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Oil Intensities and Oil Prices:

Evidence for Latin America

Veronica Alaimo
Humberto Lopez

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Abstract

Crude oil prices have dramatically increased over the past years and are now at a historical maximum in nominal terms and very close to it in real terms. It is difficult to argue, at least for net oil importers, that higher oil prices have a positive impact on welfare. In fact, the negative relationship between oil prices and economic activity has been well documented in the literature. Yet, to the extent that higher oil prices lead to lower oil consumption, it would be possible to argue that not all the effects of a price increase are negative. Climate change concerns have been on the rise in recent years and fossil fuel consumption is generally viewed as one of the main causes behind it. Thus this paper explores whether higher oil prices contribute to lowering oil intensities (that is, oil consumption per unit of gross domestic product). The findings show that following an increase in oil prices, OECD countries tend to reduce oil intensity. However, the same result does not hold for Latin America (and more generally for middle-income countries) where oil intensities appear to be unaffected by oil prices. The paper also explores why this is so.

This paper—a product of the Office of the Chief Economist, Latin America and the Caribbean Region—is part of a larger effort in the department to to understand the causes, consequences and possible solutions to the challenges created by climate change. Policy Research Working Papers are also posted on the Web at http://econ.worldbank.org. The author may be contacted at hlopez@worldbank.org.

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Veronica Alaimo and Humberto Lopez

The World Bank *

*The authors appreciate the valuable comments of Cesar Calderon and the assistance of Joana Naritomi in the earliest versions of the paper. Views expressed in this paper are those of the authors and should not be attributed to the World Bank, its Executive Directors or the countries they represent. Address for correspondence: MS I8-801, The World Bank, 1818 H Street, Washington, DC 20433. Email: Hlopez@worldbank.org. Tel: +1 (202) 473-4909. Fax: +1 (202) 522-7528

I. Introduction

Crude oil prices have dramatically increased over the past years and are now at a historical maximum in nominal terms and very close to it in real terms.[1] For example, in 1998 oil prices averaged about US$12 per barrel (about US$15 in 2007 dollars); in March 2008 they crossed the US$110 barrier and futures markets indicate that investors expect the price of oil to remain around US$98.6 through 2008.[2] In fact, if oil prices remain at the level of the March 2008 one year future during the whole year, the price increase (in real terms) during the 2000s would be comparable in magnitude to the one observed during the 1970s (figure 1).

It is difficult to argue, at least for net importers, that higher oil prices have a positive impact on welfare. In fact, the negative relationship between oil prices and economic activity has been well documented in the economics literature following the work of Hamilton (1983) who found a significant negative correlation between oil price changes and real GDP growth using post-war data for the United States. Similarly, Huntington (2005) notes that nine of the last ten U.S. recessions were preceded by increases in crude oil prices. There are a number of ways in which higher oil prices can negatively affect growth. The most obvious is perhaps through the impact that higher oil prices may have on production costs such as transportation, energy, or oil-related inputs (i.e. higher oil prices would act as a negative supply shock). In addition, high oil prices may negatively affect macroeconomic variables such as the inflation rate and the balance of payments position of a net importer and contribute to increasing economic uncertainty, which in turn may affect investment decisions and damage future growth.

However, to the extent that higher oil prices reduce oil consumption it may be possible to argue that not all the effects of a price increase are negative. Today there is little doubt that climate change is occurring. During the 20th century global atmospheric temperatures have increased by roughly 0.8°C, a pattern of temperature change somewhat unique by historical standards. More worrisome, according to the Fourth Assessment Report of the Intergovernmental Panel for Climate Change (IPCC) a best estimate of temperature change over the coming century could range (depending on underlying assumptions) between 1.8 and 4 °C, a change not seen in the past 10,000 years.

In turn, the main forces behind global warming -and more generally climate change- are the consumption of fossil fuels and the associated increase in atmospheric concentrations of green house gases (GHG), such as carbon dioxide whose concentrations have raised from around 280 ppm (parts per million) in 1800 to around 380 ppm today.[3] Thus a reduction in emissions of GHG (i.e. a reduction in fossil fuel reliance[4]) appears as a key element of any strategy to address climate change concerns. Not surprisingly then,

[1] The maximum was in December 1979 when in 2007 US$ the price of a barrel was close to US$110.
[2] On March 31, 2008, the Brent crude future for December 2008 was 98.58.
[3] The science behind the idea that that increases in carbon dioxide concentrations would lead to increases in surface temperatures dates to the work by Fourier and Tyndall in the 19th century.
[4] Implicitly we are ruling out dramatic technologically improvements that allow burning fossil fuels in a clean way, something that at least over the short run seems a reasonable assumption.

there is nowadays an ongoing debate regarding the use of carbon taxes, or market based mechanisms such as cap and trade systems, to encourage emissions reduction.

Clearly, the extent to which these measures are successful will depend on how consumption of fossil fuels -such as oil- reacts to the higher prices implied by the tax or cap and trade systems. And the existing empirical evidence on this front is somewhat mixed, at least for non-OECD countries. Gately and Huntington (2001) and Dargay, Gately, and Huntington (2007) find that that energy demand in OECD countries responds to changes in oil prices but find mixed effects for non-OECD countries. They argue that the low response to crude oil prices in most Non-OECD countries may reflect government interventions designed to avoid pass-through to final consumers.[5]

This paper enters the debate and explores the impact of oil price fluctuations on the intensity of oil consumption (i.e. oil consumption per unit of GDP produced) with a particular emphasis in the Latin American region. Note in this regard that our exercise differs from Gately and Huntington (2001) and Dargay, Gately, and Huntington (2007) in that we are exploring whether economies become more oil-efficient when prices increase (that is whether economies can continue to produce the same output levels but using less oil) rather than just whether economies demand less oil, which in principle could be the result of a decline in economic activity and hence of a decline in welfare.

True, it would be possible to argue that a reduction in oil consumption may not be the result of increases in efficiency but rather of a switch in energy sources (for example from oil to hydropower). Thus in the paper we also explore whether oil price increases are also translated into changes in the intensity of energy at large (i.e. in efficiency improvements).

To anticipate some of the results below, we find that the oil intensity of Latin American countries (excluding oil exporters) is not affected by higher oil prices. This would be in contrast to OECD countries where we find that positive oil price changes tend to significantly reduce oil, but similar to other middle income countries (excluding oil exporters) where oil intensity and oil prices appear to be unrelated. When we explore how oil prices affect energy intensity, similar results appear. Once again the OCED countries appear to become more efficient while the Latin American and the middle income countries sample do not react. We argue that this result may be due to government's decisions of reducing pass through to final consumers. In many middle income countries and in particular in Latin America energy prices are heavily regulated and energy price changes tend to be a sensitive topic. Thus while this can protect consumers by isolating them from price fluctuations (especially price increases) on the other hand it may also fail to send the appropriate signals to consumers.

