their investment behavior in the medium- to long-run either. As a result, the subsidization can have two adverse effects in the case of a price shock: first, a negative fiscal effect, which can lead to a rising import bill, current account deficit and adjustment of the exchange rate; second, no change in longer-run behavior on the part of actors in the economy relating to investing in more energy efficient technologies. In addition, subsidization can interact with energy intensity such that it exacerbates the adverse effects of price shocks on the economy, in the context of a high energy intensity environment.

CHAPTER III: EMPIRICAL EVIDENCE AND ANALYSIS

This section will follow from the theoretical framework discussed in the previous chapter, and will lay out the methodology for empirical testing and analysis of the hypotheses proposed by this paper. The empirical findings (see below) confirm the above-mentioned theoretical hypotheses. The following figure summarizes key empirical results from regression analysis, the methodology of which will be explained below.

Figure 6. Results of country fixed effect regressions of TPES/GDP and change in cyclical GDP



*Notes: (1) all variables are in first differences; (2) natural log is taken of crude price, which is lagged by one period; (3) gasoline and diesel subsidization are lagged by one period in GDP regression; (4) effects of gasoline and diesel subsidization are averaged; (5) ** and * denote 5% and 10% statistical significance respectively; (6) units are as follows: price subsidization in cents/liter, TPES/GDP in ktoe/2000 USD, cyclical GDP in billion 2000 USD*

Source: Author's analysis

Description of data set and methodological considerations

This paper primarily utilizes data that come from two sources: the International Energy Agency[2] (OECD), for energy indicators, balances, economic indicators, and world energy prices (gasoline, diesel, crude); and GTZ[3], for local retail gasoline and diesel prices.

IEA provides annual data on economic and energy indicators and energy balances for 139 countries, for the period from 1971 to 2007. This serves as the basis for this paper's analysis of energy intensity. Indicators and balances include, among other variables, TPES, GDP, energy production, net energy imports, net oil imports, oil supply, electricity consumption, GDP, GDP per capita, GDP (PPP-adjusted), population, industrial production[4], an indicator of energy self-sufficiency, TPES/GDP, and TPES/population. Additionally, IEA provides monthly, quarterly, and annual crude and oil product prices over the same the same time period. This paper has opted to use Brent (light, relatively low-sulfur crude from the North Sea) as the measure for world crude oil prices[5][6]. The price point for gasoline and diesel wholesale prices is, similarly, North-West Europe (Rotterdam).

Retail fuel prices are provided by GTZ's Transport Policy Advisory Services, which publishes a semi-annual survey of retail, post-tax gasoline and gasoil prices in 132 countries, from 1995 to 2008[7]. Following GTZ's methodology, this paper uses U.S. gasoline and gasoil prices as a

[2] IEA Statistics, IEA Beyond 20/20 Professional Browser and SourceOECD (IEA Databases: World Energy Statistics and Balances & Energy Prices and Taxes).

[3] GTZ Transport Policy Advisory Services, International Fuel Prices 2009.

[4] In general only available for OECD countries and, in some cases, only for a shorter time period.

[5] This choice is somewhat arbitrary, as in general the prices of different varieties of crude oil co-move quite closely. However, the choice of North-West Europe (NWE) as a price point shields this metric from some price volatility that may arise from political factors in other parts of the world (where supply disruptions are more common, due to political or climactic conditions); a light, sweet crude is also less susceptible to price swings relating to supply and demand of heavier, more sulfurous crude, that might relate to changing capacity levels at the relatively fewer oil refineries that can process these lower-grade crudes.

[6] Brent prices for 1971-1981 have been extrapolated on the basis of variation in Arab Light prices, using 1982 as a base year; the same is true for gasoline and gasoil prices for 1971-1974 (using Arab Light and 1974 as a base year) and for Feb-Apr. 1985 (using monthly Brent prices and Jan. 1985 as a base month). For all of these months and years, gaps existed in the data.

[7] Prices are end-November retail prices, as measured by local sources.

benchmark for prices that include a only a small taxation component, and which are not subsidized, either directly or indirectly. Countries that have prices lower than in the U.S. are net subsidizers of retail fuel prices, and ones with higher prices are net taxers. This is the way in which the subsidization dataset used in this paper has been constructed. Retail fuel prices typically comprise several components: crude price (sometimes including export duty), transport and insurance costs, refining costs and margins, eventual storage costs, import duties, wholesale fuel distribution and marketing costs and margins, excise taxes, and value-added taxes.

Due to limited available information on taxation and distribution costs, this analysis confounds the effects of subsidization and taxation, essentially treating the two phenomena as one phenomenon, which could be called "net subsidization". This paper considers that the U.S. has net subsidization equal to zero. Therefore, in Western Europe, where taxation is high and subsidization is low[8] or non-existent, net subsidization is negative; whereas, in Iran or Mexico, where taxation is low and prices are subsidized, net subsidization is positive. There may be some instances where countries both tax and subsidize significantly, for instance in India, where average net gasoline subsidization is close to zero. In cases like this, it is not possible to distinguish the effects of such a subsidization policy.

Additionally, this paper uses retail fuel subsidization as a proxy for economy-wide energy subsidization, due to lack of availability of subsidization data for electricity, heating (kerosene or district heating) or natural gas prices. While this is not an accurate description of all countries, many countries that subsidize retail fuel prices also subsidize other fuel types, and vice-versa.

