Energy Subsidies, Public Investment and Endogenous Growth

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Abstract

This paper deals with impacts of fossil fuel subsidy reform on economic growth, focusing mostly on the countries of the Middle East and East Africa (MENA) region. We first develop a theoretical growth model, and use it to demonstrate that a country can achieve higher levels of economic growth if the government reduces its energy subsidies. Our empirical work confirms the main results from the theoretical model. That is, a country that initially subsidizes its fossil fuels, and then eliminates or reduces these subsidies, will as a result experience higher economic GDP per capita growth, higher employment, and greater levels of labor force participation, especially among the youth. These effects are strongest in countries where fuel subsidies are generally high, such as those in the MENA Region. We here predict that for a given level of subsidy, a 20 cents average increase in the gasoline and diesel price per liter can increase the GDP per capita growth rate by about 0.46 percent and 0.24 percent, respectively. In the MENA countries, savings in subsidies seem to be earmarked by the region's governments to health expenditures, education expenditures and public investment in infrastructure. These channels appear to be strong contributing factors to higher long-run growth when fuel subsidies are reduced.

1 Introduction

Not much work has been done towards developing general equilibrium models in which both the removal of energy subsidies (and implementation of fuel taxes) and the investment of these subsidy savings by the government in productive public investment could i) create the appropriate environment to promote entrepreneurship and private investment; and ii) influence rates of economic growth. Neither has there been studies analyzing empirically how elimination of subsidies could foster economic growth, and the channels by which such growth could take place. The purpose of this paper is to fill up that gap. We aim to provide a partial characterization of when economies with efficient fuel taxation can be expected to grow faster than economies with high fuel subsidies. To achieve this goal, we develop and test empirically a model in which fuel subsidy savings (or collected taxes) can influence the allocation of resources (i.e. labor and reproducible capital) in ways that have implications for real rates of economic growth. We use a newly collected data set for the empirical work.

Why shall we worry about the consequences of having subsidies? Subsidies contribute to fiscal insolvency, resources are diverted from productive public investment, can lead to major distortions in the production and consumption structure of these economies, benefits mostly high income households which are usually a very small proportion of the population, and increase fuel consumption at suboptimal levels. The latter contributes to global warming and environmental pollution. Such attributes affect the overall long-run performance, particularly, economic growth.

Petroleum subsidies present major environmental and economic problems. Recent work by the International Monetary Fund (2013) indicates that on a "pre-tax" basis[1], subsidies for petroleum products, electricity, natural gas, and coal reached $480 billion in 2011 (0.7 percent of global GDP or 2 percent of total government revenues). It further reports that the costs of subsidies are even higher among oil exporters, which account for about two-thirds of the total. On a "post-tax" basis, subsidies are much higher at $1.9 trillion (2½ percent of global GDP or 8 percent of total government revenues. A prominent feature of energy markets in many countries in the Middle East and North Africa (MENA) region is also the existence of energy subsidies, for a range of energy goods including motor fuels, electricity, and natural gas. Considering a 20-year

[1] The IMF defines and constructs the "pre-tax" subsidy as the transfer to bridge the gap between domestic and international prices and the "post-tax" subsidy will include in addition an estimate of negative externalities from energy consumption. See Perry and Small (2005) and Clements et al. (2013) for further details.

period or longer, the level of subsidy has increased in many of these countries. The World Bank (2014) has indicated that even after reforms, energy subsidies in Egypt, Tunisia and Yemen still account for more than 5 percent of their GDP. This number is even higher for Algeria, Iran, Iraq and Saudi Arabia, more than 10 percent of their GDP. Reforming energy prices in the MENA region, by letting energy consumers face prices close to their optimal levels, is likely to lead to measurable benefits for these countries.

Most analysis, both theoretical and empirical, of energy pricing reform to date has focused on fiscal and environmental/climate impacts of such reform (e.g. Perry and Small (2005)), and on the effect on household welfare (e.g. Gangopadhyay, Ramaswami and Wadhwa (2005); Arze del Granado, Coady and Gillingham (2012); Coady, Parry, Sears and Shang (2015)). We here analyze how fuel taxation will affect economic growth.

Even though the issue of the relationship between economic growth and energy pricing, such as that for gasoline and diesel, is a very important economic policy topic today, hardly any work exists to shed light on such relationships. The existent empirical literature concentrates on the effects of energy prices or energy consumption on GDP, and not the effects of energy taxes or subsidies which are the focus here. This empirical work also uses statistical methods such as error-correction based panel co-integration techniques, and/or a panel autoregressive approach (e.g. Mehrara (2007) and Berk and Yetkiner (2013)).

Our empirical work will focus on the countries of the MENA region, but part of the analysis will also consider other countries and World Bank regions, for comparison purposes but also to provide a robust analysis, covering the period 1998-2012.

Besides studying how the elimination of energy subsidies promotes economic growth in countries that implement enduring energy price reforms by reducing fuel subsidies, we also aim to shed light empirically on the following: i) whether reductions in fuel price subsidies ameliorate government budget deficits; ii) determining the economic channels by which a decrease in fuel price subsidies affect economic growth (e.g. are public subsidy expenditures redirected to increased spending on health, infrastructure, education, to subsequently affect growth?); and iii) how these relevant economic channels affect the relationship between energy subsidies and GPD per capita growth.

At least two important lessons can be drawn from our theoretical model. *First,* a reduction in fuel subsidies will trigger positive economic growth. Nonetheless, if existing fuel taxes are already set at too high levels that induce drastic declines in *private savings* (i.e. income after paying income and fuel taxes and energy expenses), this economy could experience a decline in growth. Thus, to achieve maximal economic growth, an economy cannot solely rely on public investment financed with tax revenues. It is also necessary to have sound and sustained private savings. *Second,* it is crucial that the government invests its reserves from fuel subsidy reductions or tax increases, in high-return long-run investment that helps to increase productivity capacity and give private agents the adequate incentives to engage in entrepreneurial activities.

From our empirical results we draw the following conclusions. *First*, using a *cross-section* approach which considers all the countries in the World Bank regions, we find that for a given level of average subsidy, a 20 cents average increase in the diesel and gasoline price has caused an average increase in the GDP per capita growth rate by about by about 0.28 percent and 0.46 percent, respectively. *Second*, with a *panel* approach for each of the World Bank regions, we find that in most regions, a decrease in fuel (diesel and gasoline) subsidies today leads to increased economic growth in the subsequent years. The exceptions are countries in the European and Central Asia (ECA) region which already have relative high fuel taxes. Countries like those in MENA, might need to cope with immediate reductions in their GDP per capita growth and employment (specially affecting the younger population) in response to more "correct" (higher) fuel price levels. However, as countries in the MENA region redirect subsidy expenditures toward more productive investments such as infrastructure and other public goods (i.e. health and education), they will in succeeding periods experience higher economic growth and employment. *Third,* our panel analysis in fact shows us that there is a significant positive effect of reducing fuel subsidies on employment and labor force participation especially among the young population, aged 15 to 25, and induces higher social and public investments by the government.

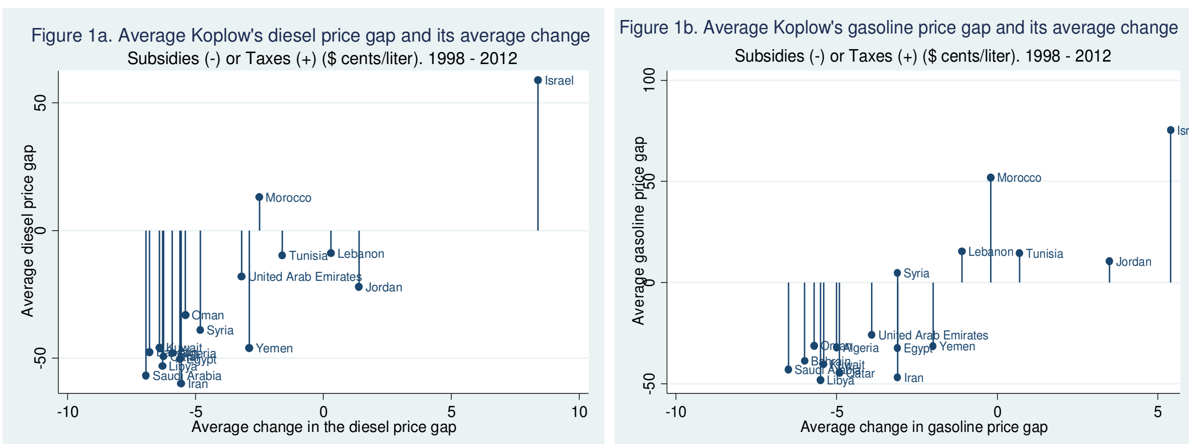
The paper is organized as follows. Section 2 presents some stylized facts from the data. Section 3 describes our theoretical model which analyzes how fuel subsidies affect economic growth. Section 4 contains the econometric modeling while Section 5 includes our empirical results. Section 6 reports the empirical analysis on how fuel subsidy savings of the countries in the MENA region are redirected toward health and infrastructure spending and serve as channels to promote employment and growth. We analyze in Section 7 how these channels affect the relationship between energy subsidies and GPD per capita growth. Section 8 concludes.

2 Data

The data set has been gathered by the Environment and Energy Team at the Development Research Department of the World Bank (DECEE), and contains also relevant and important political and economic variables for this study taken from the World Bank Data Depository, IMF, Penn World Table, Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ). The data are at the annual basis for the period 1998-2012.

Figures 1a and 1b display the diesel and gas *price gaps* as defined by Koplow (2009) [2] against the average changes in these price gaps respectively, over the period of 1998 to 2012 for countries in the MENA and ECA regions. The price gap can be *negative* (i.e. fuel is *subsidized*) or *positive* (i.e. fuel is *taxed*).

Figure 1. MENA Countries



It is noticeable that a large number of MENA countries have had relatively higher price gaps or *high average levels* of diesel and gasoline subsidies than most ECA countries. The noticeable exceptions in ECA are Azerbaijan, Kyrgyzstan, Kazakhstan, Turkmenistan and Uzbekistan, especially with respect to diesel. Moreover, the MENA countries not only have had, over the period of 1998 and 2012, higher levels of fuel subsidies, but also these subsidy levels have become larger over time. This can be seen in Figures (1a) and (1b) that the *average change* on their fuel price gaps have become more negative. This only means that MENA countries have made few attempts to improve their fuel pricing situation over these years.

[2] This is equal to the domestic fuel retail price minus the average U.S. retail price, minus 10 cents per liter for fuel importers (corresponding to the average U.S. tax), and minus an additional 10 cents per liter for fuel exporters.

Figure 2. ECA Countries

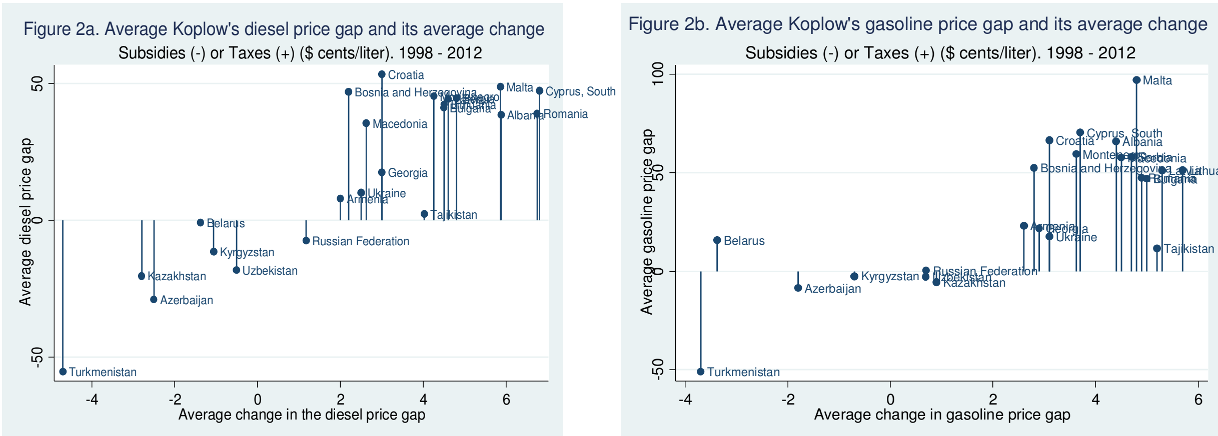
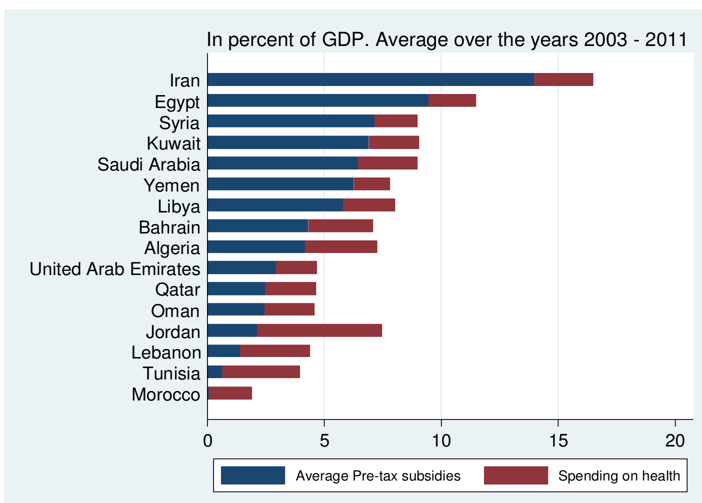


Figure 3 indicates that the MENA countries have had on average between 2003 and 2011, higher total pre-tax fossil-fuel energy subsidies (on petroleum, electricity, natural gas and coal) than public expenditures on health. The MENA countries will most likely benefit, in terms of higher productive public investment and economic growth, from reducing their fiscal costs due to energy subsidies.