We also find, in line with some of the existing literature, that there are important asymmetries in the way oil price fluctuations affect both oil and energy intensities in the OECD. For example, while we find that oil increases (whether above its historical

[5] They do find a very high income elasticity for Non-OECD countries, largely explained by the growth rates in many developing countries.

maximum or else) lead to higher efficiency levels oil decreases leave efficiency levels unaffected (i.e. there are no reversals in efficiency once prices decline).

The rest of the paper is structured as follows. In section II we review the trends in the evolution of oil intensities, introduce the econometric methodology to measure the impact of oil prices on oil intensities, and present the empirical results. In section III we explore why Latin American oil intensities do not react to changes in oil prices. Finally, section IV closes with some conclusions.

II. Oil prices and oil efficiency

II.1 Oil intensities across countries

Oil intensities (measured as barrels of oil consumed per day over annual GDP), have evolved in a very different fashion in different regions of the world. This is evident from figure 2 where we present oil intensities[6] for a selected number of countries over the period 1971-2004. In panel A, the figure shows countries belonging to the Latin American region; in Panel B, to the OECD group and in Panel C, to the non-Latin American middle income countries. Inspection of this figure suggests three main elements.

First, over the past three and half decades oil intensities have declined only moderately in Latin America. In fact, median intensity for Latin America declined from 1.6 barrels per day per million dollar produced (bdmd) in the early 1970s to 1.3 in the early 2000s The only exception would be Panama where intensities declined from 2.8 to close to 1.7 bdmd. In the rest of the Latin American countries one can observe a few modest declines and some increases. This would be in contrast to what we observe in the OECD where oil intensities have declined much more markedly. For example, over the period under consideration, the US (which is the biggest oil consumer) reduced its oil intensity from about 4.2 bdmd to about 2.1. Similarly in Japan and France: in the case of Japan, oil intensities declined from 3.6 bdmd to around 2, whereas in the case of France the decline was from about 3.1 to also 2. The median intensity for the OECD countries in this sample declined from 2.9 bdmd in the early 1970s to 1.7 in the early 2000s On the other hand, the evolution of intensities in Latin America does not seem very different from what we observe in other middle income countries.

Second, even though if the most important gains can be observed in the OECD countries, today oil intensities appear very similar in the OECD, in Latin America, and in the middle income countries and range between 1.1 and 2.1 bdmd. In fact, countries like Brazil or Turkey would have little to show in terms of inter-temporal gains, but since in the 1970s they already had very low intensities, today also fare very well on this front.

Third, about two-thirds of the reduction in oil intensity in OECD countries was achieved by 1985 (i.e. by the end of the second oil crisis). For example, Japan cut oil

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[6] Oil data are in thousand barrels per day and comes from OECD website, whereas the GDP series is from the PWT6.2 and is in million US dollar.

intensities from 3.6 to 2.2 bdmd by 1985, whereas between 1985 and 2004 the decline was much more modest (from 2.2 to about 2 bdmd). Or take, the US where by 1985 intensities had been cut to 2.7 bdmd. To a large extent that was the result of greater home insulation, better gasoline mileage, and streamlined production processes that led to a reduction in the use of oil per unit of output. Since then, progress in reducing oil intensity has continued but much more slowly and one could think that the reason was the lower level of prevailing real oil prices.

II.2 Econometric methodology

The previous discussion already suggests that whereas OECD countries oil intensities seem to have reacted to the oil price increased in the 1970s and early 1980s, the same cannot be said for Latin American and more generally non-OECD countries. Now we move to formally test any potential causal link from oil prices to oil and energy intensities using the following simple trivariate panel VAR model:

$$\Delta \ln(E)_{it} = \nu_i + \alpha_1 t + \alpha_2 \Delta \ln(E)_{i,t-1} + \alpha_3 \Delta \ln(y)_{i,t-1} + \beta \Delta \ln P_{i,t-1} + \varepsilon_{i,t} \qquad (1)$$

where E is oil consumption as a share of GDP, y is GDP and P is the price of oil. ν_i is a country-specific fixed effect, and ε_{it} is an i.i.d. error term. Our primary focus is the estimate of β in equation (1). If prices affect oil/energy intensity, we should find $\beta < 0$. However, to the extent that prices do not affect changes in energy intensity we would find that $\beta = 0$. Thus in essence we are testing whether oil price changes Granger cause oil/energy changes.

Clearly, it can be argued that the previous model is too restrictive. In fact, a number of studies (Mork, 1989, Mork, Olsen and Mysen, 1994) have argued that the relationship between oil prices and a number of economic variables (mainly economic activity) is asymmetric (i.e. the economic impact of prices increased and declines is different) and this could affect the tests based on (1). In this regard, we also estimate a model that allows for asymmetric effects. The idea here would be that higher energy prices may lead to improvements on the efficiency front through for example investment in more energy-efficient equipment and/or retrofitting of existing capital. Price declines on the other hand may lead to more intensive usage of the capital in question (e.g. adjusting thermostats to more comfortable levels) but will not lead to a reversal in the retrofitting.

Thus we also test for this possibility by defining

$\Delta \ln P^{+} = \begin{cases} \Delta \ln P & if \quad \Delta \ln P > 0 \\ 0 & if \quad \Delta \ln P \leq 0 \end{cases}$ and $\Delta \ln P^{-} = \begin{cases} \Delta \ln P & if \quad \Delta \ln P < 0 \\ 0 & if \quad \Delta \ln P \geq 0 \end{cases}$ and then augmenting (2) as in:

$$\Delta \ln(E)_{it} = \nu_i + \alpha_1 t + \\ + \alpha_2 \Delta \ln(E)_{i,t-1} + \alpha_3 \Delta \ln(y)_{i,t-1} + \beta_1 \Delta \ln P^{+}{}_{i,t-1} + \beta_2 \Delta \ln P^{-}{}_{i,t-1} + \varepsilon_{i,t} \quad (2)$$

In (2) the hypotheses of interest are now $\beta_1 < 0$ and $\beta_2 < 0$.