Given than IEA data covers 139 countries over 36 years (and for some countries, 2008 data are available as well), and GTZ data covers 132 countries over seven years, this dataset consists of an unbalanced, annual panel. This paper uses fixed effect regressions on the panel data, with heteroskedastic standard errors. The use of country fixed effects controls for unobserved characteristics across countries, such as mean income differences, minimizing the potential for omitted variable bias. Attempts have also been made to incorporate fixed time effects

[8] In many cases diesel fuel used for commercial, agricultural, or marine purposes in Europe is either subsidized, or taxed differentially, at a far lower rate than other retail fuel sold to end-consumers.

(introducing a dummy variable for each year in the panel), although these resulted in almost all cases in increasing the standard errors on the estimated coefficients dramatically, rendering results that are statistically insignificant at usual confidence levels. In some cases, notably for regressions of the cyclical component of GDP, there is the possibility of an endogeneity problem, where there is serial correlation of error terms, thereby making the lagged dependent variable endogenous. In order to address this, it is necessary to include the lagged dependent variable as a regressor, essentially using it as an instrument. This paper does this both by using the Arellano-Bond GMM estimator and by simply including the lagged dependent variable as a regressor in the initial fixed effects regression specification. In cases where this was done, results were not markedly different, i.e., the signs of coefficients did not change, nor did statistical significance, and estimated coefficients did not change drastically in magnitude, with some decreasingly slightly (see summary table of regressions below).

Finally, because of concerns about variables having time-varying means and variances, this paper works with the first difference of most variables, and in some cases takes natural logs as well. GDP data have also been de-trended using a Hodrick Prescott filter with smoothing factor 6.25[9], so as to identify trend and cyclical components of GDP and to provide a measure for changes in the business cycle.

<u>Regression of energy intensity on price and subsidization variables</u>

As hypothesized, changes in the levels of both gasoline and diesel price subsidization are positively correlated with changes in energy intensity. According to the regression results, a 0.10 USD per liter decrease in subsidization is associated with a 0.01 ktoe/USD reduction in energy intensity, controlling for country fixed effects. Additionally, a 10% increase in world crude price in period t-1 is associated with a 0.003 ktoe/USD reduction in energy intensity in period t, controlling for country fixed effects. Combining a 10% rise in the world crude price with a 0.10 USD/liter increase in fuel subsidies yields an increase in energy intensity of 0.004 ktoe/USD in the case of a subsidy to diesel, and of 0.002 ktoe/USD in the case of one to

[9] Per Ravn and Uhlig (2002), via Stata help for *hprescott* command

gasoline, taking into account the interaction between changes in energy intensity and changes in subsidization. The below table summarizes the regression results.

Table 1. Regressions of energy intensity, with country fixed effects

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
d_sub_diesel	0.001**					0.001**	0.000		
	(0.000)					(0.000)	(0.001)		
d_sub_gasoline		0.001**						0.001**	0.000
		(0.000)						(0.000)	(0.001)
dl_brent			-0.01**		-0.03**				
			(0.003)		(0.015)				
dl_brent(-1)				-0.02*	-0.02	-0.08**	-0.07**	-0.09**	-0.08**
				(0.014)	(0.014)	(0.030)	(0.030)	(0.033)	(0.033)
dl_brent(-2)					-0.02*				
					(0.014)				
dl_brent(-1) * d_sub_diesel							0.007**		
							(0.002)		
dl_brent(-1) * d_sub_gasoline									0.006**
									(0.002)
R^2	0.005	0.005	0.983	0.001	0.002	0.007	0.000	0.008	0.000
Lagged dependent variable			YES						
N (observations)	606	606	4520	4433	4320	606	606	606	606
n (groups)	133	133	139	139	139	133	133	133	133
T-bar (avg obs/group)	4.6	4.6	32.5	31.9	31.1	4.6	4.6	4.6	4.6

*Notes: (1) ** and * denote 5% and 10% significance; (2) standard errors in parentheses; (3) "d" indicates first difference, "l" indicates log*

Source: Author's analysis

Regression of cyclical component of GDP on macroeconomic price and energy variables

Similarly, by regressing changes in the cyclical component of GDP on changes in the level of energy intensity, crude price changes, and changes in subsidization level – controlling for country fixed effects and, in some cases, for time fixed effects as well – this paper finds, as hypothesized, a negative relationship between these two variables and the indicator of changes in the position in the business cycle. According to this analysis, an increase in diesel or gasoline price subsidization is by 0.10 USD/liter is associated with a decrease in the cyclical component of GDP by 0.3 percentage points. A reduction in energy intensity by 0.01 ktoe/USD, holding subsidization constant, is correlated with a 0.1 percentage point increase in the cyclical component of GDP. Combining the two – a 0.01 ktoe/USD reduction in energy intensity and a

0.10 USD/liter decrease in subsidization – is associated with an increase in the cyclical component of GDP by roughly 0.4 percentage points. Additionally, increases in the world crude price are associated with a decrease in the change in the cyclical component of GDP: a 50% increase in the crude price is correlated with a 0.3 percentage point decline in cyclical GDP. The below table summarizes the regression results.