Figure 3. MENA Countries. Pre-Tax Subsidies and Spending in Health



Del Granado, Coady and Gillingham (2012) and Manzoor, Shahmoradi, and Haqiqi (2012) in addition stress that in most MENA countries where fuel subsidies are very large, the economy is generally much more energy-intensive, and the increase in prices triggered by subsidy reform would have a bigger impact than in economies that have already adapted to the high oil prices.

Del Granado et al. (2012) also indicate that the removal of subsidies will eliminate price distortions, not only for fuels but also for final goods whose production depend on fuels. The overall allocation of resources would improve; many energy-intensive activities, with an artificial competitive advantage originated by subsidies, would be eliminated; and energy-saving investments would become more profitable.

3 How elimination of energy subsidies can contribute to economic growth: An analytical perspective

We study how elimination of energy subsidies (e.g. taxing energy consumption) promotes higher productivity capacity and raises rates of economic growth by considering an endogenous growth model (Paul Romer 1986, 1990).

Our contribution consists in explaining how such entrepreneurial activity will be more encouraged in an environment where the government uses fuel taxes to invest in infrastructure and public goods in order to facilitate innovation, and higher productivity and profits in the private sector. A failure from the government to reduce energy subsidies, will leave this government with fewer resources to provide the necessary public services. This can result in a disproportionally large number of agents who would prefer to "overconsume" and retire early, and not become entrepreneurs. There will be then too many early retirees and fewer participants in the labor force which could cause the Social Security System to go bankrupt or become unfunded.

Agents should normally prefer to pay their taxes since the government is more suitable to make such public investments and take advantage of economies of scale. If agents instead self-finance their public investment projects, they face the risk of having to prematurely liquidate their investments to meet primary needs in the event of an income shock. This problem can be avoided by having a government that can maximize the welfare of the whole economy by collecting taxes and invest in public goods from which all agents can benefit.

Our theoretical model encompasses the following lines of reasoning for the government and private agent activities: i) the government collects income and fuel taxes from a large number of agents in the first period of their life when they work, and invests the tax revenues in infrastructure, R & D, public goods and producible capital in general[3]; ii) in the second period of the agents' life, a certain proportion of them will prefer to consume from their net income right away, and retire early from the labor force claiming their pensions; others prefer to forego early consumption and become entrepreneurs and benefit from the government's infrastructure investments because these increase their productive capacity, and thereby promoting higher profits and economic growth; iii) the government, using the law of large numbers, make an assessment about how many will leave the labor force early (and receive pensions) and consume early; and how many will become entrepreneurs and contribute to increasing production and employment; iv) the government accordingly invests certain amount of the collected taxes in short-run investments in very liquid assets (e.g. in bank savings, mutual funds) to satisfy the demand of agents who retire early from the labor force, and the rest in long-term public investments; v) after paying taxes, individuals will have savings which they can invest and obtain a return if these investments are not withdrawn prematurely.

3.1 Main Assumptions

The economy consists of:

- A sequence of three-period-lived, overlapping generations. Each generation includes a continuum of agents. Time is indexed by t=0,1,2,…
- At each t, there is an equal number of young and old agents.
- All young generations are identical, which means that there is no population growth. Each young agent is endowed with a single unit of labor supplied inelastically. There are no labor endowments at ages 2 and 3.
- At t=0 there is an initial old generation, endowed with an initial per-firm working capital of k_0 units, and an initial "middle-aged" generation, which is endowed with an initial per-firm capital stock of k_1 units at t=1.
- Except for the initial old and middle-aged generations, agents have no endowment of capital (and consumption good) at any date. All working capital is owned by a subset of old agents, which are the entrepreneurs. Entrepreneurs only use "their own" capital which together with

[3] We here focus on energy subsidies but the reasoning can be extended to subsidies to any sort of consumption subsidies.

the young generation of workers, produce a single consumption good. There is not capital rental market.

- The economy has a single consumption good and a capital good, and a non-renewable natural resource. The consumption of natural resource is determined after all taxes are paid. Each individual pays either taxes or receive subsidies for every unit of consumption of these resources.
- The government has the opportunity of allocating one unit of its tax revenues, collected from labor income plus energy taxes in the short-term investment (e.g. savings, mutual funds) at time t that gives a return $\rho > 0$ units of consumption good at t+1. At this point, this type of investment that is not consumed is liquidated. On the other hand, when the government allocates one unit of its tax revenues in a long-run investment (e.g. public goods, R&D, infrastructure), it will transform its tax revenues into producible capital at t+2 at the rate of return R.[4] If the long-run investment is liquidated at t+1, its "scrap value" is zero units. Thus, we have a government that can make two types of investments: 1) in liquid assets; and 2) illiquid long-term assets.
- Once agents decide to be entrepreneurs, they use at time t, their *net incomes* (income after taxes) to make long-run savings or invest in assets such as stocks to receive a return $R_b > 0$ at t+2 (at age-3) for every unit of net income saved/invested for two periods. An earlier withdrawing of savings will give an $R_b = 0$. The government cannot without difficulty affect these agents' preferences on how to spend and distribute their incomes after paying taxes and consuming the natural resource that contributes to the generation of energy.[5]
- Defining c_i as age i consumption, the utility function of all young agents is a CRRA type:

$$u(c_1, c_2, c_3; \varphi) = -\frac{(c_2 + \varphi c_3)^{-\gamma}}{\gamma}; \tag{1}$$

where γ>-1, and φ is an individual-specific random variable that is realized at the beginning of age-2 (at t+1) and determines a saver's consumption preferences according to the following probability distribution:

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[4] We here think of long-run investments as the ones entrepreneurs need to produce the consumption good and boot entrepreneurs' productivity capacity.

[5] We do not model the non-renewable resource assets/financial markets not because they are not important but because we would like instead to concentrate on the effects that subsidies and taxes and the government administration of such taxes could have on the economy.

$$\varphi = \begin{cases} 0 \ with \ \ probability \ 1-\pi \\ 1 \ with \ \ probability \ \pi \end{cases} . \quad (2)$$

(1) and (2) indicate that young agents do not care to consume when they are young, i.e. at age-1 (at t). A proportion ($1 - \pi$) will retire early and consume at age-2. On the other side, a fraction π of the individuals will only care about consuming at age-3 (i.e. $\varphi = 1$) and will rather choose to become entrepreneurs. By forgoing consumption at age-2 (t+1), they will be able to receive at age-3 (t+2): i) their returns in terms of producible capital (including better infrastructure and public goods) from paying their taxes to the government; and ii) their returns from investing their private savings.

- k_t is the working capital that is held by an individual entrepreneur at t. We will have $\overline{k}_t$ which represents the "average resources" (capital and financial assets) available to each entrepreneur at t. An entrepreneur who employs L_t units of labor at t, paying each a real wage w_t, produces the consumption good according to the following production function:

$$y_t = \overline{k}_t^{\delta} k_t^{\theta} L_t^{1-\theta} . \quad (3)$$

$\theta \in (0, 1)$, $\delta = 1 - \theta$. (δ is distinguished from $1 - \theta$ to emphasize that it represents an "external effect" in production. Capital is totally depreciated after one period.

3.2 Entrepreneurs' decisions and the labor market

Assuming the production function (3) and taking as given the real wage rate, the demand for labor that maximizes the representative entrepreneur's profits will be:

$$L_t = k_t \left[\frac{(1-\theta)\overline{k}_t^{\delta}}{w_t} \right]^{1/\theta} . \quad (4)$$

If we note that the condition for labor market equilibrium is $L_t = 1/\pi$, after averaging (4) over firms and equating the result to $1/\pi$, we find that the equilibrium real wage at t is:

$$w_t = \overline{k}_t (1-\theta) \pi^{\theta} . \quad (5)$$

Given that the marginal value of the working capital is $\theta \overline{k}_t k^{\theta-1} L^{1-\theta}$, the level of profits per entrepreneur, Φ, will be:

$$\Phi_t = \theta \overline{k}_t^{\delta} k_t^{\theta} L_t^{1-\theta} . \quad (6)$$

By using (4), (5) and (6), we can find the reduced form for profits per entrepreneur at t:

$$\Phi_t = \theta\psi k_t \,; \quad \text{where } \psi=\pi^{\theta\text{-}1} \quad . \tag{7}$$

3.3 The government's public investment decisions

The government receives labor income taxes, Tw_t, from the young generation which leaves them with a disposable income equal to $((1\text{-}T)w_t)$. A percentage e of this disposable income will be used for energy consumption, $((1\text{-}T)w_t\, e)$, which will be also taxed by the government. This taxed energy consumption will be then $(\tau(1\text{-}T)w_t\, e)$. If the government instead subsidize energy, individuals will received subsidies equal $(-\tau(1\text{-}T)w_t\, e)$.[6]

For each unit of tax received, $(t+\tau(1\text{-}T)e)$, the government invests a proportion $f_t \in [0,1]$ units in the short-run project; and a proportion $n_t \in [0,1]$ units of it in the long-run project. Thus, each unit of tax is allocated as follows:

$$f_t + n_t = 1. \tag{8}$$

If an individual decides to retire from the labor force and consume at age-2 (at t+1), he/she receives r_{1t} units of the consumption good for each unit of tax paid at t to the government. Individuals who claim the return for their paid taxes at age-3 (at t+2) and decide to be entrepreneurs to produce the consumption good, will receive a return r_{2t} of reproducible capital for each unit of tax paid at t to the government. The following constraints should be then satisfied:

$$(1\text{-}\pi)r_{1t} = \rho f_t\,. \tag{9}$$

$$\pi_t r_{2t} = Rn_t\,. \tag{10}$$

Constraint (9) says that the returns that the government obtains from its short-term investment ρf_t; should be enough to satisfy the total demand for consumption goods of middle-aged individuals (age-2) which is equal to $(1\text{-}\pi)r_{1t}$, in exchange for the taxes paid when they were young. Thus, the returns from the government's investment decisions should be equal to the pledged returns (equal to $(1\text{-}\pi)r_{1t}$) to private individuals on each unit their paid taxes in terms of *units of consumption goods*. On the other hand, constraint (10) indicates that the returns that the government will obtain at t+2 from its long-run investment, Rn_t, should be enough to satisfy the

[6] τ represents the taxes to be paid to the government to compensate for the externalities that the consumption of fuel generates in addition to financing the government's public finances. This can be associated as the post-tax rate as defined by the IMF.

promised returns (equal to πr_{2t}^{k}) to the entrepreneurs on each unit of their paid taxes in terms of reproducible capital including infrastructure.

Note that agents will have a net income equal to $(1-T)(1-e(1+\tau))w_t$ (i.e. after deducting energy consumption and paying income and fuel taxes) which they can save or invest in assets.