The previous model can be pushed forward and allow for more flexibility as in Gately and Huntington (2002) or Dargay, Gately, and Huntington (2007) who propose a model also based on asymmetry and imperfect price-reversibility. Yet, they allow for the possibility that not all price increases are the same and hence not all price increases have the same effect. In principle, it would be possible that increases that break a price record do not have the same effect as increases within what could be considered a normal range. More specifically, Gately and Huntington (2002) propose the following decomposition for the price level

$$\ln P = \ln P_0 + \ln P_{max} + \ln P_{cut} + \ln P_{rec} \quad (3)$$

where P_0 is the price in the starting year; P_{max} is the cumulative increase in the log of maximum historical price; P_{cut} is cumulative decreases in log of price; and P_{rec} is the cumulative sub-maximum increases in log of price. Figure 3 presents a graphical decomposition of the (logged) oil prices into the three sub components just defined. It shows that: during the 1970s P_{max} and P go hand in hand (i.e. each observation for the price of oil was a maximum); during the 1980s and most of the 1990s, most of the variation in P is due to P_{cut} (i.e. price declines dominate the evolution of P); and finally, during the last 10 years it is P_{rec} the component that dominates (i.e. prices on the rise but without reaching the maximum level).

Using (3) to substitute for the price of oil in (1), then we obtain the following unrestricted version for the changes in oil efficiency:

$$\Delta \ln(E)_{it} = \nu_i + \alpha_1 t + \alpha_2 \Delta \ln(E)_{i,t-1} + \alpha_3 \Delta \ln(y)_{i,t-1} + \\ + \beta_1 \Delta \ln P_{\max,t-1} + \beta_2 \Delta \ln P_{cut,t-1} + \beta_3 \Delta \ln P_{rec,t-1} + \varepsilon_{i,t} \quad (4)$$

In (4) the hypotheses of interest are now $\beta_1 < 0$, $\beta_2 < 0$, and $\beta_3 < 0$. Note that the idea in this specification is that price increases may now have different effects depending on past prices (i.e. a price increase above the historical maximum is different to a price increase in a period of more or less normal variations). In the case of oil demand, Gately and Huntington (2002) expected (and found) that $\beta_1 > \beta_2 > \beta_3$. Here our prior would be similar.

II.3. Results

We now review the results of estimating equations (1), (2) and (4) for a sample of 108 countries in the world, high income OECD countries, middle income countries and LAC. Oil data and the GDP series are as above whereas energy use (in kt of oil equivalent) is from the World Development Indicators database. Crude oil (Brent) prices (in US dollars per barrel) are from British Petroleum.

Inspection of table 1, which reports the results for the less flexible model, indicates that the only sample where oil prices appear to Granger cause oil intensities is the OECD. In Latin America, other middle income countries, and the world as a whole the parameter of the variable capturing changes in oil prices does not come close to being significant (i.e. we cannot reject the null hypothesis of no Granger causality).

Clearly, one could argue that these results are driven by the particular specification used. Yet, when we inspect table 2, which is based on model (2), the results are in line with those in table 1 except for the sample including all the countries (which admittedly could be driven by the OECD sample), although with a qualification. In fact, it seems that there are important asymmetric effects associated to price increases and price declines. In fact, price declines seem to have no effect on oil intensities.

Table 3 goes one step beyond and present the results of our more general model. It suggests that price increases above the maximum historical price have a significant and negative impact only in the world and OECD countries. In the latter case, the cumulative sub-maximum price recoveries also have a negative and significant effect on oil intensity. However, when we test the equality of both coefficients, i.e. $\beta_1 = \beta_3$, we find that they are not statistically different. This may suggest that even though oil demand (as measured by oil consumption per capita) responds differently to price recoveries (Gately and Huntington, 2001; Dargay, Gately, and Huntington, 2007) than to price beyond historical maximum, the oil intensity is equally affected by both types of price increases. On the contrary, when we look at price decreases we cannot reject the null of no causality.

Are these results, at least those for the OECD, driven by overall energy efficiency gains or instead by a switch in energy sources? To address this question we now re estimate the previous models but using overall energy intensity (rather than oil intensity) as our variable of interest. The results for these models are in tables 4 to 6. They indicate that while in principle it is may be possible that in OECD countries there is a switch between energy sources, it is also the case that when oil prices increase, OECD countries experience a gain in overall energy efficiency levels.

IV. Why is it that in Latin American countries intensities do not react to prices?

What can be the reason that makes the Latin American countries behave in a different way than the OECD countries and in a similar way to the middle income counties? Although the analysis in the preceding section cannot be used to give an answer to this question, one can put forward some hypotheses. For example, to the extent that oil price changes are not passed through to consumers and instead are covered by, for example, public subsidies it could be argued that oil prices may not dramatically affect consumption or efficiency levels, as individuals may not have the right incentives to save on energy.

In this regard, the existing evidence for Latin America suggests that, in general, oil exporter countries allow limited pass-through from oil price to gasoline prices, whereas oil importer countries tend to allow higher levels of pass-through to final consumers. Table 7 summarizes the results of two studies that have explored the degree of (international oil prices/domestic gas prices) pass-through over past 10 years in a selected number of countries in the region.

For example, Bacon and Kojima (2006) compute the ratio between the change in domestic prices (gasoline, diesel) and the change in oil prices -both measured in dollars- over 2004-2006 for 8 Latin American countries. They find that Venezuela, Argentina, and Mexico have negligible pass-through; Bolivia and Honduras would have pass-throughs of around 60 percent for gasoline and 80 percent for diesel; finally, Guatemala, Nicaragua and Chile have the highest pass-through of their sample with coefficients ranging from .95 to 1.15.

These findings are to a large extent consistent with those in World Bank (2006). In this case, the degree of pass-through is estimated as the coefficient from a regression of the overall price index of gasoline prices on energy prices. World Bank (2006) concludes that in Argentina, Mexico and Venezuela there is no pass through. This would also be the case in Ecuador. On the contrary in Brazil, Colombia, Dominican Republic, El Salvador, and Guyana the pass through would be complete.

Artana et al. (2007) adopt a different approach and estimate the level of "cushioning" of gasoline prices in Central America (net-oil importer countries) as the tax-wedge in end-user prices. A negative tax-wedge means that governments are cushioning consumer prices, reducing the impact that oil prices have on final prices. They find a strong cushioning in Costa Rica and Guatemala (diesel), a neutral cushioning in El Salvador, Nicaragua and Panama –where neutral means that the tax-wedge for gasoline is smaller than the value-added tax, and a weak cushioning in Guatemala (gasoline) and Honduras (table 8).