Table 2. Regression of first difference of cyclical component of GDP, with country fixed effects

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
d_sub_diesel(-2)	-0.04**			-0.04**	-3.07		-0.04**					
	(0.023)			(0.023)	(2.680)		(0.024)					
d_sub_gasoline(-2)		-0.06**				-0.05**		-0.06**				
		(0.018)				(0.018)		(0.019)				
d_tpes_gdp			-2.21**	-6.12**	0.009	-5.61**	-6.69**	-6.71**		-2.24**	-2.23**	-1.82**
			(0.412)	(1.957)	(0.032)	(1.901)	(1.890)	(1.872)		(0.428)	(0.406)	(0.458)
d_tpes_gdp * d_sub_diesel(-2)							-0.13					
							(0.092)					
d_tpes_gdp * d_sub_gasoline(-2)								-0.27**				
								(0.100)				
dl_brent(-1)									-1.22**	-1.23**	-1.25**	-1.12
									(0.537)	(0.537)	(0.539)	(0.796)
dl_brent(-1) * d_tpes_gdp											-2.25*	-0.66
											(1.257)	(1.836)
Constant	-0.21	-0.13	-0.00	-0.34	0.742	-0.25	-0.34	-0.26	0.111	0.089	0.088	-1.00
	(0.58)	(0.58)	(0.15)	(0.59)	(1.25)	(0.59)	(0.59)	(0.59)	(0.16)	(0.16)	(0.16)	(0.63)
Time fixed effects					YES							YES
R^2	0.005	0.006	0.001	0.006	0.113	0.007	0.006	0.007	0.002	0.002	0.002	0.036
N (observations)	476	476	4520	476	476	476	476	476	4407	4407	4407	4407
n (groups)	132	132	139	132	132	132	132	132	139	139	139	139
T-bar (avg obs/group)	3.6	3.6	32.5	3.6	3.6	3.6	3.6	3.6	31.7	31.7	31.7	31.7

*Notes: (1) ** and * denote 5% and 10% significance; (2) standard errors in parentheses; (3) "d" indicates first difference, "l" indicates log*

Source: Author's analysis

The data therefore appear to confirm that high energy intensity increases the susceptibility of a country to price shock-related crises, intensifying the magnitude of these crises and their effects on macroeconomic variables. The hypothesis, as described in the literature on emerging market crises, is that these macroeconomic adjustments take place through the channel of negative effects on the current account and consequent effects on currency prices. Additionally, the data indicate that net subsidization of fuel prices (at the retail level) reduces the responsiveness of demand and efficiency levels to price signals, thereby exacerbating the crisis-inducing potential of price shocks. Finally, net subsidization of fuel prices seems to induce relatively less investment in energy efficiency in the long run.

The two below tables indicate the responsiveness of energy intensity and of the cyclical component of GDP to changes in subsidization and in crude price.

A one standard deviation decrease in net price subsidization (corresponding to USD 0.34/liter) is associated with a 0.9 percentage point gain in cyclical GDP, while a one standard deviation increase in crude price (11% increase) is associated with a future decline in cyclical GDP by 0.1 percentage points.

Table 3. Impact of price subsidization on energy intensity and cyclical GDP

		TPES/GDP (ktoe/US$)	Cyclical GDP (% of GDP)
Δ subsidization	s.d. ($0.34/l) decrease	-0.04	0.9%
	$0.10/l decrease	-0.01	0.3%

Source: Author's analysis

Table 4. Impact of crude price on energy intensity and cyclical GDP

		TPES/GDP (ktoe/US$)	Cyclical GDP (% of GDP)
Δ crude price	s.d. (11%) increase	-0.001	-0.1%
	50% increase	-0.006	-0.3%

Source: Author's analysis

CHAPTER IV: OVERVIEW OF POLICY ALTERNATIVES

This paper argues that there is a strong correlation between energy price subsidization, energy intensity, changes in the position in the business cycle, and world price shocks. In the presence of price shocks, high energy intensity and net price subsidization exacerbate the magnitude of changes in the cyclical component of GDP. Price subsidization is also correlated with higher energy intensity and mutes the positive efficiency-improving effects of price shocks.

As such, from the standpoint of a policy maker, it would appear to be desirable to employ policy measures so as to act to decrease the energy intensity of the economy in question. This paper raises three possible policies that would have an effect on energy intensity: reduction of net subsidization, intervention to accelerate the turnover of the capital stock, such that the rate of growth of energy efficiency increases, and maintaining the status quo, i.e., no implementation of new policies. The following sections will provide an overview of these policy approaches and of possible variations on them.

Reduction of energy price subsidization

Since changes in net subsidization have been shown to have an effect on energy intensity levels, reducing subsidies to energy prices (or increasing taxation, as this would also decrease net subsidization) is one policy option. There are several different ways to achieve this. In terms of phasing out subsidization of energy prices, it would be possible to vary this phase out by type of price that is being subsidized (retail versus wholesale prices), by target of the subsidy (end-consumer versus business, or intermediate versus end-user), and by degree and duration of the phase out. It is also possible to vary the price subsidy phase out by energy type: e.g., retail fuel sales, industrial energy inputs (natural gas, coal), primary fuels, or electricity (either on the wholesale or end-user level). The type and degree of subsidy phase out would affect its effectiveness, its political palatability, and the ease with which it could be implemented.

Additionally, since this analysis confounds taxation and subsidization, increases in taxation would have the same net effect as decreases in subsidization, however a more substantial energy taxation policy could have ramifications for efficiency and industry competitiveness, and may lead to perverse or unanticipated outcomes (for instance, in the long run, substitution toward less heavily-taxed inputs or sectors).