The problem of the government is to maximize the expected utility of the representative young taxpayer at time t, while anticipating that some middle-aged agents may retire early and the rest will become entrepreneurs. Taking into account the law of large numbers, the government will maximize the following expected utility of the representative tax-payer, evaluated at t:

$$EU = -\left(\frac{1-\pi}{\gamma}\right)\left[(1-T)(1-e(1+\tau))w_t + r_{1t}(Tw_t + \tau\left(1-T\right)w_t e)\right]^{-\gamma} - \left(\frac{\pi}{\gamma}\right)\left[(1-T)(1-e(1+\tau))w_t R_b + \theta\psi(r_{2t}(Tw_t + \tau(1-T)w_t e)\right]^{-\gamma}. \qquad (11)$$

This expression follows from the fact that at t, all young agents (of age-1) pay their taxes, on their income and energy consumption. Also, a fraction $1-\pi$ of agents (of age-2) are expected to retire from the labor force, demand their pensions prematurely, and has consumption only at age-2 (at t+1) equal to $(1-T)(1-e(1+\tau))w_t + r_{1t}(Tw_t + \tau(1-T)w_t e)$ (i.e. i.e. $\varphi = 0$). A fraction π are however expected to become entrepreneurs, instead of retiring early, and forgo consumption until they are of age-3, i.e. $\varphi = 1$. Each entrepreneur receives r_{2t} units of the reproducible capital good for every unit of tax paid. These entrepreneurs will consume i) their profits derived from their entrepreneurial activity equal to $\theta\psi k_{t+2}$ (see equation (7)) , where, $k_{t+2} = r_{2t}(Tw_t + \tau(1-T)w_t e)$; plus ii) their returns on their savings or investments in assets equal to $(1-T)(1-e(1+\tau))w_t R_b$.

We rewrite equation (11) taking into account the constraints (8), (9) and (10):

$$Max\{EU\} = Max\left\{-\left(\frac{1-\pi}{\gamma}\right)\left((1-T)(1-e(1+\tau))w_t + \rho\frac{(1-n_t)}{1-\pi}(Tw_t + \tau(1-T)w_t e)\right)^{-\gamma} - \left(\frac{\pi}{\gamma}\right)\left(R_b(1-T)(1-e(1+\tau))w_t + \theta\psi R\left(\frac{n_t}{\pi}\right)(Tw_t + \tau(1-T)w_t e)\right)^{-\gamma}\right\}. \qquad (12)$$

The government finds the optimal share of tax revenues to be invested in long-run projects, n_t, by maximizing (12) with respect to n_t, which is:

$$n_t = \frac{(1-T)(1-e(1+\tau))\left[\rho^{\gamma/(1+\gamma)} - (\theta\psi R)^{\gamma/(1+\gamma)} R_b\right] + (T+\tau(1-t)e)(C_1)}{(T+\tau(1-T)e)\left(C_1+C_2\right)}; \text{ where} \qquad (13)$$

$$C_1 = \left(\frac{1}{(1-\pi)}\rho^{(1+2\gamma)/(1+\gamma)}\right) \text{ and } C_2 = \left(\frac{1}{\pi}(\theta\psi R)^{(1+2\gamma)/(1+\gamma)}\right)$$

Keep in mind that per unit of income, $(1\text{-}T)(1\text{-}e(1+\tau))$ is the *savings* after taxes and energy expenses; $(T+\tau(1\text{-}T)e)$, and $(1\text{-}t)e$ is *energy consumption*. Also notice in (13) that if $\rho^{\gamma/(1+\gamma)} = (\theta\psi R)^{\gamma/(1+\gamma)} R_b$, then n_t is independent of fuel taxes and is only determined by the parameters of the model (i.e. $n_t = C_1/(C_1+C_2)$).

Our most important results from equation (13):

Result 1. Higher fuel taxes will cause the government to allocate a larger proportion of the tax revenues into the long-run investment. This can be seen from the following expression:

$$\frac{\partial n_t}{\partial \tau} = -\underbrace{\left[\rho^{\gamma/(1+\gamma)} - (\theta\psi R)^{\gamma/(1+\gamma)} R_b\right]}_{?}\underbrace{\frac{(1-T)e-(1-T)^2 e^2}{(t+\tau(1-T)e)^2(C_1+C_2)}}_{+} \quad . \qquad (14)$$

Equation (14) however needs to be further explained as it shows that the sign of the impact of fuel taxes, τ, on the government's allocation of its tax revenues into the long-run investment, n_t, might seem ambiguous (i.e., the sign of $\rho^{\gamma/(1+\gamma)} - (\theta\psi R)^{\gamma/(1+\gamma)} R_b$ is ambiguous).

The government will increase its long-run investments when energy taxes increase ($\partial n_t/\partial\tau > 0$) if $\rho^{\gamma/(1+\gamma)} - (\theta\psi R)^{\gamma/(1+\gamma)} R_b < 0$. This condition entails that:

- $\rho < R$. The return on short-term investment is smaller than the return to long-run investment. This is important to give agents enough incentives to forgo early consumption;
- $R_b > 1$ which encourages agents to save or invest in the asset markets;
- θ, the output elasticity of capital, is large enough; and/or

- π, the probability of becoming an entrepreneur, is not extremely large.[7]

Result 2. For given fuel tax rate, if ρ increases (i.e. return to the short-run investment), the government will allocate a larger proportion of every unit of tax collected into the long-run investment, that is, in infrastructure and in public goods. The effect is stronger if there are robust preferences for avoiding inequality between generations in excess of what follows from the discounting in the utility function (i.e. γ is large in absolute terms). To achieve higher welfare, it is then optimal for the government to invest more in other sectors of the economy, including infrastructure and public goods when the return to non-renewable energy increases.

Result 3. For given fuel tax rate, too large increase in the return to long-run investment R, would not necessarily give more incentives to the government to make such investments. Thus, the government will not invest enough in infrastructure in spite of the higher returns. This can be viewed as a distortion as Jones (1998, 2013) described in the context of determining optimal research and development. Jones postulates that such type of distortion is a result of incomplete markets. In our case, there is a missing market for infrastructure and public goods which makes it difficult to identify the correct value (price) of the government's long-term investments. As a result, the government will not respond strongly enough to higher R.

It is now necessary to establish the conditions under which agents will have more incentives to forego consumption and become entrepreneurs. As we pointed out above, agents who withdraw at t+1 will consume $r_{1t}w_t = \{(1-T)(1-e)w_t + \rho\,(Tw_t + \tau(1-T)w_te_t)(1-n_t)/(1-\pi)\}$, while agents who become entrepreneurs will consume $\{(1-T)(1-e)w_tR^b + \theta\psi R(Tw_t + \tau(1-T)w_te_t)n_t/\pi)$. We find that agents with φ=1 will become entrepreneurs if the following condition holds:

$$(1-T)(1-R_b)(1-e(1+\tau)) < (T+\tau(1-T)e)\left[\theta\psi R\frac{n_t}{\pi} - \rho\frac{1-n_t}{1-\pi}\right]; \qquad (15a)$$

or equivalently:

[7] Note that $\psi = \pi^{\theta-1}$. There should be a smaller allocation of the tax resources into long-run investment when fuel taxes rise and a larger number of agents are expected to become entrepreneurs. This should be optimal to avoid that decreasing returns to scale would be at work.

$$(T+\tau(1-T)e)\left[\rho\frac{1-n_t}{1-\pi}\right]<(T+\tau(1-T)e)\left[\theta\psi R\frac{n_t}{\pi}\right]-(1-T)(1-R_b)(1-e(1+\tau)). \qquad (15b)$$

From (15) we obtain the following results:

Result 4. The larger the returns on the government's long-term investment, *R*, relatively to ρ, the greater the incentives to become entrepreneurs. There will be then sufficiently large return/gains on the government long-run investment in terms of reproducible capital. It is therefore crucial that the government translates tax revenues in its entirety into productive investment to succeed with its energy price reforms.

In summary, equation (15) indicates that any fuel price reforms, through elimination of subsidies, will be successful and induce higher production if the government guarantees high rates of return on its public productive investments. Otherwise fewer agents will choose to become entrepreneurs and many more will seek to retire early. In the latter case, the government will need to invest most of its tax revenues in short-term projects to fund the pensions of early retirees.

3.4 Equilibrium conditions

In equilibrium we have:

$$\bar{k}_{t+2}=(1-T)(1-e(1+\tau))w_tR_b+r_{2t}(tw_t+\tau(1-T)w_te)= \qquad (16)$$
$$(1-T)(1-e(1+\tau))w_tR_b+\frac{Rn_t(Tw_t+\tau(1-T)w_te)}{\pi}.$$

Equation (16) indicates that at equilibrium the average resource level (working capital plus financial assets) at t+2, $\bar{k}_{t+2}$, depends on the returns on the government's long-run investments, (*R*); how much of each unit of tax the government allocates into long-run investments such as infrastructure and public goods (n_t); the probability that individuals will become entrepreneurs, π; income taxes *t*; fuel taxes on energy consumption τ, the fraction of consumption that goes into energy consumption, *e*; the output elasticity of capital, θ; real wages (w_t) and ultimately the return to entrepreneurs' private savings, R_b. Particularly, note that at t+2, $\bar{k}_{t+2}$, depends on taxes (in addition to the other mentioned variables) paid at t which is reasonable since capital formation is assumed to take two periods.

Inserting (5) into (16) and dividing it by $\bar{k}_t$ yields:

$$\frac{\bar{k}_{t+2}}{\bar{k}_t} = (1-\theta)\pi^{\theta}\left[(1-T)(1-e(1+\tau))R_b + \frac{Rn_t}{\pi}(t+\tau(1-T)e)\right] . \qquad (17)$$

Under our assumed production function (equation (3)), and taking into consideration the optimal levels of employment (equation (4)) and real wage (equation (5)) that clears the labor market, the *output per firm* at time t at *equilibrium equals to* $\bar{k}_t^{(\delta-(1-\theta))/\theta} k_t \psi$. Since the number of firms is constant over time, equation (17) *also gives the equilibrium rate of growth of output.*

Defining g_{t+2} as the rate of growth between t and t+2, if $\bar{k}_{t+2} / \bar{k}_t$ (= $(1+g_{t+2})$) is *greater than one*, the economy has *positive growth* (i.e. *g_{t+2} is positive*). If $\bar{k}_{t+2} / \bar{k}_t$ is *less than one*, this economy is experiencing negative growth (i.e. *g_{t+2} is negative*). Thus, from equation (17), we can draw the following Result:

Result 5. Ceteris paribus, an economy will experience economic growth ($\bar{k}_{t+2} / \bar{k}_t > 1$) if fuel taxes τ increases or if fuel subsidies are reduced (i.e. ($T + (\tau(1-T)$) increases)[8]. Note however that in a country that already enforces fuel taxes, setting these taxes at too high levels can cause a decline in *savings $(1-T)(1-e(1+\tau))$*. Relative insufficient private savings or investment in assets can result in lower economic growth (lower positive g_{t+2}).[9]

The conclusion is that an economy cannot exclusively rely on public investment financed with tax revenues to attain positive growth. But high subsidies ($-\tau$) on the other hand, will have a negative effect on growth because the government will not have enough funds to invest long-run investments (including public investment) in reproducible capital for the use of the

[8] τ becomes less negative.
[9] An extreme but unlikely case will be one in which fuel taxes are extremely high that causes a negative growth (i.e. negative g_{t+2} yielding $\bar{k}_{t+2} / \bar{k}_t < 1$).

entrepreneurs. In such circumstances, most agents will retire early and very few will become entrepreneurs.