On the whole, the picture that emerges from these studies is somewhat mixed, with some countries passing oil price fluctuations (at least to some extent) to final consumers (typically net importers) and some others showing a clear disconnect between domestic and international price changes (typically net exporters).

Does this conclusion still hold today where crude oil prices are reaching record levels? To address this question we have collected data for 13 countries covering the period January 2005 to December 2007 in most cases, and longer periods for Argentina, Bolivia, Colombia, Mexico, and Peru.[7] Table 9 provides the average price of three derivatives: premium gasoline, regular gasoline, and diesel in each country, measured in dollars per gallon.[8] Net oil exporter countries appear with lower prices than net oil

[7] We also estimated all the models for the 2005-2007 balanced panel, and for the individual countries with longer series. The results remained unchanged.
[8] The octane varies by country. Nonetheless, we classify as premium and regular gasoline following international standards.

importers. For example, the gallon of regular gasoline was less than a dollar in Argentina, Bolivia, Colombia, and Mexico, while it averaged 1.15 US$/gallon in net oil importers. Table 10 provides the simple correlation between changes in oil prices and changes in the prices of the three derivatives. Inspection of this table indicates that oil price changes are positively and significantly correlated with premium and regular gasoline in net oil importer countries even though the correlation is very modest: .22 for premium and .14 for regular. On the contrary, oil prices do not appear to be correlated with diesel at the pump regardless of net importer/net exporter status or with gasoline in net exporters.

More formally, we explore the degree of pass through with the following panel fixed-effects model:[9]

$$\Delta \ln(PG)_{it} = \nu_i + \alpha_2 \Delta \ln(PG)_{i,t-1} + \alpha_3 \Delta \ln(PO)_{i,t} + \beta \Delta \ln(PO)_{i,t-1} + \varepsilon_{i,t} \qquad (5)$$

where PG is our variable of interest (either end-user price of premium, regular, or diesel fuels) in dollars, and *PO* is the price of oil. ν_i is a country-specific effect, and ε_{it} is an i.i.d. error term

Tables 11 and 12 report average results based on pooling the previous data for exporters (table 11) and importers (table 12) countries. In both cases, the estimated model allows for fix-effects. These tables continue to indicate that in net exporters there is no pass-through whereas in importers there is a limited pass through: on average a 1 percent increase in crude oil would translate into an average domestic gas increase of between .5 and .65 depending of the type of fuel considered and model used to estimate the pass through.

Finally, we estimate equation (5) using ordinary least squared methods with robust standard errors for each individual country. Table 14 reports the econometric results. To facilitate the interpretation of the results, in Table 13 we classify countries into four groups: (i) no pass-through, if neither the change in current oil price nor the change in the price the month before is significant (or significant but negatively related); (ii) low pass-through if the coefficients α_2 and/or β are positive and significant, with a value below 0.33; (iii) medium pass-though if the coefficients α_2 and/or β are positive and significant, with values between 0.33 and 0.66; and (iv) high pass-though if the coefficients α_2 and/or β are positive and significant, with values above 0.66.

Reinforcing the findings from the panel analysis, the four net oil exporters in our sample are classified in the "no pass-through category" for all types of fuels. In addition, Peru does not show signs of pass-though for regular gasoline (the only type available in our sample). Paraguay also appears with no pass-though in the case of regular gasoline, but it shows signs of low pass-through for premium gasoline and diesel (15 percent and 23.7 percent, respectively). Costa Rica is the only Central American country with no pass-through in two types of derivatives (premium and diesel), while it translates oil price changes to regular gasoline (44 percent). The rest of Central American countries and

[9] This model is similar to the one used by World Bank (2006).

Uruguay show evidence of medium or high pass-throughs. In particular, our estimations suggest that Nicaragua and Uruguay have high pass-through on premium and regular gasoline prices and medium pass-though on diesel prices. El Salvador also shows evidence of high pass-through for regular gasoline. Guatemala and Honduras are classified as countries with medium pass-through for the three types of derivatives.

V. Conclusions

In this paper we have explored the relationship between oil price changes and the changes in oil and energy use intensity. Consistent with the literature on oil demand in developed countries, we find that OECD oil intensity responds asymmetrically to price increases and decreases, although there are no significant differences between price beyond historical maximum and price recoveries. However, the same is not true for developing countries. In fact, in Latin American and in middle income countries oil intensities do not appear to respond to price changes at all.

The paper then has explored whether behind the lack of a causal relationship from oil prices to oil and energy efficiency there is a limited pass through from oil prices to retail price at the pump. Our estimates suggest that indeed in most Latin American countries the pass-through is not complete and hence that oil price increases may not be creating the appropriate incentives in the region.

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Table 1. Oil intensity and prices: the symmetric hypothesis

	Dependent variable: D Oil consumption / GDP			
	LAC	Hi-OECD	MIC	World
	(1)	(2)	(3)	(4)
D ln(Oil Price) (t-1)	-0.168	-0.053	-0.0184	-0.0455
	[1.47e-01]	[1.71e-02]**	[1.89e-02]	[2.84e-02]
D ln(GDP) (t-1)	0.0607	-0.222	0.0311	-0.16
	[4.29e-01]	[2.40e-01]	[2.07e-01]	[1.75e-01]
D Oil consump/GDP (t-1)	0.091	0.039	-0.111	-0.112
	[0.158]	[0.052]	[0.063]	[0.079]
Time trend	0.00793	0.00223	-0.000863	0.00254
	[2.08e-03]**	[5.92e-04]**	[6.86e-04]	[8.10e-04]**
Constant	-0.221	-0.0785	-0.00308	-0.0756
	[5.01e-02]**	[1.52e-02]**	[2.14e-02]	[1.90e-02]**
Observations	498	704	1263	3505
Number of group(countrycode)	16	22	51	129
R-squared	0.05	0.06	0.01	0.02

Robust standard errors in brackets. * significant at 5%; ** significant at 1%

Table 2. Oil intensity and prices: an asymmetric relationship?