Finally, it may be possible to make reductions in energy price subsidization more palatable to the population by bundling them with political promises, e.g., by tying fiscal revenues saved from reducing subsidies to investments in sectors such as health or education. This could be done, for instance, through the creation of a “fuel price stabilization fund” to which saved revenues would be channeled. This would not only produce the positive effects of reducing subsidies and improving efficiency, but could also be used as a mechanism for intertemporal saving and counter-cyclical spending on social services.

Incentivization of investments in energy efficiency

Another method of acting on economy-wide energy intensity is to accelerate the turnover of the capital stock, by incentivizing investment in more productive technologies. This could be done in several ways, the most direct of which would be to influence the return on these investments, by reducing the cost of capital. (Acting on the revenue side would be more difficult, and might involve price controls or granting of temporary monopolies, both of which are likely more difficult to implement, more prone to corruption, and more likely to produce unintended side-effects.) One possible approach to reducing the cost of investing in efficiency-enhancing activities would be to offer government-subsidized loans for such investments, or to increase relative taxation on less energy-productive technologies (for instance by putting into place a carbon tax or a cap-and-trade scheme, insofar as energy efficiency is related to carbon emissions efficiency). It may also be possible to decrease or remove taxation on investments that would contribute to substantial improvement in the energy efficiency of the capital stock.

Status quo

Given that there has been a natural downward trend in energy intensity in the past 30 years, and that this trend is likely to persist, a third policy approach would be to maintain the status quo, i.e., not to alter subsidization or taxation policy or to implement any policies that would provide subsidies or differential treatment to investments in energy productivity-enhancing activities (other than those currently in place). This status quo "policy" would arguably achieve the same end as the interventionist alternatives, albeit over a longer time horizon, though perhaps at lower cost.

CHAPTER V: TECHNICAL AND POLITICAL CONSIDERATIONS

This paper will seek to evaluate the three above-mentioned policies according to the metrics of: technically correct, administratively feasible, and politically supportable, and will support the technical analysis with data and estimations, and political and institutional considerations.

Additionally, as not all policies are appropriate for all countries, this paper also proposes to establish a typology of countries for which specific policies are appropriate. This paper proposes to differentiate countries within this typology by:

- Degree of energy import dependence (whether a net energy importer or exporter)
- Sectoral composition of the economy (a significant determinant of energy intensity)
- Form of subsidization (consumer/business)

The following table summarizes the technical, political, and administrative characteristics of the policies evaluated in this paper.

Table 5. Summary of technical, political, and administrative characteristics of policies

Policy option	***Technical characteristics***	***Political feasibility***	***Administrative implementability***
Reduce subsidization	Economically efficient and cost-effective	DEPENDS on targeting and regime type	Depends on structure
Incentivize investments in energy efficiency	• Depends on implementation • Likely most costly option	YES, unless cost prohibitively high	• Prone to corruption • Requires choice of mechanism, e.g., targeted subsidized loans
Status quo	• Costly, disruptive to business cycle • Natural trend in TPES/GDP is down	YES, until high subsidization leads to crisis	Yes

Source: Author's analysis

Cost/benefit analysis

Improvements in energy efficiency yield clear economic savings down the road, particularly in the context of high energy prices or a regime such as an emissions-trading scheme that disincentives energy inefficiency (this is the case to the extent that energy inefficiency is related to higher emissions efficiency). As such, reducing price subsidies (or increasing energy taxation) would yield some economic gains, though there is uncertainty surrounding the magnitude of these gains, as they would depend on expectations of future energy prices. Additionally, reducing subsidization (or increasing taxation) would have positive fiscal implications for the government. However, to the extent that the profits of firms are correlated with price subsidization, this could also have detrimental effects in terms of their economic output and related tax revenue (though these should be accounted for in the regression specification in Chapter III, as they would be included in GDP and in country fixed effects). This policy would likely be cost-saving both in the short run and particularly in the long run, as compared to the status quo case.

Incentivizing investment in energy efficiency – for instance, through a subsidized loan program – would also have a positive cost-saving effect, dependent, again, on expectations of future energy price levels. However, such a policy would have an upfront cost associated with it, either direct (in the case of a loan subsidy) or indirect (in the case of a differential taxation policy). It could, however, also have beneficial quantity effects in terms of economic output coming from firms benefitting from the policy and from increased resultant tax revenue. This type of policy would likely be costly in the short run and cost-neutral or cost-saving in the long run, as compared to the status quo case.

Administrative feasibility and implementability

From the standpoint of administrative feasibility, reducing subsidization across the board is relatively simple, however incremental programs (such as putting into place quotas on purchases of subsidized energy) may be substantially more complex. In the case of Iran, such a program has spawned a large black market in fuel quota cards, which is not the desired effect of the policy and which may have negative second-order effects (EIA 2010).

Subsidizing investments in energy efficiency could pose substantially more difficult obstacles in terms of logistical and administrative implementation, especially in the context of developing countries that have poor operational or technical capabilities. This is the case because such policies may be technically complex or may require extensive data or infrastructure for effective implementation. Additionally, any targeted subsidization program is more vulnerable to abuse or to corruption.