We now address the following question: *how will a reduction in fuel subsidies or an increase in fuel taxes affect g_{t+2}, for given initial levels of subsidies or taxes, respectively?*

We consider n_t, as determined by (13). We note that the rate of return on savings (R^b) is smaller than the pledged return to the entrepreneurs for each unit of their tax paid to the government (r_{2t}) to have incentives to become entrepreneur; and that tax revenues, $(tw_t + \tau(1 - T)w_t e_t)$, are always positive. We obtain the following result:

Result 6. For given parameter values, a reduction in fuel subsidies (i.e. a less negative τ) will increase the rate of economic growth. *This effect on the growth rate will be greater the higher is the initial level of fuel subsidies.* On the other hand, higher fuel taxes (i.e. a higher positive τ) will also raise the growth rate. It is nonetheless important to note that *if the existing level of fuel taxes is already very high, the effect of higher fuel taxes on growth will be minimal.* Thus, such an economy will experience decreasing returns as its fuel taxes, τ, start increasing and if its taxes are already too high. This result can be examined in the following expression:[10]

$$\frac{\partial\left(\frac{\bar{k}_{t+2}}{\bar{k}_t}\right)}{\partial\tau} = \frac{\partial g_{t+2}}{\partial\tau} = (1-\theta)\pi^{\theta}(1-t)e\left[-R^b + r_{2t} - \frac{R}{\pi}\underbrace{(\rho^{\gamma/(1+\gamma)} - (\theta\psi R)^{\gamma/(1+\gamma)}R_b)}_{-}\underbrace{\frac{(1-(1-t)e)}{(t+\tau(1-t)e)(C_1+C_2)}}_{+}\right] \quad (18)$$

By taking the second derivative to (18), we can determine whether the *equilibrium rate of growth of output*, $\bar{k}_{t+2}/\bar{k}_t$, is a concave or convex function with respect to fuel taxes, τ. Indeed, we find that this growth rate with respect to τ is concave:

$$\frac{\partial^2(g_{t+2})}{(\partial\tau)^2} = (1-\theta)\psi R\underbrace{(\rho^{\gamma/(1+\gamma)} - (\theta\psi R)^{\gamma/(1+\gamma)}R_b)}_{-}\underbrace{\frac{(1-(1-t)e)(1-t)^2e^2}{(t+\tau(1-t)e)^2(C_1+C_2)}}_{+} < 0 \quad (19)$$

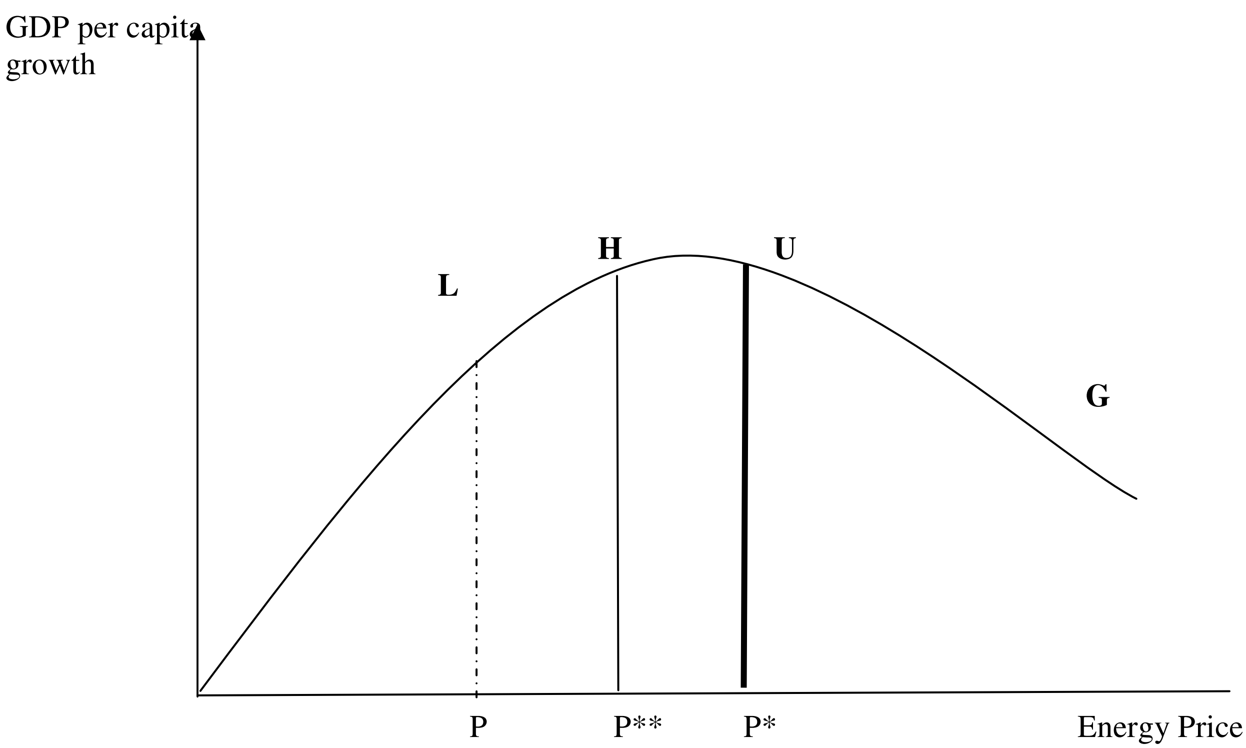
This second derivative will be more negative, the smaller the fuel subsidies, τ, is. ***Results 5*** and ***6*** are illustrated in **Figure 5.**

[10] Keep in mind that $r_{2t} = Rn_t/\pi$.

Figure 5 shows a concave curve **G** illustrating GDP growth as a function of the fuel retail price in a particular country. When a country has initially too low energy prices relative to certain fuel reference price such as **P**, as a result of energy subsidies or too low taxes (as for many MENA countries), our endogenous growth model predicts that the country will experience higher GDP growth as the energy price level rises (Result 6, equation (18)). Such effect is greater, the larger the initially level of subsidies. This would suggest moving from point **L** to point **H** on the curve for GDP growth (**G**).

However, our model also predicts that if the country has already higher energy prices relative to some fuel reference price and continues increasing the fuel retail price, to for example P*, this country will face diminishing returns with respect to fuel taxes. This is probably the case of many ECA countries. The country will be moving to the right of **H** at **U** on curve **G.** This will occur because, according to the growth model, setting too high fuel taxes will induce a substantial decline in *private savings* and this economy will experience lower, or even negative rates of economic growth. To achieve economic growth, an economy should have an appropriate balance between public investment financed from tax revenues and private savings to avoid the diminishing returns to too high fuel taxes (Result 6, equation (17)).

Figure 4



4. The Empirical Models: What does the data tell us about effects of energy subsidies on economic performance?

This section contains the econometric models that helps to understand better the effect of energy prices on economic growth per capita and test our results of our theoretical model. Again, we test the following ***Hypothesis*** drawn from our theoretical model***:***

Hypothesis: *elimination of energy subsidies can have positive impacts on economic growth in countries that implement enduring energy price reforms by reducing fuel subsidies.*

Our empirical strategy consist of making an approximation to (17) and explicitly separate out the main effects from the interaction effects of interest. Our empirical work involves both *cross-sectional* and *panel* estimations:

1. A *cross-section* approach to analyze *long-run effects*. We here study whether a reduction in subsidies (or increases in fuel price gaps) moves a country toward its optimal steady state potential for economic growth. All countries of all the World Bank Regions are analyzed, covering the periods i) from 1998 to 2012; and ii) two shorter time horizons, (1998 – 2004) and (2005 – 2012). This econometric approach requires that we obtain, for each country, the mean value of the relevant variables for each of the periods of study.
2. A *panel* approach to study *short- and medium-run effects*. This analysis will quantify both the contemporaneous and the two-year-lagged effect of the fuel price gap on economic growth. The analysis here will be done by World Bank Region at the annual basis. Understanding the short-term impacts of fuel price reforms is also important because it is often how reforms affect the welfare of low income households in the first periods that determine their survival politically.

These two approaches are therefore not only technically different, but each of them gives us different perspectives on the relationship between energy subsidies and economic growth.

The analysis considers relationships between GDP per capita growth on one hand, and the *price gap* as defined by Koplow's (2009). This gap is equal to fuel retail price minus the average U.S. retail price, minus 10 cents per liter for fuel importers (corresponding to the average U.S. tax), and minus an additional 10 cents per liter for fuel exporters. *If the price gap is positive, there is a tax on this fuel; and a subsidy in the opposite case.*

4.1 Cross-Sectional Modeling

The *cross-sectional* approach uses the following simple empirical relation which represents our theoretical result represented by equation (17):

$$GDP_{per\,capita}\ growth_i = \alpha_{1c} + \beta_{1c}(price\ \ gap)_i + \varphi_{1c}(price\ \ gap)^2{}_i + \theta_{1c} I_{i,1998} + \eta_{ic} \qquad (20a)$$

GDP per capita $growth_i$ and $(price\ gap)_i$ are measured for each country *i* in *ALL World Bank Regions* from 1998 to 2012. η_{ic} is the error term for the empirical equation (3a).

GDP per capita $growth_i$ and $(price\ gap)_i$ (using the Koplow's methodology) are the average for each country *i* in all *World Bank Regions* from 1998 to 2012. A sufficiently large increase in the price gap indicates that there are net taxes on energy, instead of subsidies. η_{ic} is the error term for the empirical equation (1). $I_{i,1998}$ represents the initial income for each country in 1998, which serves to quantify the differences in the effect of subsidies on the economic growth across countries.

One will fail to reject the main ***Hypothesis*** if β_{1c} is positive and statistically significant in the empirical relationship (20a). The coefficient φ_{1c} accompanying the square of the differences in prices is expected to be negative, in which case diminishing returns to increasing fuel prices will be at work. Such expected empirical results are also predicted by our endogenous growth model . That is, for a country whose energy prices are initially low, one should expect there to be much to gain in terms of additional growth by increasing energy prices. However, as an economy has fuel prices reaching higher levels, the gains in economic growth are reduced (Result 6).

4.2 Panel Estimations Modeling

This approach allows an analysis by Bank Region. Equation (3a) is modified as follows:

$$\begin{aligned} GDP_{per\,capita}\ growth_{it} &= \alpha_{1p} + \beta_{1p}(price\ \ gap)_{it} + \beta_{2p}(price\ \ gap)_{it-1} + \beta_{3p}(price\ \ gap)_{it-2} \\ &\quad \varphi_{1p}(price\ \ gap)^2{}_{it} + \varphi_{2p}(price\ \ gap)^2{}_{it-1} + \theta_{1p} I_{i,1998} + \tau_t + c_i + \eta_{it} \end{aligned} \qquad (20b)$$

GDP *per capita* $growth_{it}$ and $(price\ gap)_{it}$ are for *each country* i *in each of the World Bank Regions* at year t. Time and country fixed effects are denoted by τ_t and c_i, respectively. η_{it} is the error term. Statistically positive and significant β_{2p} and β_{3p} indicate that a country will experience an increase in its *current* GDP per capita growth by β_{2p}% and β_{3p}% if it had pursued fuel price reforms by increasing its fuel retail price by 1 cent relative to a specific fuel reference price (i.e. Δprice gap = 1 cent), during each of the past two years, respectively. There will be in addition a change of β_{1p}% in the current GDP per capita growth if there is also an increase of 1 cent in the current price gap. A negative β_{1p} should not however lead to reject our underlying Hypothesis, if β_{2p} and/or β_{3p} are above all positive. Such result would only indicate that fuel price reforms do not have contemporaneous positive effects on output, but need to work their way through the economic system over time and it should not necessarily lead to a rejection of our underlying *Hypothesis.*

On the other hand, a significant positive/negative φ_{1p} and φ_{2p} would indicate increasing/diminishing returns, in terms of growth, to increasing energy prices in the previous and current period. This is again also predicted by our theoretical model.

Accordingly, one should expect the *lagged effects* (of the last past one- or two-year fuel price gaps), and the *contemporaneous effects* (of current fuel price gaps) on contemporaneous GDP growth, to differ. Increases in fuel retail prices today will likely increase fuel costs for enterprises which could lead to abrupt adjustments in their production, investment and employment, which can be manifested in an immediate reduction in growth, that is the same year the fuel subsidy reforms are implemented (with possible exceptions in cases where these fuel increases are compensated contemporaneously via increased money transfers to the public). This will be echoed with a negative value of β_{1p}. Nonetheless, with time, a country that puts in practice enduring fuel price reforms will likely encounter positive effects on its economy in the following periods. Such effect will be reflected in positive values of β_{2p} and/or β_{3p}. The GDP per capita in such reforming countries could start rising in the following periods via a number of different "pathways" stimulated by the lasting fuel price increases (lower budget deficits, larger social and infrastructure investment), while enterprises adjust their businesses to the new fuel pricing.

4.3 Estimation Method

We use the (robust) OLS estimation method for the cross-sectional data, and the System General Method of Moments (GMM) (Arellano-Bover (1995)/Blundell-Bond (1998)) for the panel data. The GMM corrects for possible endogeneity and non-stationarity of the regressors or explanatory variables. In particular, diesel and gasoline prices are most likely to be endogenous, being affected by both demand and supply conditions.

The tables below report both the two-step estimates (which yield theoretically robust results, Roodman (2009)). Note also that by applying the two-step estimator, we can obtain the robust Sargan test (i.e. the robust Hansen J-test). This is important for testing the validity of the instruments (or overidentifying restrictions). The validity of the model depends also on testing the presence of first- and, in particular, second-order autocorrelation in the error term. These important statistical diagnostics are presented together with estimated parameters (De Hoyos and Sarafidis (2006). At the outset, it should be mentioned that all our empirical models, the Sargan tests of overidentifying restrictions do not reject the null hypothesis (e.g. of correct model specification and valid overidentifying restrictions) at any conventional level of significance; hence, it is an indication that the models have valid instruments. Our test results on autocorrelation indicate that we cannot reject the null hypothesis (e.g. the cross section dependence is homogeneous across pairs of cross section units after including time dummy variables). Hence, inclusion of time-dummies in our specification have removed universal time-related shocks from the error term in our empirical models below.