	Dependent variable: D Oil consumption / GDP			
	LAC	Hi-OECD	MIC	World
	(1)	(2)	(3)	(4)
Positive D ln(Oil Price) (t-1)	-0.249	-0.0791	-0.0040	-0.095
	[2.46e-01]	[2.63e-02]**	[2.54e-02]	[4.44e-02]*
Negative D ln(Oil Price) (t-1)	0.016	0.004	-0.049	0.062
	[1.33e-01]	[3.31e-02]	[4.51e-02]	[4.51e-02]
D ln(GDP) (t-1)	0.0299	-0.212	0.033	-0.161
	[4.07e-01]	[2.41e-01]	[2.07e-01]	[1.75e-01]
D Oil consump/GDP (t-1)	0.093	0.033	-0.111	-0.113
	[0.158]	[0.052]	[0.063]	[0.079]
Time trend	0.0079	0.0022	-0.0009	0.0025
	[2.08e-03]**	[5.91e-04]**	[6.88e-04]	[8.07e-04]**
Constant	-0.193	-0.070	-0.008	-0.059
	[5.57e-02]**	[1.59e-02]**	[2.27e-02]	[1.98e-02]**
Observations	498	704	1263	3505
Number of group(countrycode)	16	22	51	129
R-squared	0.05	0.07	0.02	0.02

Robust standard errors in brackets. * significant at 5%; ** significant at 1%

Table 3. Oil intensity and prices: maximum versus recovery price changes

	Dependent variable: D Oil consumption / GDP			
	LAC	Hi-OECD	MIC	World
	(1)	(2)	(3)	(4)
D Maximum historical ln(oil price) (t-1)	-0.290	-0.073	0.015	-0.114
	[3.12e-01]	[2.84e-02]**	[2.38e-02]	[5.60e-02]*
D Cumulative cuts ln(oil price) (t-1)	-0.036	0.029	-0.020	0.037
	[1.17e-01]	[3.47e-02]	[4.64e-02]	[4.55e-02]
D Cumulative sub-maximum recoveries ln(oil price) (t-1)	-0.018	-0.132	-0.089	0.005
	[2.52e-01]	[3.84e-02]**	[4.79e-02]	[5.57e-02]
D ln(GDP) (t-1)	0.030	-0.145	0.041	-0.163
	[4.12e-01]	[2.45e-01]	[2.07e-01]	[1.74e-01]
D Oil consump/GDP (t-1)	0.096	0.037	-0.110	-0.112
	[0.158]	[0.052]	[0.063]	[0.079]
Time trend	0.0063	0.0023	-0.0004	0.0019
	[2.93e-03]*	[6.12e-04]**	[7.42e-04]	[9.08e-04]*
Constant	-0.179	-0.066	-0.008	-0.054
	[5.82e-02]**	[1.61e-02]**	[2.29e-02]	[2.03e-02]**
Observations	498	704	1263	3505
Number of group(countrycode)	16	22	51	129
R-squared	0.05	0.1	0.02	0.02

Robust standard errors in brackets. * significant at 5%; ** significant at 1%

Table 4. Energy use intensity and prices: the symmetric hypothesis

	Dependent variable: D Energy use / GDP			
	LAC	Hi-OECD	MIC	World
	(1)	(2)	(3)	(4)
D ln(Oil Price) (t-1)	-0.016	-0.004	-0.002	-0.004
	[1.50e-02]	[1.41e-03]**	[1.49e-03]	[2.90e-03]
D ln(GDP) (t-1)	0.022	-0.031	-0.003	-0.015
	[3.89e-02]	[1.71e-02]	[2.04e-02]	[2.79e-02]
D Energy use/GDP (t-1)	0.034	-0.123	-0.040	-0.091
	[0.218]	[0.062]*	[0.064]	[0.101]
Time trend	0.00042	0.00002	-0.00004	0.00008
	[2.09e-04]*	[4.11e-05]	[4.68e-05]	[6.57e-05]
Constant	-0.013	-0.002	0.000	-0.003
	[5.78e-03]*	[1.02e-03]	[1.54e-03]	[1.81e-03]
Observations	498	704	1082	3201
Number of group(countrycode)	16	22	38	108
R-squared	0.02	0.04	0.00	0.01

Robust standard errors in brackets. * significant at 5%; ** significant at 1%

Table 5. Energy use intensity and prices: an asymmetric relationship?

	Dependent variable: D Energy use / GDP			
	LAC	Hi-OECD	MIC	World
	(1)	(2)	(3)	(4)
Positive D ln(Oil Price) (t-1)	-0.026	-0.007	-0.002	-0.006
	[2.48e-02]	[2.19e-03]**	[2.14e-03]	[4.57e-03]
Negative D ln(Oil Price) (t-1)	0.007	0.001	-0.004	0.001
	[1.05e-02]	[2.56e-03]	[3.20e-03]	[4.15e-03]
D ln(GDP) (t-1)	0.018	-0.030	-0.003	-0.015
	[3.66e-02]	[1.71e-02]	[2.04e-02]	[2.79e-02]
D Energy use/GDP (t-1)	0.035	-0.129	-0.040	-0.092
	[0.218]	[0.063]*	[0.064]	[0.101]
Time trend	0.00042	0.00002	-0.00004	0.00008
	[2.07e-04]*	[4.11e-05]	[4.70e-05]	[6.54e-05]
Constant	-0.010	-0.001	-0.001	-0.002
	[5.46e-03]	[1.11e-03]	[1.67e-03]	[1.82e-03]
Observations	498	704	1082	3201
Number of group(countrycode)	16	22	38	108
R-squared	0.03	0.05	0.00	0.01

Robust standard errors in brackets. * significant at 5%; ** significant at 1%

Table 6. Energy use intensity and prices: maxim versus recovery price changes

	Dependent variable: D Energy use / GDP			
	LAC	Hi-OECD	MIC	World
	(1)	(2)	(3)	(4)
D Maximum historical ln(oil price) (t-1)	-0.037	-0.007	-0.002	-0.009
	[3.16e-02]	[2.64e-03]**	[2.14e-03]	[5.74e-03]
D Cumulative cuts ln(oil price) (t-1)	-0.006	0.001	-0.004	-0.004
	[8.54e-03]	[2.50e-03]	[3.36e-03]	[4.14e-03]
D Cumulative sub-maximum recoveries ln(oil price) (t-1)	0.023	-0.004	-0.002	0.009
	[2.18e-02]	[2.82e-03]	[4.10e-03]	[5.12e-03]*
D ln(GDP) (t-1)	0.018	-0.029	-0.003	-0.016
	[3.67e-02]	[1.74e-02]	[2.04e-02]	[2.78e-02]
D Energy use/GDP (t-1)	0.036	-0.125	-0.039	-0.092
	[0.217]	[0.063]*	[0.063]	[0.101]
Time trend	0.00013	-0.00001	-0.00005	-0.00001
	[2.57e-04]	[4.45e-05]	[5.17e-05]	[7.29e-05]
Constant	-0.008	-0.001	0.000	-0.002
	[5.62e-03]	[1.12e-03]	[1.66e-03]	[1.83e-03]
Observations	498	704	1082	3201
Number of group(countrycode)	16	22	38	108
R-squared	0.04	0.06	0.01	0.01