Political considerations

Reducing subsidization would be the most politically difficult policy to implement, as price subsidization is generally quite popular, particularly among end-consumers and among the poor. For this reason, in the vast majority of cases, phasing out subsidies to retail fuel prices would be politically difficult. However, in cases of crises, it may be easier to do this, at least incrementally. Indonesia is an example of a country that has recently phased out price subsidies in the presence of the oil shocks of 2006-08, which caused the government to incur a large budget deficit that was reaching unsustainable, crisis-inducing proportions. Iran has not formally phased out subsidization of retail fuel prices, however it has placed a cap on the amount of subsidized fuel that each individual can purchase—fuel purchased beyond the quota costs close to market prices. This is an example of an incremental subsidy phase-out program that could be successful, at least as a second-best solution. However, reducing subsidies to prices of energy inputs such as natural gas or wholesale electricity for intermediate goods – though likely unpopular among firms – may be less politically difficult.

While perhaps not easy to argue in a political setting, a policy of subsidizing energy prices can also have distributional effects, notably by being regressive (Coady et al 2006). While this is not always the case and would depend on measurements of price and quantity effects and estimation of demand elasticities, it is likely that the rich benefit disproportionately from such policies. It may also be the case that in countries with relatively equitable income distributions, implementation of taxation policies – or reduction of subsidization policies – may be more politically-supportable, because of their perceived distributional impacts.

Subsidizing investments in energy efficiency would likely be more politically palatable, depending on the cost of such a policy. In a context in which developing countries, in particular, have limited budgets and abilities to spend and borrow, there may be a role for financing for such subsidization programs to come from multilateral organizations, such as the European Union, World Bank, or regional development banks. It is possible that such a policy could be implemented by the government of a developing country, in conjunction with outside financing.

Institutional environment

In general, the status quo energy policy will remain politically acceptable until such a policy leads to a cost-overrun that threatens the economic stability of the country or the political stability of the government—for instance, in the case that a subsidization program leads to ever-increasing budget and current account deficits, eventually causing a crisis. However, evidence indicates that certain institutional environments are also more conducive to subsidization policies than others. Specifically, analysis suggests that more autocratic regimes and ones with competitive electoral systems tend to subsidize energy less.

Hypotheses

This paper examines two types of political institutions that influence the ability of governments to pass politically-sensitive fiscal reforms, as is the case of reducing price subsidization. These two types of institutions are regime type and the structure and competitiveness of electoral systems. This paper uses a dataset compiled by Cheibub, Gandhi, and Vreeland (Cheibub, Ghandi, and Vreeland 2009) that classifies regimes into six categories: parliamentary democracy, mixed democracy, presidential democracy, civilian dictatorship, military dictatorship, and royal dictatorship. It also classifies countries by the existence of a legislative body (and distinguishes between elected and non-elected legislatures), by the forms of legislative and executive selection (direct election, indirect election, or no election), and by the number of parties in the legislature and number of de facto parties existing in the system (for both classifications, the possible categories are zero, one, or multiple).

Two sets of hypotheses follow from the models and research included in the studies cited above. First, this paper posits that autocratic systems should have less incentive to pass difficult reforms than presidential regimes, as decision making in these systems is more centralized, depends on fewer political actors, and generally is less accountable. Further, countries with presidential regimes should, in turn, be less adept at passing sensitive political reforms than parliamentary democracies, as the former are less responsive to the need for reform. The result is that the more autocratic or stronger is the executive branch of a regime, the higher should be the level of energy price subsidization in this country, controlling for other factors. (A separate argument that also supports this hypothesis is that more autocratic or centralized regimes have a greater incentive to appease the population, e.g., by maintaining subsidies, and so subsidizes relatively more for this reason as well.)

Second, this paper suggests that electoral systems that exhibit more competitive electoral systems (as evidenced by elections for executive and legislative posts and by the existence of multiple political parties) should be more effective at passing reforms, and should, therefore, exhibit lower levels of price subsidization (again, controlling for other factors).

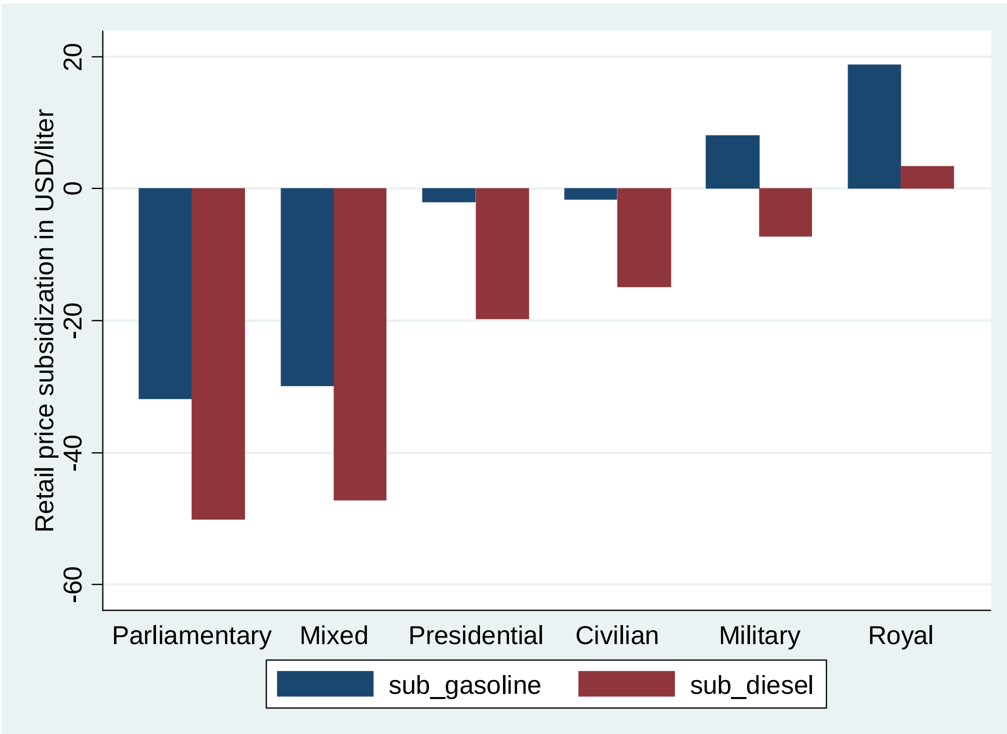
While other political institutions and aspects of electoral systems, e.g., presence of party-list or proportional representation voting, also exist and may have some correlation with the variables mentioned above, this paper takes the view that the two types of political institutions mentioned are the most critical for explaining cross-country variation in energy price subsidization.