5. Estimation Results

5.1 Cross-Sectional Analysis on the effect of energy subsidies on GDP per capita growth across all countries excluding High-Income OECD countries

We here present the (robust) OLS estimates of equation (21a). Selected relevant estimates are displayed in Table 1. We consider the entire period; and the sub-periods 1998-2004 and 2005-2012. The estimates for both the entire period and the sub-period 1998-2004 are mostly statistically insignificant. For the sub-period of 2005 to 2012 however, our estimates are all significant at reasonable statistical levels. They indicate that for a given level of average subsidy, a 20 cents average increase in the diesel and gasoline price per liter has caused an average increase in GDP per capita growth rates by about 0.28 percent and 0.46 percent, respectively.

The results are interesting, and highly plausible. It is likely that during the period from 2005 to 2012, which includes the years of global financial crisis from 2008 on; many countries have faced fiscal budget constraints that have been far more serious than in previous years. This 2008 financial crisis situation has made it less affordable for them to finance energy subsidies;

and has resulted in greater damage in terms of reduced economic growth from energy subsidies. Thus, a decrease in subsidies must have helped to achieve increased rates of economic growth over this period. This would also appear much less likely to have been the case before 2005.

Table 1: Cross-Sectional Analysis: GDP per capita growth (%) and Koplow's fuel price gap (US$ cents per liter)[a]. All countries except OECD. 1998-2012. OLS robust estimates[b]

Effect on GDP per capita growth		
1998-2012		
RHS Variables	**Gasoline Price**	**Diesel Price**
Koplow's fuel price gap	0.00948 (0.0108)	0.00297 (0.0091)
(Koplow's fuel price gap)^2	-0.00020* (0.00011)	-0.00019 (0.00013)
1998-2004		
RHS Variables	**Gasoline Price**	**Diesel Price**
Koplow's fuel price gap)	0.02982 (0.03561)	0.0159 (0.0287)
(Koplow's fuel price gap)^2	-0.00088 (0.00062)	-0.00078 (0.00064)
2005-2012		
RHS Variables	**Gasoline Price**	**Diesel Price**
Koplow's fuel price gap	**0.02316***** **(0.0090)**	**0.01374*** **(0.0079)**
(Koplow's fuel price gap)^2	-0.00022*** (0.00008)	-0.00026* (0.00014)

[a] A positive price gap implies a tax on this fuel; a negative price gap implies a subsidy.
[b] Error terms in parentheses. * Significant at 1% level; ** significant at 5% level; *significant at 10% level**

In MENA, most countries subsidize gasoline; while in ECA, most countries tax it, as shown in Figures 1 and 2. Consider simple correlations for 1998 - 2012 between the average of the gasoline Koplow's price gap, and the average *GDP per capita growth* for these two Regions. We notice, from Figures 5 and 6, that low fuel price gaps (high energy subsidies) in the countries in the MENA Region have, on the whole, been harmful to economic growth over this period. The opposite is the case for the countries in the ECA Region (excluding the OECD countries). MENA and ECA Regions are representative of two opposing sets of policies.

From observing these contrasting facts, it becomes obvious that one needs to analyze these patterns by Region, and quantify the impact of fuel prices on the economic growth on the Regional basis. Such differentiation cannot be done by using the Cross-Sectional Approach.

Figure 5. Correlation between GDP per capita growth and Gasoline Price Gap: Subsidies (-) Taxes (+) ($ cents/liter)

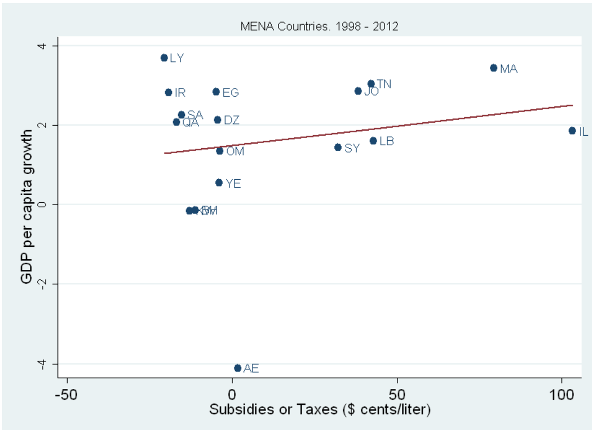
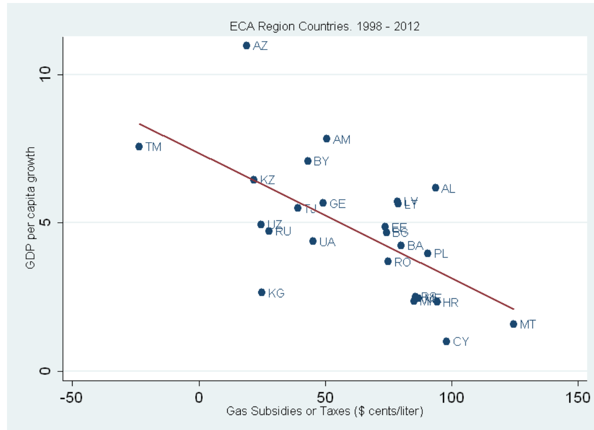


Figure 6. Correlation between GDP per capita growth and Gasoline Price Gap: Subsidies (-) Taxes (+) ($ cents/liter)



5.2 Panel Country Analysis of effects of energy subsidies on GDP per capita growth per World Bank Region

We have constructed a panel dataset of countries by each World Bank Region to estimate equation (20b) and test the underlying hypothesis.

Tables 2 and 3 show the empirical results of the effect of countries' diesel and gasoline price policies on growth, respectively. We consider the countries in the MENA, LAC, ECA, EAP and AFR World Bank regions, but also the OECD group. For the ECA, LAC and EAP regions these tables have two separate columns. For ECA there are additional columns for calculations where four "subsidy countries" (Azerbaijan, Kyrgyzstan, Turkmenistan and Uzbekistan) are removed; for LAC we add a separate set of columns for results when 4 "energy subsidy" countries (Bolivia, Ecuador, Mexico and Venezuela) are excluded; and for EAP there are additional columns showing estimations where five high-income countries (Australia, Japan, Hong Kong, New Zealand and Singapore) are not part of the estimation since these are high-income countries.

One should recognize that increases in fuel retail prices today will likely increase fuel costs for enterprises which could lead to abrupt short-run adjustments in their production, investment and employment. This can be manifested in a reduction in growth in the same year that fuel subsidy reforms are implemented. This will be echoed with a negative value of β_{1p} in equation (20b). Nonetheless, any fuel price reform made today will be beneficial in the subsequent periods. The GDP per capita in reforming countries could start rising in the following periods via a number of different "pathways" stimulated by the positive effects that these reforms have on government budget and social and infrastructure investment. In the meantime, enterprises gradually adjust their businesses to the more "correct" and new fuel price levels and their positive effects on its economy in the following periods. Such effect will be reflected in positive values of β_{2p} and/or β_{3p} from equation (20b).

Indeed, the estimated parameters β_{2p} and β_{3p} (parameters of the RHS variables (price gap)$_{t-1}$ and (price gap)$_{t-2}$, respectively) in equation (20b) are statistically significant and positive. These results then indicate that the benefits of decreasing fuel (diesel or gasoline) subsidies today will be noticed in each of the next couple of years, respectively. Thus, a subsidy reduction in t-1 or t-2 will cause an increase in GDP per capita growth in period t in all World Bank Regions except in countries of the ECA Region and OECD for both diesel and gasoline, and the LAC and AFR Regions for gasoline.

Note that the GDP per capita growth in countries of certain Regions could rise concurrently (i.e. at t) with reductions in fuel subsidies (also at t). This would be the case when β_{1p} (which accompanies the RHS variable (price gap)$_t$) is positive and statistically significant. This is especially notable for MENA (only diesel), LAC, and AFR. It is however found that only countries in the EAP Regions (and ECA and OECD) might need to cope with contemporaneous (i.e. at t) reductions in their GDP per capita growth in response to increases in domestic retail diesel price (i.e. also occurring at t).

A significant positive (negative) φ_{1p} and φ_{2p} (parameters accompanying the square of the fuel price gaps at t and t-1, respectively) would indicate increasing (diminishing) returns, in terms of growth, to increasing energy prices not only in the same year when the fuel price reform took place, but also in the subsequent year. This is the case of countries in most Regions: they face diminishing returns in terms of growth as they increase their fuel prices. This result corresponds to the reasoning behind the inverted U-form curve G in Figure 5 and our endogenous growth model.

Referring again to Figure 5, one can say that most of the countries in all World Bank Regions seem to be on the left-rising (upward-sloping) part of the curve G in section 2 above. Interestingly, for the ECA Region (and OECD countries) results are directly opposite in response to increases in these countries' fuel prices, which indicates that lower fuel prices and taxes would, in general, lead to higher economic growth in this particular region.

Table 2: GDP per capita growth (%) and Koplow's diesel price gap (US$ cents per liter)[a]. 1998-2012[b]. System GMM

Effect on GDP per capita growth (%)									
RHS Variable	**MENA**	**LAC**	**LAC (minus 4 countries)**	**EAP**	**EAP (minus 5 HIC)**	**AFR**	**ECA**	**ECA (minus 4 countries)**	**OECD**
Diesel Price Gap1$_t$	**0.0462**** **(0.0222)**	0.0298 (0.0234)	**0.0875***** **(0.0344)**	-0.0186 (0.0492)	-0.1770*** (0.0659)	**0.0559***** **(0.0017)**	-0.0603*** (0.0063)	-0.1055*** (0.0048)	-0.1311*** (0.0055)
Diesel Price Gap1$_{t-1}$	-0.0612*** (0.0216)	-0.0231 (0.0149)	**0.0725**** **(0.0320)**	0.0266 (0.0951)	**0.2039***** **(0.0754)**	**0.0121***** **(0.0034)**	-0.0465*** (0.0123)	-0.0163*** (0.0048)	-0.0664*** (0.0088)
Diesel Price Gap1$_{t-2}$	**0.0164*** **(0.0098)**	**0.0254***** **(0.0090)**	**0.0255***** **(0.0079)**	**0.0509***** **(0.0098)**	**0.0456***** **(0.0124)**	**0.00073** **(0.0033)**	-0.0216*** (0.0021)	-0.0307*** (0.0029)	-0.0089 (0.0029
(Diesel Price Gap1)^2_t	-0.00037*** (0.00015)	0.00020 (0.00023)	-0.00040 (0.00032)	0.00025 (0.00039)	0.0013*** (0.00046)	-0.00030*** (0.00002)	0.00055*** (0.000357)	0.00112*** (0.00002)	0.00104*** (0.000033)
(Diesel Price Gap1)$^2_{t-1}$	0.00078*** (0.00016)	-0.00046*** (0.00013)	-0.00131*** (0.00038)	-0.00078 (0.00074)	-0.0025*** (0.00065)	0.00013*** (0.00002)	-0.00015** (0.000073)	-0.0007*** (0.00005)	-0.00097*** (0.000050)
AR(1) test[c]	z = -1.115 Pr>z=0.265	z = -2.179 Pr>z=0.029	z = -1.913 Pr>z=0.056	z = -2.9804 Pr>z=0.003	z = -1.7856 Pr>z=0.074	z = -3.622 Pr>z=0.000	z = -3.228 Pr>z=0.001	z = -2.3035 Pr>z=0.021	z = -3.454 Pr>z=0.006
AR(2) test[c]	z = 0.282 Pr>z=0.778	z = -0.1805 Pr>z=0.857	z = 0.485 Pr>z=0.628	z = -0.804 Pr>z=0.422	z = 1.504 Pr>z=0.133	z = -0.556 Pr>z=0.578	z = -3.032 Pr>z=0.002	z = -0.491 Pr>z=0.624	z = -0.158 Pr>z=0.875
Sargan test[d]	Prob>chi2 = 0.99	Prob>chi2 = 0.97	Prob>chi2 = 0.95	Prob>chi2 = 0.99	Prob>chi2 = 1.00	Prob>chi2 = 1.00	Prob>chi2 = 1.00	Prob>chi2 = 1.00	Prob>chi2 = 1.00

[a] A positive price gap implies a tax on this fuel; a negative price gap implies a subsidy.