Robust standard errors in brackets. * significant at 5%; ** significant at 1%

Table 7: Pass-through estimations of previous studies

	GASOLINE		DIESEL
Authors	Bacon & Kojima, 2006	The World Bank, 2006	Bacon & Kojima, 2006
Years covered	2004-2006	mid 90s, 2000s	2004-2006
Argentina	0.02	None	0.11
Bolivia	0.64		0.84
Brazil		Complete	
Chile	1.15		1.11
Colombia		Complete	
Dominican Rep.		Complete	
Ecuador		None	
El Salvador		Complete	
Guatemala	0.93		0.99
Guyana		Complete	
Honduras	0.60	Complete	0.87
Mexico	0.15	None	0.11
Nicaragua	0.95		0.88
Venezuela	0.00	None	0.00

Sources: bacon and Kojima (2006), The World Bank (2006)

Table 8: "Cushioning" of gasoline prices through tax-wedges

	GASOLINE	DIESEL		GASOLINE	DIESEL
Costa Rica	Strong	Strong	Honduras	Weak	Weak
El Salvador	Neutral	Neutral	Nicaragua	Neutral	Neutral
Guatemala	Weak	Strong	Panama	Neutral	Neutral

Note: The authors classify countries with strong, neutral or weak “cushioning” based on the reduction on the tax-wedge.
Source: Artana et al (2007)

Table 9: Average prices (US$/gallon)

	Premium gasoline	Regular gasoline	Diesel	Obs.
Argentina	0.86	0.76	0.60	73
Bolivia	0.90	0.55	0.52	111
Colombia	na	0.54	na	108
Costa Rica	1.25	1.20	0.88	29
El Salvador	1.14	1.08	0.95	29
Guatemala	1.14	1.12	0.91	29
Honduras	1.24	1.17	1.02	29
Mexico	0.86	0.73	0.54	120
Nicaragua	1.19	1.14	1.02	29
Panama	2.32	na	na	36
Paraguay	1.19	1.07	0.99	36
Peru	na	0.90	na	120
Uruguay	1.59	1.55	1.27	20

Sources: Argentina: Secretaría de Energía de la Nación. Bolivia: Gathered by World Bank staff. Colombia: Sistema de Información de Petróleo y Gas Colombiano, UPME. Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua: SIECA. México: Petróleos Mexicanos. Indicadores Petroleros. Panamá: Contraloría General de la República, Dirección de Estadística y Censo. Perú: Instituto Nacional de Estadística e Informática. Paraguay: Ministry of Finance (diesel), and Central Bank of Paraguay (gasoline). Uruguay: ANCAP - Administración Nacional de Combustibles, Alcohol y Pórtland. Expressed in US dollars using the Exchange rate from WDI.

Table 10: Pair-wise correlation between oil and gasoline price changes, in US$

Gasoline	Correlation with oil price	P-value
Net oil-importers		
Premium	**0.220**	**0.001**
Regular	**0.139**	**0.016**
Diesel	0.041	0.588
Net oil-exporters		
Premium	-0.028	0.629
Regular	-0.071	0.156
Diesel	0.001	0.987

Note: net oil-importers: Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua, Panamá, Paraguay, Perú, Uruguay
Net oil-exporters: Argentina, Bolivia, Colombia, México.
Source: Own calculations

Table 11: Pass-though in net oil exporter countries

Dep. Var.	Premium gasoline			Regular gasoline			Diesel		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
D(dep. var.) (t-1)	0.354	0.353	0.354	0.464	0.462	0.463	0.340	0.340	0.340
	[0.151]*	[0.151]*	[0.152]*	[0.116]**	[0.116]**	[0.117]**	[0.182]	[0.182]	[0.182]
D (oil price) (t)	-0.035		-0.035	-0.063		-0.062	-0.005		-0.004
	[0.034]		[0.034]	[0.035]		[0.035]	[0.033]		[0.033]
D (oil price) (t-1)		-0.011	-0.010		-0.014	-0.011		-0.024	-0.024
		[0.030]	[0.029]		[0.030]	[0.029]		[0.030]	[0.030]
Constant	0.002	0.002	0.002	0.003	0.003	0.003	0.003	0.003	0.003
	[0.002]	[0.002]	[0.002]	[0.001]*	[0.001]	[0.001]*	[0.002]	[0.002]	[0.002]
Observations	295	295	295	401	401	401	295	295	295
Countries	3	3	3	4	4	4	3	3	3
R-squared	0.16	0.16	0.16	0.29	0.28	0.29	0.16	0.16	0.16

Net oil-exporters: Argentina, Bolivia, Colombia, México. Robust standard errors in brackets. * significant at 5%; ** significant at 1%
Source: authors' calculations

Table 12: Pass-though in net oil importer countries

Dep. Var.	Premium gasoline			Regular gasoline			Diesel		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
D(dep. var.) (t-1)	0.147	0.023	0.036	0.159	0.107	0.109	-0.059	-0.079	-0.078
	[0.085]	[0.087]	[0.088]	[0.065]*	[0.060]	[0.060]	[0.073]	[0.069]	[0.069]
D (oil price) (t)	0.190		0.153	0.098		0.061	0.041		0.010
	[0.062]**		[0.054]**	[0.056]		[0.047]	[0.050]		[0.044]
D (oil price) (t-1)		0.493	0.481		0.470	0.465		0.412	0.411
		[0.064]**	[0.061]**		[0.055]**	[0.053]**		[0.046]**	[0.047]**
Constant	0.008	0.003	0.001	0.007	0.003	0.003	0.016	0.009	0.009
	[0.005]	[0.004]	[0.004]	[0.003]*	[0.003]	[0.003]	[0.004]**	[0.003]**	[0.003]**
Observations	200	200	200	284	284	284	166	166	166
Countries	8	8	8	8	8	8	7	7	7
R-squared	0.06	0.3	0.32	0.04	0.31	0.31	0.01	0.36	0.36

Note: net oil-importers: Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua, Panamá, Paraguay, Perú, Uruguay. Robust standard errors in brackets. * significant at 5%; ** significant at 1%
Source: authors' calculations