Empirical evidence

This analysis combines the existing subsidization dataset with that of Cheibub, Gandhi, and Vreeland and uses cross-country regressions of retail gasoline and diesel price subsidization levels that include year fixed effects and control for variables such as GDP per capita and net energy imports. The key independent variables are regime type (according to the classification mentioned above) and electoral system (type of legislative and executive systems and number of political parties existing and in the legislature).

Empirical data seem to confirm the hypotheses posited by this paper. As seen in Figure 7 (below), more autocratic regimes tend to subsidize the most (where autocracies increase in severity from civilian to military to royal), while subsidization in presidential regimes is at around an average level, and parliamentary democracy and mixed regimes subsidize less.

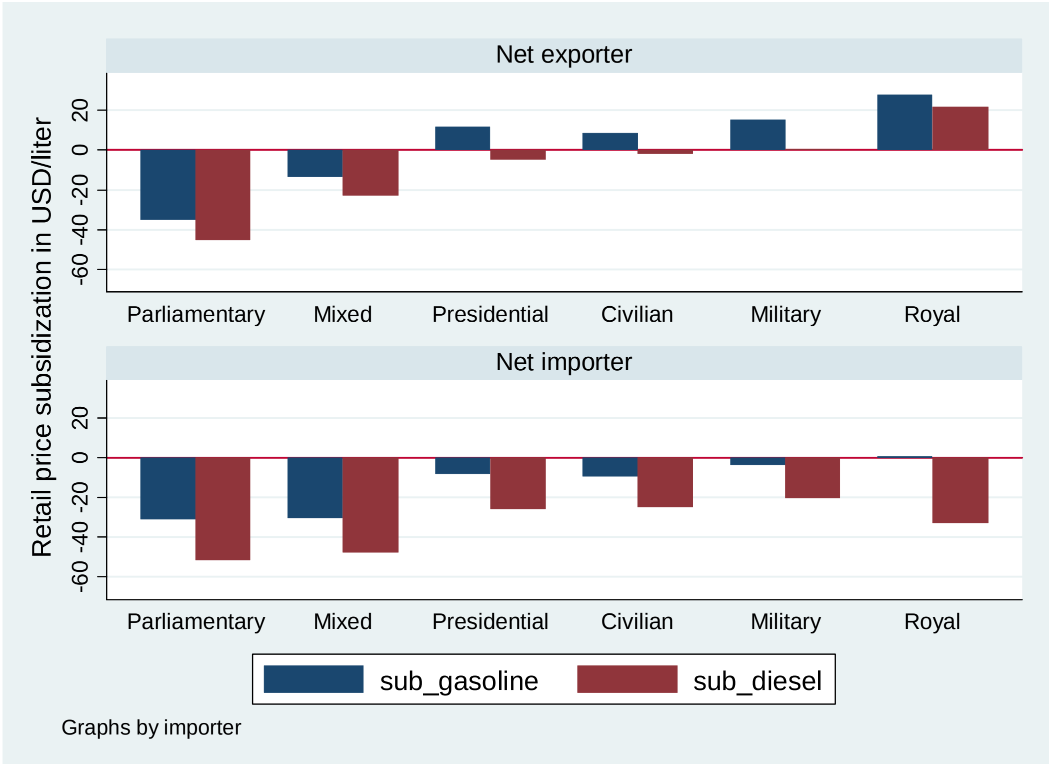
Figure 7. Regime type versus average net price subsidization level, 1993-2008



Source: GTZ, IEA, Cheibub and coauthors

Additionally, as seen in Figure 8 (below), the relationship between regime type and subsidization level is less clear in the case of countries that are net energy importers, though it still appears to hold well among democracies. These countries have less domestic political pressure to subsidize energy prices (since energy is not on net domestically-produced) and also have a greater fiscal incentive to pass reforms that reduce subsidization levels (as they are not awash in revenue from energy exports). Interestingly, in the case of democracies that are net energy exporters, the posited relationship between regime type and subsidization level appears to hold better—there is a clear positive relationship between level of autocracy or power of executive and price subsidization level.

Figure 8. Regime type versus subsidization by energy imports



Source: GTZ, IEA, Cheibub and coauthors

Additionally, within democracies, countries in which multiple political parties exist and are represented within the legislature are associated with lower levels of net fuel price subsidization, as illustrated by the following table.