[b] Standard errors in parentheses. *** Significant at the 1% level; ** significant at the 5% level; *significant at the 10% level

[c] These are the Arellano-Bond test for AR(1) and AR(2) in first differences. There, the corresponding null hypotheses (H_0) are respectively:

- There is no first-order serial correlation in residuals
- There is no second-order serial correlation in residuals

[d] With the Sargan statistics, one can test the null hypothesis of correct model specification and valid overidentifying restrictions

Table 3: GDP per capita growth (%) and Koplow's gasoline price gap (US$ cents per liter)[a]. 1998-2012[b].

Effect on GDP per capita growth (%)									
Variable	**MENA**	**LAC**	**LAC (minus 4 countries)**	**EAP**	**EAP (minus 5 HICs)**	**AFR**	**ECA**	**ECA (minus 3 countries)**	**OECD**
Gasoline Price Gap2$_t$	0.0193 (0.0196)	**0.0488** (0.0218)**	**0.0948*** (0.0300)**	-0.0167 (0.0508)	0.0055 (0.0264)	**0.0454*** (0.0077)**	-0.00467 (0.0210)	-0.00201 (0.02071)	-0.07283*** (0.00989)
Gasoline Price Gap2$_{t-1}$	-0.0993*** (0.0244)	-0.0103 (0.0129)	**0.0460* (0.0286)**	-0.0048 (0.0383)	0.0721 (0.0935)	**0.0210*** (0.0036)**	-0.0724*** (0.0112)	-0.08171*** (0.00438)	-0.04176*** (0.00493)
Gasoline Price Gap2$_{t-2}$	**0.0653*** (0.0180)**	-0.0122* (0.0070)	-0.0062 (0.0078)	**0.0571*** (0.0078)**	**0.0533*** (0.0096)**	-0.00059 (0.00124)	-0.0343*** (0.00081)	-0.02264*** (0.00234)	-0.03690*** (0.00219)
(Gasoline Price Gap2)^2_t	-0.000756 (0.000207)	0.00003 (0.00018)	-0.00047* (0.00028)	0.000024 (0.00022)	-0.00016* (0.000097)	-0.00024*** (0.00003))	0.00013*** (0.00005)	0.000074 (0.000062)	0.00042*** (0.000055)
(Gasoline Price Gap1)$^2_{t-1}$	0.00120*** (0.00025)	-0.00047*** (0.00013)	-0.00084*** (0.00018)	-0.00038** (0.00019)	-0.00076 (0.00050)	-0.00011*** (0.00001)	0.00024*** (0.000037)	0.000265*** (0.000027)	0.000199*** (0.000024)
AR(1) test[c]	z = -1.123 Pr>z=0.262	z = -2.351 Pr>z=0.019	z = -2.023 Pr>z=0.043	z = -2.815 Pr>z=0.005	z = -2.175 Pr>z=0.030	z = -3.737 Pr>z=0.000	z = -2.565 Pr>z=0.010	z = -2.965 Pr>z=0.003	z = -2.679 Pr>z=0.007
AR(2) test[c]	z = -0.622 Pr>z=0.530	z = -1.007 Pr>z=0.314	z = -0.1815 Pr>z=0.856	z = -1.541 Pr>z=0.123	z = -1.019 Pr>z=0.308	z = -0.5889 Pr>z=0.556	z = -3.063 Pr>z=0.002	z = -2.802 Pr>z=0.005	z = -1.146 Pr>z=0.252
Sargan test[d]	Prob>chi2 = 0.99	Prob>chi2 = 0.98	Prob>chi2 = 0.99	Prob>chi2 = 0.99	Prob>chi2 = 0.97	Prob>chi2 = 0.99	Prob>chi2 = 0.99	Prob>chi2 = 0.95	Prob>chi2 = 0.96

[a] A positive price gap implies a tax on this fuel; a negative price gap implies a subsidy.

[b] Standard errors in parentheses.*** Significant at the 1% level; ** significant at the 5% level; *significant at the 10% level

[c] These are the Arellano-Bond test for AR(1) and AR(2) in first differences. There, the corresponding null hypotheses (H_0) are respectively:

- There is no first-order serial correlation in residuals
- There is no second-order serial correlation in residuals

[d] With the Sargan statistics, one can test the null hypothesis of correct model specification and valid overidentifying restrictions

6. Will reductions in diesel subsidies decrease employment in the MENA and ECA Regions?

The analysis of the effect of a reduction in diesel subsidies on employment, and labor participation of youth aged 15 to 24, and on labor participation of the populations aged from 15 to 65 (all of them measured with respect to the total populations aged above 15 years old) is important. We estimate a similar equation (20b), except that we have the employment variables on the left-hand side. The effect is particularly strong for the case of diesel subsidies. The results are shown in Tables 4 for MENA and ECA countries, for comparison purposes. *Much more significant positive effects of subsidy reductions on employment and participation in the labor force are found for MENA than for the ECA countries, even when it happens with some delay.*[11]

Table 4. MENA and ECA Regions: Employment, Labor Force Participation and Koplow's diesel price gap (US$ cents per liter)[a]. 1998-2012.[b] System GMM.

Effect on Total Employment/Population, age 15+ (%)			*Effect on Labor Force Participation ages 15 to 24/Population, age 15+ (%)*			*Effect on Labor Force Participation ages 15 to 65/Population, age 15+ (%)*		
MENA								
Diesel Price Gap$_t$	**Diesel Price Gap$_{t-1}$**	**Diesel Price Gap$_{t-2}$**	**Diesel Price Gap$_t$**	**Diesel Price Gap$_{t-1}$**	**Diesel Price Gap$_{t-2}$**	**Diesel Price Gap$_t$**	**Diesel Price Gap$_{t-1}$**	**Diesel Price Gap$_{t-2}$**
0.01589	**0.09256*****	-0.03372	-0.01961**	**0.03450*****	**0.00874*****	-0.0326***	**0.0515*****	0.00089
(0.03294)	**(0.03981)**	(0.02048)	(0.00914)	**(0.00562)**	**(0.00197)**	(0.00692)	**(0.00774)**	(0.00581)
AR(1) test[c]: z=0.0169; Pr>z=0.9865			**AR(1) test[c]**: z=1.3305; Pr>z=0.1834			**AR(1) test[c]**: z=0.328; Pr>z=0.743		
AR(2) test[c]: z=1.5647; Pr>z=0.1177			**AR(2) test[c]**: z=1.1187; Pr>z=0.2633			**AR(2) test[c]**: z=1.1519; Pr>z=0.2494		
Sargan test[d]: Pr > chi2 = 1.00			**Sargan test[d]** Pr > chi2 = 1.00			**Sargan test[d]**: Pr > chi2 = 1.00		
ECA								
Diesel Price Gap$_t$	**Diesel Price Gap$_{t-1}$**	**Diesel Price Gap$_{t-2}$**	**Diesel Price Gap$_t$**	**Diesel Price Gap$_{t-1}$**	**Diesel Price Gap$_{t-2}$**	**Diesel Price Gap$_t$**	**Diesel Price Gap$_{t-1}$**	**Diesel Price Gap$_{t-2}$**
-0.0568***	-0.0053***	**0.0109*****	-0.0381***	-0.0314***	-0.0049***	-0.0312***	-0.0232***	**0.0061*****
(0.00139)	(0.00091)	**(0.00072)**	(0.00681)	(0.00463)	(0.00222)	(0.00162)	(0.00210)	**(0.00096)**
AR(1) test[c]: z=-0.9002; Pr>z=0.3680			**AR(1) test[c]**: z=0.2246; Pr>z=0.8223			**AR(1) test[c]**: z=2.0839; Pr>z=0.0372		
AR(2) test[c]: z=-0.7057; Pr>z=0.4804			**AR(2) test[c]:** z=1.8578; Pr>z=0.0632			**AR(2) test[c]:** z=0.0589; Pr>z=0.9530		
Sargan test[d]: Pr > chi2 = 1.00			**Sargan test[d]**: Pr > chi2 = 1.00			**Sargan test[d]**: Pr > chi2 = 1.00		

[a] A positive price gap implies a tax on this fuel; a negative price gap implies a subsidy.

[b] Standard errors in parentheses.***Significant at 1% level;**significant at 5% level;*significant at 10% level

[c] These are the Arellano-Bond test for AR(1) and AR(2) in first differences. There, the corresponding null hypotheses (H_0) are respectively:

- There is no first-order serial correlation in residuals
- There is no second-order serial correlation in residuals

[d] With the Sargan statistics, one can test the null hypothesis of correct model specification and valid overidentifying restrictions

[11] Not significant, statistically and numerically, effects were found when considering gasoline subsidies.

It should be noted that an effect of raising diesel taxes might reduce labor participation in the very short run (as subsidies are removed), including the youth population aged 15 to 24 in the MENA countries. But as the entire economy adjust and reallocates resources to less-capital and less-energy intensive sectors in response to the new energy prices, and with the help of better infrastructure and better supply of public services (which is what we find and presented below), labor market participation and employment will increase in subsequent years. For example, a *20 cents increase in diesel retail price* for two consecutive periods could *increase employment as a percentage of working population above 15 years old by 2.2%; and youth participation as a percentage also of working population above 15 years old by 0.86%.*

A recent World Bank (2014) report emphasizes that energy subsidies encourage energy-intensive production, which also tends to be capital-intensive, and discourages labor employment. If the MENA countries substantially reduce their levels of energy subsidies, their levels of employment will increase, in particular among the young.

7. Will savings from reducing fuel subsidy expenditures be relocated to productive public investment and spur economic growth?

As Figure 3 above indicates, a disproportionate amount of resources are used to finance subsidies in the MENA Region relative to those used in public investment. It is of relevance to learn whether any savings in fuel subsidies made by the MENA Countries have been (and could be) redirected toward more productive public investment. On the other hand, to assess whether or not fiscal budgets improve in response to reduced fuel subsidies in the MENA countries, we need to determine how government investment in public goods such as health, education and infrastructure, respond to reductions in fuel subsidies.

Due to data restrictions, the focus here is only on infrastructure, health and education. For comparison purposes, the analysis also include the countries in the ECA Region.

Figures 7 and 8 show a positive correlation between the fuel price gap and health expenditures as a percentage of GDP in the MENA countries.

Figure 7. Correlation of Health Expenditures/GDP and Gasoline Price Gap: Subsidies (-) Taxes (+) ($cents/liter)

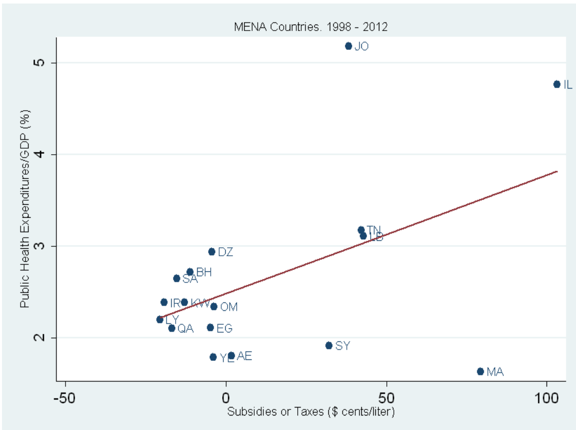
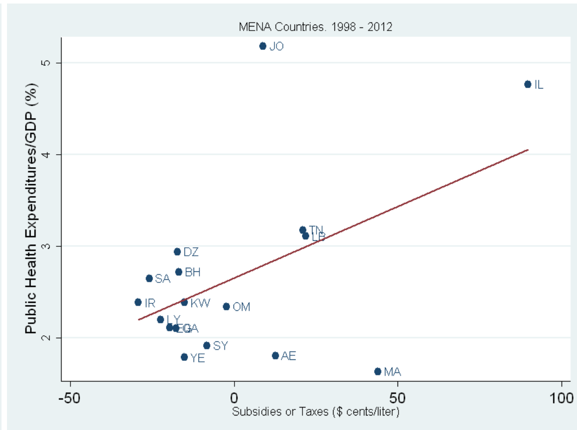


Figure 8. Correlation of Health Expenditures/GDP and Diesel Price Gap: Subsidies (-) Taxes (+) ($cents/liter)



The figures give a strong indication that these countries redirect at least part of their subsidy savings to health. This is also shown empirically. We estimate the following relationship:

$$(X)_{it} = a + b_1(price\ \ gap)_{it} + b_2(price\ \ gap)_{it-1} + b_3(price\ \ gap)_{it-2} + \tau_t + c_i + \xi_{it} \qquad (21)$$

X_{it} is a matrix containing variables related to *Education, Health,* and *Infrastructure* for each country at time t. The other explanatory variables have been defined above. ξ_{it} is the error term.