Table 13: A taxonomy of pass-though by country

Level of Passthrough	**Premium**	**Regular**	**Diesel**
None (*)	Argentina, Bolivia, Costa Rica, Mexico	Argentina, Bolivia, Colombia, Mexico, Paraguay, Peru	Argentina, Bolivia, Costa Rica, Mexico
Low (<.33)	Paraguay		Paraguay
Medium (.33-.66)	El Salvador, Guatemala, Honduras, Panama	Costa Rica, Guatemala, Honduras	El Salvador, Guatemala, Honduras, Nicaragua, Uruguay
High (>.66)	Nicaragua, Uruguay	El Salvador, Nicaragua, Uruguay	

(*) None means that either the coefficients for oil price changes were not significant or they were significant but negatively related to the gasoline price change. See next table for the regression results.
Source: authors' calculations

Table 14: Pass-though by country

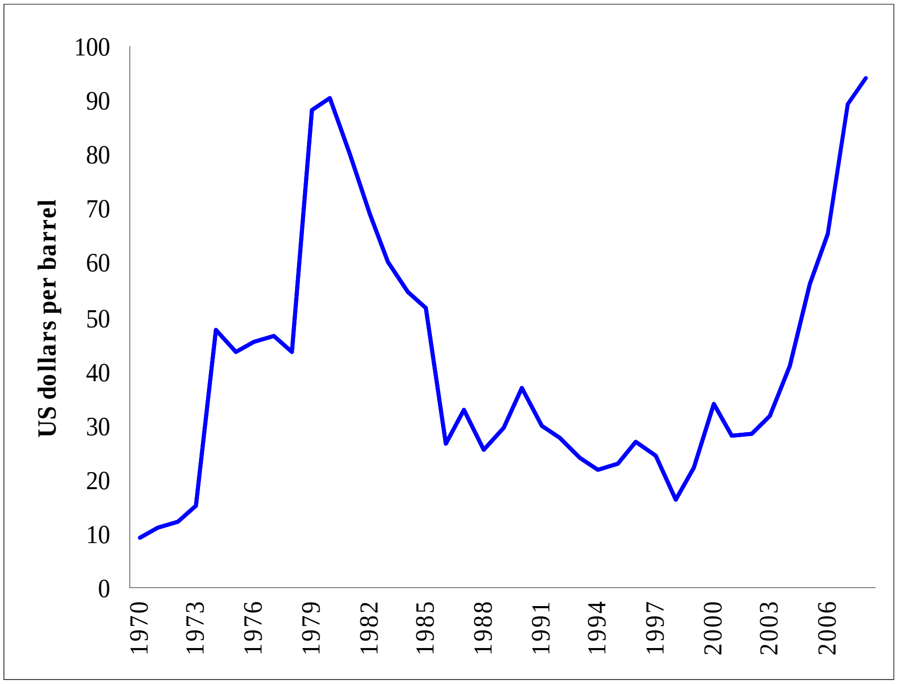
	ARG	BOL	COL	CRI	SLV	GTM	HND
Premium							
D(dep. var.) (t-1)	0.593	-0.007		0.135	0.198	0.383	-0.219
	[0.169]**	[0.041]		[0.176]	[0.167]	[0.110]**	[0.138]
D (oil price) (t)	-0.069	-0.244		-0.04	0.063	-0.022	0.257
	[0.274]	[0.261]		[0.151]	[0.129]	[0.111]	[0.165]
D (oil price) (t-1)	0.15	-0.041		0.399	0.611	0.595	0.49
	[0.204]	[0.117]		[0.195]	[0.115]**	[0.105]**	[0.101]**
Regular							
D(dep. var.) (t-1)	0.616	0.145	0.338	0.077	0.169	0.384	-0.186
	[0.150]**	[0.121]	[0.090]**	[0.168]	[0.176]	[0.111]**	[0.154]
D (oil price) (t)	0.054	-0.041	-0.644	-0.035	0.037	-0.02	0.207
	[0.267]	[0.058]	[0.154]**	[0.149]	[0.146]	[0.114]	[0.106]
D (oil price) (t-1)	0.158	-0.149	-0.125	0.44	0.662	0.597	0.508
	[0.182]	[0.063]*	[0.171]	[0.204]*	[0.122]**	[0.106]**	[0.089]**
Diesel							
D(dep. var.) (t-1)	0.534	-0.187		-0.091	0.198	0.302	-0.368
	[0.205]*	[0.123]		[0.148]	[0.140]	[0.099]**	[0.215]
D (oil price) (t)	0.223	-0.124		-0.125	-0.064	-0.146	0.231
	[0.314]	[0.168]		[0.115]	[0.065]	[0.121]	[0.117]
D (oil price) (t-1)	-0.2	0.023		0.307	0.508	0.567	0.419
	[0.251]	[0.072]		[0.174]	[0.085]**	[0.069]**	[0.103]**
Observations	71	106	106	27	27	27	27

	MEX	NIC	PAN	PRY	PER	URY
Premium						
D(dep. var.) (t-1)	0.127	-0.299	0.134	0.08		-0.194
	[0.076]	[0.273]	[0.240]	[0.144]		[0.086]
D (oil price) (t)	-0.025	0.327	0.474	0.054		-0.01
	[0.033]	[0.219]	[0.143]**	[0.044]		[0.051]
D (oil price) (t-1)	-0.021	0.916	0.416	0.15		0.717
	[0.031]	[0.263]**	[0.217]	[0.062]*		[0.075]**
Regular						
D(dep. var.) (t-1)	0.100	-0.253		0.136	0.367	-0.206
	[0.080]	[0.193]		[0.126]	[0.087]**	[0.034]**
D (oil price) (t)	-0.042	0.232		0.086	-0.188	-0.022
	[0.036]	[0.175]		[0.054]	[0.128]	[0.027]
D (oil price) (t-1)	-0.02	0.797		0.133	0.102	0.758
	[0.029]	[0.185]**		[0.071]	[0.119]	[0.037]**
Diesel						
D(dep. var.) (t-1)	0.145	-0.323		-0.093		-0.161
	[0.116]	[0.173]		[0.117]		[0.120]
D (oil price) (t)	-0.011	0.125		0.031		0.143
	[0.034]	[0.155]		[0.073]		[0.094]
D (oil price) (t-1)	-0.029	0.611		0.237		0.489
	[0.031]	[0.108]**		[0.108]*		[0.084]*
Observations	118	27	34	35	118	10

Notes: All variables are in logs. All models included a constant term. Robust standard errors in brackets. * significant at 5%; ** significant at 1%