Table 6. Average net price subsidization by number of parties

Multiple parties	mean(sub_diesel)	N(sub_diesel)	mean(sub_gasoline)	N(sub_gasoline)
0	-5.5	83	9.8	83
1	-29.4	765	-12.8	764

Source: GTZ, IEA, Cheibub and coauthors

Finally, a cross-country panel regression of gasoline subsidization on a dummy variable for having an elected legislature indicates that having this elected body is associated on average with lower subsidization (0.14 USD/liter) for both gasoline and diesel. Democracies also are associated with an average subsidization level that is lower than under autocracies (by 0.19 USD/liter). These regressions controls for level of GDP per capita and for oil supply, as net energy imports are positively correlated with subsidization level. The effect of having an elected executive is statistically not different from zero. The results for the regression of gasoline subsidization on democracy are in Table 7.

Table 7. Cross-country regression of gasoline subsidization

	Coefficient	**Standard Error**
democracy	-17.51**	(1.93)
gdp_pc	-1.22**	(0.11)
oil_supply	0.06**	(0.01)
Year fixed effects		
1993	29.89**	(5.61)
1995	38.09**	(4.77)
1998	36.95**	(4.53)
2000	51.96**	(4.61)
2002	42.98**	(4.59)
2004	40.36**	(5.02)
2006	36.27**	(5.26)
2008	16.38**	(7.22)
constant	-30.66**	(4.25)

*Note: ** denotes 5% significance*

Source: Author's analysis

Policy implications

Evidence suggests strongly that there is a relationship between degree of autocracy or power of the executive branch and the level of subsidization in a given country. Confirming the findings of Frederiksson and Millimet and of Persson and coauthors, this paper finds that greater legislative powers and more democracy are conducive to passing reforms that reduce the level of subsidization in an economy. While this is not yet a complete picture or proof of the mechanisms through which this takes place, it has policy implications for targeting countries to phase out price subsidization or reduce their energy intensity, for being aware of the nature of the institutional obstacles to passing such reforms, and for having an idea of the mechanism through which such reforms are passed.

CHAPTER VI: CONCLUSIONS AND POLICY RECOMMENDATIONS

This paper has attempted to establish relationships between energy intensity, severity of changes in the business cycle, and energy price subsidization. The conclusions that this analysis draws are that more price subsidization is associated with higher energy intensity, and that it also amplifies the negative effects of price shocks on the business cycle and dampens the positive effects of increases in energy efficiency on changes in economic output. For these reasons, it is in the interest of a policy maker to implement policies that mitigate the effects of price shocks on changes in GDP, notably by acting to decrease the energy intensity of the economy in question. While phasing out net subsidies is the most economically-efficient means of doing this, it is often difficult to gain political support for such measures. As such, this paper recommends reducing subsidies insofar as it is possible—either if the political and institutional environments allow it, or if a politically-palatable incremental or partial solution is available. Beyond this, limited implementation of incentives to raise energy efficiency is advisable as well, however, the choice of these measures depends on the degree to which the country has the operational capacity to implement these measures, and their financial ability to support them.

REFERENCES

Bacon, R. and M. Kojima. (2006a). “Phasing Out Subsidies: Recent Experiences with Fuel in Developing Countries”. World Bank Public Policy for the Private Sector.

Bacon, R. and M. Kojima. (2006b). “Coping with Higher Oil Prices”. World Bank Energy Sector Management Assistance Program.

Baig, T., A. Mati, D. Coady and J. Ntamatungiro. (2007). Domestic Petroleum Product Prices and Subsidies: Recent Developments and Reform Strategies”. IMF.

Calvo, Guillermo A. (2005). “Crises in Emerging Market Economies: A Global Perspective”. NBER Working Paper No. 11305. NBER.

Cheibub, José Antonio, J. Gandhi, and J. Vreeland. (2009). “Democracy and dictatorship revisited”. *Public Choice.*

Coady, D., M. El-Said, P. Gillingham, K. Kpodar, P. Medas and D. Newhouse. (2006). “The Magnitude and Distribution of Fuel Subsidies: Evidence from Bolivia, Ghana, Jordan, Mali, and Sri Lanka”. IMF.

Energy Information Agency. (2010). “Country Analysis Brief: Iran”.

Frederiksson, Per G. and D. Millimet. (2004). “Comparative politics and environmental taxation”. *Journal of Environmental Economics and Management.*

Gordon, R. (1999). “Foundations of the Goldilocks Economy: Supply Shocks and the Time-Varying NAIRU”.

Gordon, R. (2009). “Is Modern Macro or 1978-era Macro More Relevant to the Understanding of the Current Economic Crisis?”.

GTZ. (2007). “International Fuel Prices 2007”. Transport Policy Advisory Services.

GTZ. (2009). “International Fuel Prices 2009”. Transport Policy Advisory Services.

Hamilton, J. (2005). “Oil and the Macroeconomy”.

Hausmann, R. and R.Rigobon. (2003). “An Alternative Interpretation of the 'Resource Curse': Theory and Policy Implications”. NBER Working Paper No. 9424. NBER.

Hossain, S. (2003). “Taxation and Pricing of Petroleum Products in Developing Countries: A Framework for Analysis with Application to Nigeria”. IMF Working Paper.

IEA. (2002). “Reforming Energy Subsidies”.