Due to availability of data, we only consider public education expenditures as a percentage of GDP; and the ratio of the number of students enrolled to pursue a tertiary education as a proportion of the population of the same age group that officially corresponds to the level of education; infrastructure expenditures relative to GDP; the percentages of rural populations that have access to water; and the percentage of rural population that have access to sanitation.

Much of the government savings due to reduced gasoline and diesel subsidies have been used to increase spending in health in the MENA countries. An increase in the price of diesel or gasoline of 20 cents per liter for two consecutive years can lead to an increase in health expenditures of 0.24 percent of GDP. See Table 5.

It is however evident from Table 5 that subsidy savings have not been enough to sustain higher health expenditures for long periods into the future. This is also confirmed by Figure 5. The governments might need other funding sources as well as a longer-lasting reduction in fuel subsidies to sustain permanent increases in health expenditure. This is reasonable since adjustments in the personnel and infrastructure would need continuously more funding to have a positive impact on the health sector. For comparison purposes, we also present the empirical results for the ECA countries which indicate that these countries consistently use their fuel tax revenues to maintain higher health expenditures over longer periods of time.

Table 5. MENA and ECA Regions: Health Expenditures and Koplow's fuel price gap (US$ cents per liter)[a]. 1998 – 2012.[b] System GMM.

Effect on Health Expenditures/GDP (%)		
MENA - Diesel		
Diesel Price Gap$_t$	**Diesel Price Gap$_{t-1}$**	**Diesel Price Gap$_{t-2}$**
0.00946* (0.00167)**	**0.00254* (0.00147)**	-0.00189 (0.00196)
AR(1) test[c]: z=-0.7538; Pr>z=0.4510; **AR(2) test**[c]**:** z=0.7794; Pr>z=0.4357 **Sargan test**[d]: Pr > chi2 = 1.00		
ECA - Diesel		
Diesel Price Gap$_t$	**Diesel Price Gap$_{t-1}$**	**Diesel Price Gap$_{t-2}$**
0.00898* (0.00152)**	**0.00737* (0.00460)**	**0.00460*** (0.00097)**
AR(1) test[c]**:** z=0.6709; Pr>z=0.5023; **AR(2) test**[c]**:** z=-0.0962; Pr>z=0.9234 **Sargan test**[d]: Pr > chi2 = 1.00		
MENA - Gasoline		
Gasoline Price Gap$_t$	**Gasoline Price Gap$_{t-1}$**	**Gasoline Price Gap$_{t-2}$**
0.00092 (0.00232)	**0.00968*** (0.00099)**	**0.00245** (0.00114)**
AR(1) test[c]: z=-0.6355; Pr>z=0.5251; **AR(2) test**[c]: z=-1.8511; Pr>z=0.0642 **Sargan test**[d]: Pr > chi2 = 1.00		
ECA - Gasoline		
Gasoline Price Gap$_t$	**Gasoline Price Gap$_{t-1}$**	**Gasoline Price Gap$_{t-2}$**
0.00627* (0.00043)**	**0.00615*** (0.00034)**	**0.00242** (0.00015)**
AR(1) test[c]: z=0.2794; Pr>z=0.7799; **AR(2) test**[c]: z=-0.5392; Pr>z=0.5897 **Sargan test**[d]: Pr > chi2 = 1.00		

[a] A positive price gap implies a tax on this fuel; a negative price gap implies a subsidy.

[b] Standard errors in parentheses. ***Significant at the 1% level; **significant at the 5% level; *significant at the 10% level

[c] These are the Arellano-Bond test for AR(1) and AR(2) in first differences. There, the corresponding null hypotheses (H_0) are respectively:

- There is no first-order serial correlation in residuals
- There is no second-order serial correlation in residuals

[d] With the Sargan statistics, one can test the null hypothesis of correct model specification and valid overidentifying restrictions

Investments in infrastructure have been delayed from the time the governments obtain savings from reduced diesel subsidies. This can be seen from Table 6.[12] We find that in the MENA countries, it takes at least one year to observe a positive and statistically significant reallocating of subsidy savings toward infrastructure investments. This is much in contrast to the ECA countries, which seem to not only immediately redirect a larger proportion of their fuel taxes to infrastructure investments, but also allocate more permanent such taxes into future investments.

Table 6. MENA and ECA Regions: Infrastructure Investment and Koplow's diesel price gap (US$ cents per liter)[a]. 1998 – 2012[b]

Effect on Public Infrastructure/GDP			***Effect on % Rural Population with improved water access***			***Effect on % Rural Population with improved sanitation access***		
MENA								
Diesel Price $Gap2_t$	**Diesel Price $Gap2_{t-1}$**	**Diesel Price $Gap2_{t-2}$**	**Diesel Price $Gap2_t$**	**Diesel Price $Gap2_{t-1}$**	**Diesel Price $Gap2_{t-2}$**	**Diesel Price $Gap2_t$**	**Diesel Price $Gap2_{t-1}$**	**Diesel Price $Gap2_{t-2}$**
-0.0201** (0.00865)	**0.01602* (0.00919)**	-0.0595*** (0.00704)	**0.02748*** (0.00787)**	-0.01771 (0.01825)	-0.02402 (0.01609)	-0.0461*** (0.00565)	**0.01840*** (0.00356)**	-0.0867*** (0.0067)
AR(1) test[c]: z=-1.0994; Pr>z=0.2716			**AR(1) test[c]**: z=1.5031; Pr>z=0.1328			**AR(1) test[c]**: z=0.9885; Pr>z=0.3229		
AR(2) test[c]: z=-0.7954; Pr>z=0.4264			**AR(2) test[c]**: z=1.3522; Pr>z=0.1763			**AR(2) test[c]**: z=2.6115; Pr>z=0.009		
Sargan test[d]: Pr > chi2 = 1.00			**Sargan test[d]**: Pr > chi2 = 1.00			**Sargan test[d]**: H_0: Pr > chi2 = 1.00		
ECA								
Diesel Price $Gap2_t$	**Diesel Price $Gap2_{t-1}$**	**Diesel Price $Gap2_{t-2}$**	**Diesel Price $Gap2_t$**	**Diesel Price $Gap2_{t-1}$**	**Diesel Price $Gap2_{t-2}$**	**Diesel Price $Gap2_t$**	**Diesel Price $Gap2_{t-1}$**	**Diesel Price $Gap2_{t-2}$**
0.01307 (0.00624)**	-0.00295 (0.00569)	**0.01044*** (0.00375)**	**0.06947*** (0.01480)**	**0.03503*** (0.00478)**	**0.03777*** (0.00517)**	**0.06197*** (0.00316)**	**0.03019*** (0.00208)**	**0.01579*** (0.00286)**
AR(1) test[c]: z=-1.7701; Pr>z=0.0767			**AR(1) test[c]**: z=2.4226; Pr>z=0.0154			**AR(1) test[c]**: z=0.281; Pr>z=0.437		
AR(2) test[c]: z=-1.0064; Pr>z=0.3142			**AR(2) test[c]**: z=-2.4377; Pr>z=0.0148			**AR(2) test[c]**: z=0.519; Pr>z=0.6494		
Sargan test[d]: Pr > chi2 = 1.00			**Sargan test[d]**: Pr > chi2 = 1.00			**Sargan test[d]**: Pr > chi2 = 1.00		

[a] A positive price gap implies a tax on this fuel; a negative price gap implies a subsidy.

[b] Standard errors in parentheses. *** Significant at 1% level; ** significant at 5% level; *significant at 10% level

[c] These are the Arellano-Bond test for AR(1) and AR(2) in first differences. There, the corresponding null hypotheses (H_0) are respectively:

- There is no first-order serial correlation in residuals
- There is no second-order serial correlation in residuals

[d] With the Sargan statistics, one can test the null hypothesis of correct model specification and valid overidentifying restrictions

[12] The data on infrastructure comes from the IMF which was used in their World Economic Outlook (IMF (2014a)). The source for data on employment comes from the International Labor Organization while the data for Health Expenditures, Water and Sanitation Access comes from the World Development Indicators.

Raising diesel taxes or eliminating diesel subsidies have improved access to water and sanitation among rural populations in the MENA countries.[13] Today's savings of about 20 cents per liter on diesel subsidies can facilitate i) an immediate up-front investments to facilitate an additional 0.55 percent access to water in the rural sector; and a year later ii) another 0.37 percent of the rural population will experience a greater access to sanitation facilities and iii) an increase in infrastructure spending of 0.32 percent of GDP.

Nevertheless, today's diesel subsidy savings are not enough to continue building up the infrastructure stock over longer periods of time. See Table 7. Today's savings are not enough to finance infrastructure spending beyond two years. The estimated coefficients, b_2 and/or b_3 in equation (21) are not significant and may even be negative. The MENA countries need to make the reductions in fuel subsidies substantial and permanent to obtain more steady revenues.

The countries in the ECA Region seem to have contrasting practices. They benefit more from their more persistent fuel tax policies practices. These allow them to experience more long-term positive effects and boosting their aggregate demand through the short-run fiscal multiplier, crowding in private investment and benefitting from the highly complementary nature of infrastructure services.

Table 7 shows how *savings in diesel subsidies can be redirected toward education expenditures*. For instance, today's education spending will increase around 0.27 percent of GDP if a government saves today 20 cents per liter in diesel subsidies. However, savings from reducing or eliminating fuel subsidies in a specific year t only serve to finance education expenditures the same concurrent year and not beyond that year. For the ECA countries in contrast, the same amount of forgone subsidies are used for at least three consecutive future years to finance public education.

With regard to enrollment in tertiary education, there will be more incentives to pursue higher education in response to higher fuel prices in countries of both Regions. The enrollment increases by about 2.8 percent in response to a 20 cents increase in retail diesel price. Thus, higher fuel prices might make individuals aware that they need more education to i) increase their likelihood to participate in the labor force and be able to finance their fuel consumption;

[13] We have also considered urban populations and the results are available upon request.

and/or ii) respond to a demand for specific skilled labor as their countries' production structure changes in response to reduced subsidies. Note also here the contrasting situation between the MENA and ECA countries.

Table 7. MENA and ECA Regions: Education Expenditures and Koplow's diesel price gap (US$ cents per liter)[a]. 1998 – 2012.[b] System GMM.

Effect on Education Expenditures/GDP (%)			*Effect on Enrollment in Tertiary Education/Population of same age (%)*		
MENA					
Diesel Price $Gap2_t$	**Diesel Price $Gap2_{t-1}$**	**Diesel Price $Gap2_{t-2}$**	**Diesel Price $Gap2_t$**	**Diesel Price $Gap2_{t-1}$**	**Diesel Price $Gap2_{t-2}$**
0.00957* (0.00244)**	-0.00279 (0.00242)	-0.00629*** (0.00282)	**0.05864*** (0.01219)**	**0.08343*** (0.01615)**	-0.11354 (0.01359)
AR(1) test[c]: z=0.90325; Pr>z=0.3664 **AR(2) test[c]**: z=0.4564; Pr>z=0.6481 **Sargan test[d]:** Pr > chi2 = 1.00			**AR(1) test[c]**: z=0.652; Pr>z=0.4241 **AR(2) test[c]**: z=0.581; Pr>z=0.6624 **Sargan test[d]:** Pr > chi2 = 1.00		
ECA					
Diesel Price $Gap2_t$	**Diesel Price $Gap2_{t-1}$**	**Diesel Price $Gap2_{t-2}$**	**Diesel Price $Gap2_t$**	**Diesel Price $Gap2_{t-1}$**	**Diesel Price $Gap2_{t-2}$**
0.00681* (0.00272)**	**0.01089*** (0.00318)**	**0.01365*** (0.00212)**	**0.10415*** (0.00975)**	**0.09673*** (0.00973)**	**0.09409*** (0.00958)**
AR(1) test[c]: z=-0.535; Pr>z=0.651 **AR(2) test[c]**: z=-1.3511; Pr>z=0.342 **Sargan test[d]**: Pr > chi2 = 1.00			**AR(1) test[c]**: z=-0.3823; Pr>z=0.2531 **AR(2) test[c]**: z=-1.011; Pr>z=0.2542 **Sargan test[d]**: Pr > chi2 = 1.00		

[a] A positive price gap implies a tax on this fuel; a negative price gap implies a subsidy.