Source: authors' calculations

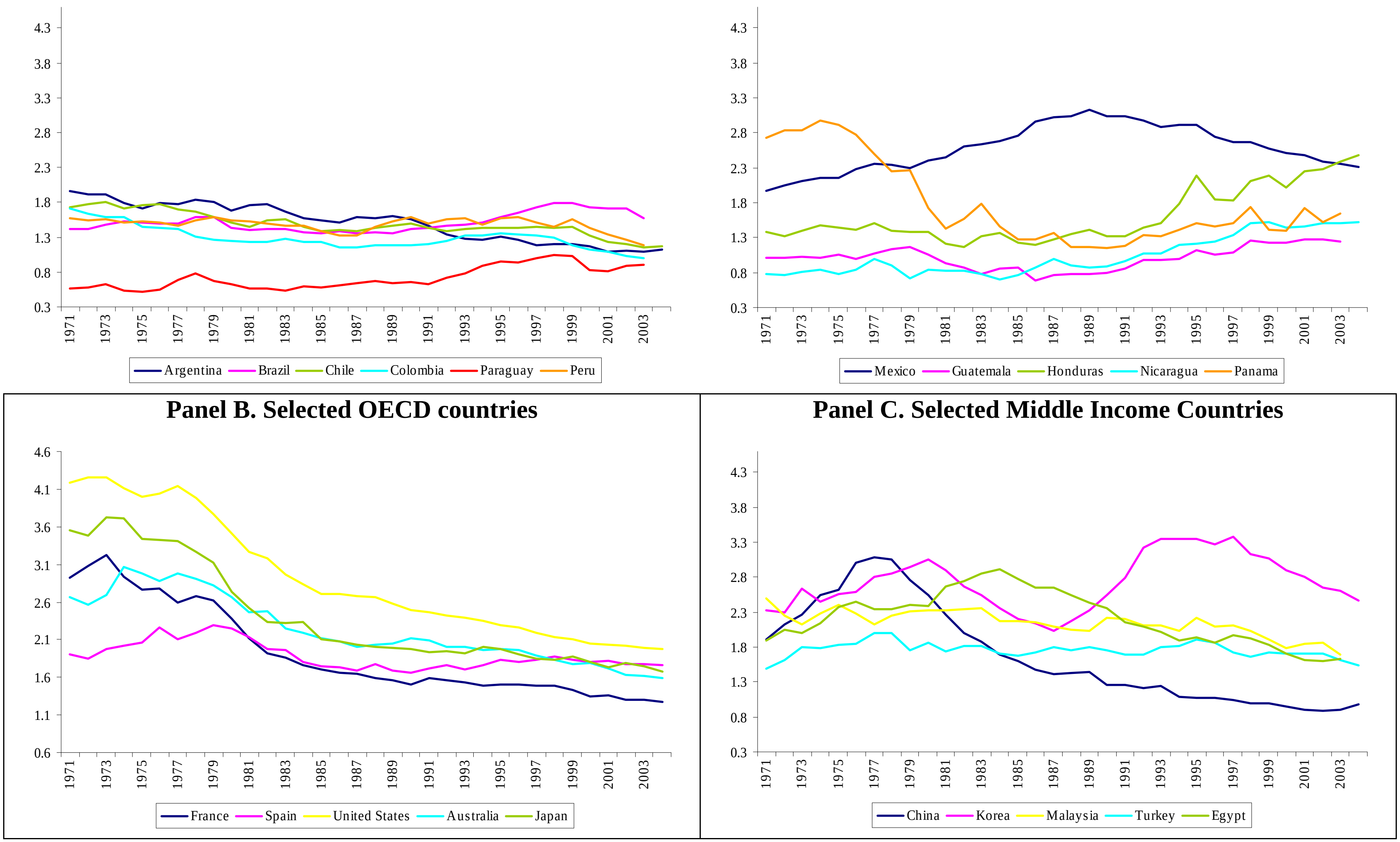
Figure 1: Oil prices, evolution 1970-2008*



Note: Crude oil prices in US dollars per barrel; Brent, money of $ 2006.
2008 value is one year future (as of March 31, 2008)
Source: BP Statistical Review.

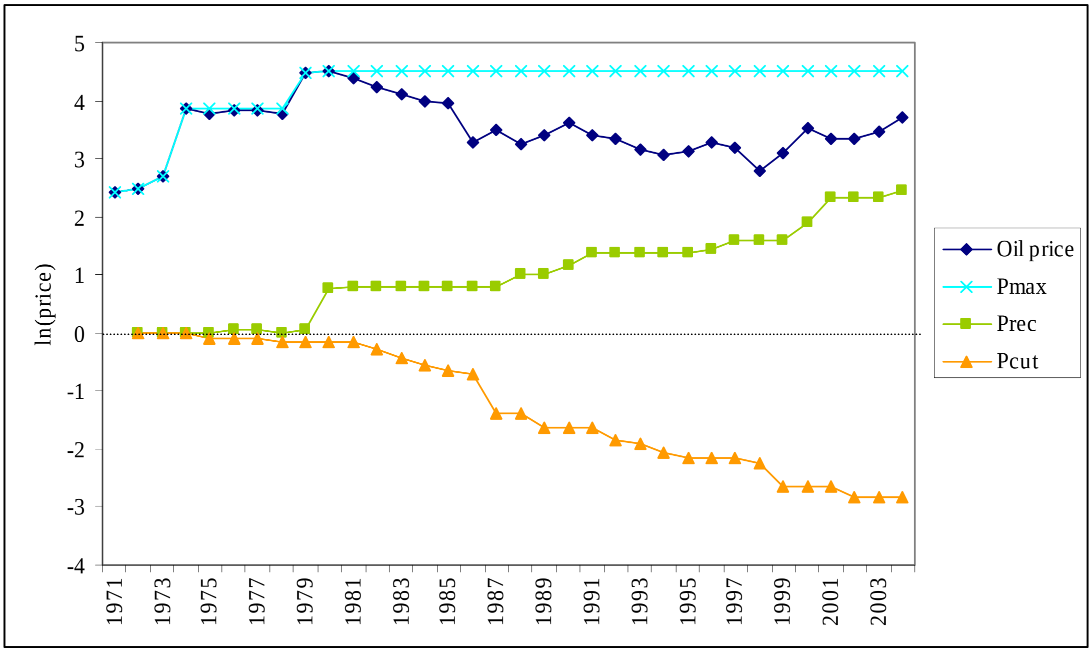
Figure 2. Oil Intensity

Panel A. Selected Latin American Countries



Source: authors' calculations

Figure 3. Decomposition of oil price



Source: authors' calculations