IEA. (2004). “Analysis of the Impact of High Oil Prices on the Global Economy”.

IMF. (2007). “Oil Shocks and External Balances”.

IMF. (2008a). “Fuel and Food Price Subsidies: Issues and Reform Options”.

IMF. (2008b). “Oil Price Movements and the Global Economy: A Model-Based Assessment”.

Jorgenson, D. (1981). “Energy Prices and Productivity Growth”.

Jorgenson, D. (1984). “The Role of Energy in Productivity Growth”.

Jorgenson, D. (1999). “Why Has the Energy-Output Ratio Fallen in China?”.

Killian, L. (2007). “The Response of Business Fixed Investment to Changes in Energy Prices: A Test of Some Hypotheses About the Transmission of Energy Price Shocks”.

Killian, L. (2008). “The Economic Effects of Energy Price Shocks”.

Killian, L. (2009). “Not All Oil Price Shocks Are Alike: Disentangling Demand and Supply Shocks in the Crude Oil Market”.

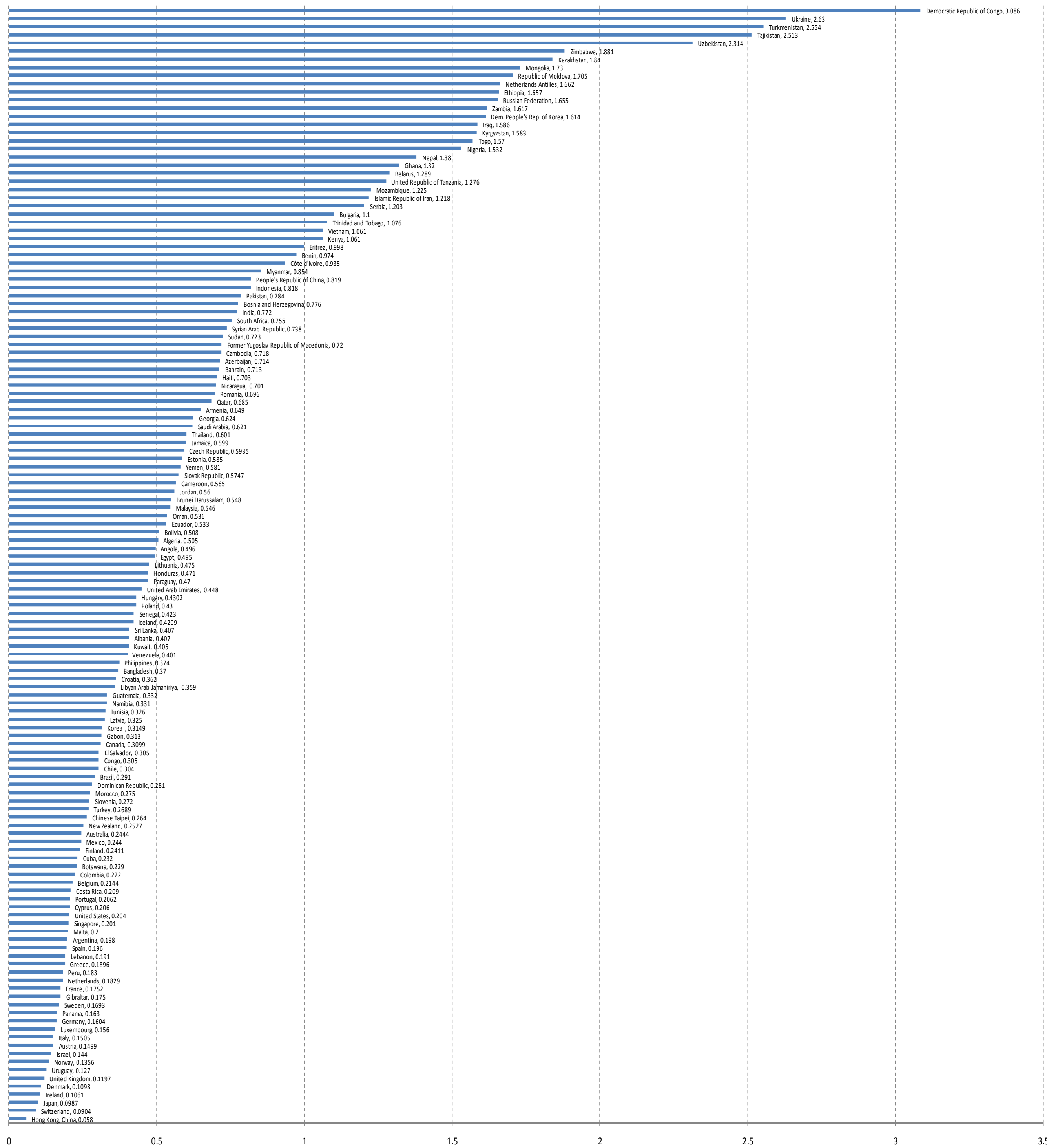
Kojima, M. (2009). “Changes in End-User Petroleum Product Prices”. Wold Bank Extractive Industries and Development Series #2.

Persson, Torsten, G. Roland, and G. Tabellini. (2000). “Comparative politics and public finance”. *Journal of Political Economy.*

Reich, K. and W. Teplitz. (2009). “Energy Subsidies: Why, When and How?”. GTZ.

APPENDIX

Figure A. TPES/GDP by Country (ktoe/2000 USD), 2007



Source: IEA