[b] Standard errors in parentheses. ***Significant at 1% level; **significant at 5% level; *significant at 10% level

[c] These are the Arellano-Bond test for AR(1) and AR(2) in first differences. There, the corresponding null hypotheses (H_0) are respectively:

- There is no first-order serial correlation in residuals
- There is no second-order serial correlation in residuals

[d] With the Sargan statistics, one can test the null hypothesis of correct model specification and valid overidentifying restrictions

7. Will reductions in fuel price subsidies ameliorate government budget balance?

There is a general perspective that fuel subsidies could cause government budget deficits. A reduction or elimination in subsidies should then reduce deficits, unless the government uses the entire savings from subsidies on productive public investments, or to grant cash transfers to the public to compensate them for any loss in welfare caused by higher fuel prices.

Table 8 displays estimated effects of fuel subsidy reductions (or fuel tax increases) on the government budget balance as a percentage of total GDP (GBB) for the MENA countries. The relation we estimate is the following:

$$(Government\ Budget\ Balance / GDP)_{it} = a + b_1(price\ gap)_{it} + b_2(price\ gap)_{it-1} + b_3(price\ gap)_{it-2} + \tau_t + c_i + \mu_{it} \quad (22)$$

The explanatory variables have been defined above. μ_{it} is the error term.

The estimates indicate that a reduction in fuel subsidies does not immediately improve the GBB. Such improvement only occurs gradually. This result is reasonable because, as documented above, savings in fuel subsidies seem to have served to increase spending in health, education and infrastructure in the first year or first two years after the fuel price reform. Thus, a subsidy reduction in diesel and gasoline of 20 cents per liter would ameliorate the GBB by 1.57 percent and 1.16 percent, respectively but with a delay of two years.

Table 8. MENA: Government Budget Balance/GDP (GBB) and Koplow's fuel price gap (US$ cents per liter)[a]. 1998 – 2012.[b] System GMM.

Effect on GBB (%)		
Diesel Price Gap$_t$	**Diesel Price Gap$_{t-1}$**	**Diesel Price Gap$_{t-2}$**
-0.07123*** (0.02820)	-0.05789 (0.03559)	**0.07841*** (0.02928)**
AR(1) test[c]: z=0.925; Pr>z=0.664 ; **AR(2) test**[c]: z=0.564; Pr>z=0.484 **Sargan test[d]:** Pr > chi2 = 1.00		
Gasoline Price Gap$_t$	**Gasoline Price Gap$_{t-1}$**	**Gasoline Price Gap$_{t-2}$**
-0.02018 (0.02678)	-0.13177*** (0.03005)	**0.05832** (0.03069)**
AR(1) test[c]: z=0.3725; Pr>z=0.452 ; **AR(2) test**[c]: z=0.157; Pr>z=0.214 **Sargan test[d]:** Pr > chi2 = 1.00		

[a] A positive price gap implies a tax on this fuel; a negative price gap implies a subsidy.

[b] Standard errors in parentheses. ***Significant at the 1% level; **significant at the 5% level; *significant at the 10% level

[c] These are the Arellano-Bond test for AR(1) and AR(2) in first differences. There, the corresponding null hypotheses (H_0) are respectively:

- There is no first-order serial correlation in residuals
- There is no second-order serial correlation in residuals

[d] With the Sargan statistics, one can test the null hypothesis of correct model specification and valid overidentifying restrictions

8. The channels by which fuel price reforms stimulate economic growth in MENA countries

We have demonstrated that i) a reduction in subsidies is likely to spur economic growth; and ii) in MENA region countries a fraction of government savings from reduced energy subsidies are redirected toward public expenditures such as health, education and infrastructure. The obvious next step is to explore and disentangle whether each of these types of public investments are channels by which energy subsidies affect economic growth in this region.

Education expenditures is a main contributor to explaining economic growth, from relevant economic literature.[14] Table 9 presents the interaction between *education*, *fuel subsidies* (Koplow's fuel price gap) and *economic growth*. From this analysis we will also learn if the *fuel subsidies – economic growth relationship* is robust to the alternative we here propose.

The following empirical relationship is estimated using a ***panel analysis****:*

$$\begin{aligned} GDP_{per\,capita}\ growth_{it} = {} & \alpha_{1p,x} + \beta_{1p,x}(price\ gap)_{it} + \beta_{2p,x}(price\ gap)_{it-1} + \beta_{3p,x}(price\ gap)_{it-2} \\ & \varphi_{1p,x}(price\ gap)^2{}_{it} + \varphi_{2p,x}(price\ gap)^2{}_{it-1} + \gamma_1(X)_{it} + \gamma_2(X)_{it-1} + \gamma_3(X)_{it-2} \\ & \theta_{1p,x} I_{i,1998} + \tau_t + c_i + \zeta_{it} \end{aligned} \tag{23}$$

X_i is a vector contains the *Education Spending/GDP,* for each country *i* at time, *t, t-1* and *t-2.* The other explanatory variables have been defined above. ζ_{it} is the error term. These variable education enters with lags to take into account that they represent long-term public investment, and that it normally takes time for changes in these variables to have an effect on GDP.

The results indicate that it takes time for increases in education expenditures relative to GDP to have an impact on GDP per capita growth. A 1 percent increase today in education spending as a percentage of GDP would increase GDP per capita growth by at least 2% in the following year. It might look a relatively high effect but note however that the levels of education expenditures are so low in the MENA countries, as reported by the IMF (2014b) that it should not take much to have a large impact on GDP once education spending start rising.

[14] See Jones (1997), Aghion and Howitt (1999), and Jones and Vollrath (2013).

The other important result is to notice that now there are no effects of *diesel* and *gasoline* subsidies on GDP per capita in our new specification. That indicates that any effect that a reduction in subsidies can have on GDP per capita must has occurred through increases in the different public investments, especially in education.

Table 9. MENA: GDP per capita Growth (%); Koplow's diesel price gap (US$ cents per liter); and Education[a]. 1998 – 2012.[b] System GMM.

Effect on GDP per capita growth (%)							
Diesel Price Gap_t	**Diesel Price Gap_{t-1}**	**Diesel Price Gap_{t-2}**	**(Diesel Price $Gap_t)^2$**	**(Diesel Price $Gap_{t-1})^2$**	**(Education Expenditures/ $GDP)_t$ (%)**	**(Education Expenditures/ $GDP)_{t-1}$ (%)**	**(Education Expenditures/ $GDP)_{t-2}$ (%)**
0.00218 (0.04276)	-0.06518 (0.0991)	0.02113 (0.04037)	0.00104 (0.00067)	-0.00076 (0.00112)	0.39254 (0.84168)	***2.11043* (1.2114)***	0.00064 (0.56807)
AR(1) test[c]: z=-1.9479; Pr>z=0.0514; **AR(1) test[c]**: z=0.6759; Pr>z=0.4991 **Sargan test[d]:** Pr > chi2 = 1.00							
Gasoline Price Gap_t	**Gasoline Price Gap_{t-1}**	**Gasoline Price Gap_{t-2}**	**(Gasoline Price $Gap_t)^2$**	**(Gasoline Price $Gap_{t-1})^2$**	**(Education Expenditures/ $GDP)_t$ (%)**	**(Education Expenditures/ $GDP)_{t-1}$ (%)**	**(Education Expenditures/ $GDP)_{t-2}$ (%)**
0.00348 (0.02962)	-0.0378 (0.0391)	0.02971 (0.04500)	0.00087*** (0.00079)	0.000070 (0.00045)	0.15781 (0.52794)	***2.18655*** (0.84436)***	0.50624 (0.59324)
AR(1) test[c]: z=-1.6855; Pr>z=0.0919; **AR(1) test[c]**: z=0.5955; Pr>z=0.5515 **Sargan test[d]:** Pr > chi2 = 1.00							

[a] A positive price gap implies a tax on this fuel; a negative price gap implies a subsidy.

[b] Standard errors in parentheses. *** Significant at 1% level; ** significant at the 5% level; *significant at 10% level

[c] These are the Arellano-Bond test for AR(1) and AR(2) in first differences. There, the corresponding null hypotheses (H_0) are respectively:

- There is no first-order serial correlation in residuals
- There is no second-order serial correlation in residuals

[d] With the Sargan statistics, one can test the null hypothesis of correct model specification and valid overidentifying restrictions

9. Conclusions

To fully understand why and how a country can gain from eliminating fuel subsidies, it requires a thorough analysis involving various fields including economics, politics, and life sciences, to mention just a few, as well as a deep understanding of human behavior and the government's role in the lives of its citizens.

Our objective and approach have been here more modest, and has aimed to promote an awareness of potential benefits of phasing out fuel subsidies. This paper has studied the relationships between fuel pricing and economic growth, and mechanisms by which removing fuel subsidies or imposing fuel taxes can spur growth.

One of the purposes of this paper has been to study relationships between fuel pricing and economic growth, and to investigate the mechanisms by which the removal of fuel subsidies, or imposing fuel taxes, can spur growth. We first present a theoretical analysis in which young agents derive their incomes from supplying labor, and pay income and fuel taxes. The government can invest such fuel tax revenues in short-term projects, or in long-term productive projects in productive capital (including infrastructure) and generate positive externalities. When agents become middle-aged, a certain proportion of them will choose to spend their net income right away, and retire early from the labor force and collect their pensions which is financed with the government's short-term investments. The rest of the individuals prefer to become entrepreneurs and use the productive capital stock derived from the government's investments.

We first demonstrate that higher economic growth is possible if government revenues from reduced fuel subsidies, or increased fuel taxes, are used less in short-term investment, and more for long-term investments (e.g. in public goods, infrastructure, producible capital) that yield high returns. Such a type of decisions give agents incentives to become entrepreneurs and be productive instead of retiring early and become just consumers. At least two important lessons can be drawn from our model. *First,* we have identified a plausible mechanism by which higher fuel subsidies will lead to lower economic growth. *Second,* it is important that the government spends its revenues from increasing fuel taxes to expand the economy's productive capital (e.g. infrastructure. This is a useful result that can serve as a basis for guidelines to governments.

We then go on to empirically test our hypothesis, derived from our theoretical model. This is, a country that initially subsidizes its fuels, and implements a reform to eliminate or reduce these subsidies, will experience higher economic GDP growth. We also test if there are diminishing returns in terms of increased growth if fuel prices rise too much as our model predicts.

The results confirm these hypotheses both from analyzing jointly all countries of all the World Bank Regions (*cross-sectional analysis*); but also the countries individually for each of the World Bank Regions (*panel analysis*).

Taxing fuels, or reducing fuel subsidies, will lead to higher rates of GDP per capita growth, especially for countries with high initial fuel subsidies, such as for most of the countries in the MENA region. Thus, countries that subsidize or under-tax diesel and gasoline are the most likely candidates to reap economic gains by subsidizing these fuels less and/or taxing them more; and thus gain the most by growing at higher rates. On the other hand, countries which at the outset have relatively high taxes on their fuels, such as most of the ECA and OECD countries, have somewhat less to gain from further fuel price increases; growth rates might here in fact decrease.

The channels by which reduced energy subsidies, or the imposition of energy taxes, may increase economic growth are also analyzed. It is found, in particular, that reduced fuel subsidies at a given current period in the MENA region increase not only to contemporaneous but also future expenditures on health, education, and public infrastructure investments.

Note however that in the case of the MENA countries, subsidy savings might not sustain higher health, education and infrastructure expenditures for long periods into the future. The governments in MENA countries might need to make more long-lasting reductions in fuel subsidies to finance permanently and stable health expenditures. In contrast, governments in the ECA countries seem to consistently smooth their use of their high fuel taxes to sustain public goods expenditures over time.

As a consequence of these large responses of public goods expenditures to subsidy savings, the governments in MENA will not obviously experience much improvement in their government budget deficits immediately following a fuel price reform. Such improvements appear to be achieved, according to our empirical results, only with a two-year lag.

Our final important empirical result is a significant positive effect of subsidy savings on employment and labor force participation in the MENA countries. Such effects are particularly strong when diesel subsidies are phased out. We found that raising diesel taxes might reduce labor participation in the very short run (as subsidies are removed), including the youth population aged 15 to 24 in the MENA countries. But as the economy adjusts and reallocates resources in response to the new energy prices, and with the help of better infrastructure and better supply of public services (which is what we find and presented below), labor market participation and employment increase substantially in subsequent years.

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