Welfare Implication of Energy Subsidies Reform

with Focus on Iran`s Practice in 2010

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Agenda

1. Background
2. Empirical Evidences: Iran's Practice
3. Our Model & Its Implications
4. Conclusion & Policy Impacts

Background: Policy Instruments

Three different methods to deal with the environmental market externality (Baumol, 1988):

1. **Quantity limitation**: emission caps, fuel rationing

2. **Price adjustment**: carbon tax, subsidies reform

3. **Mixed options:** Cap and Trade

The net benefit of price instruments reaches up to five times of quantity instruments (Aldy and Pizer, 2008).

Background: Definitions

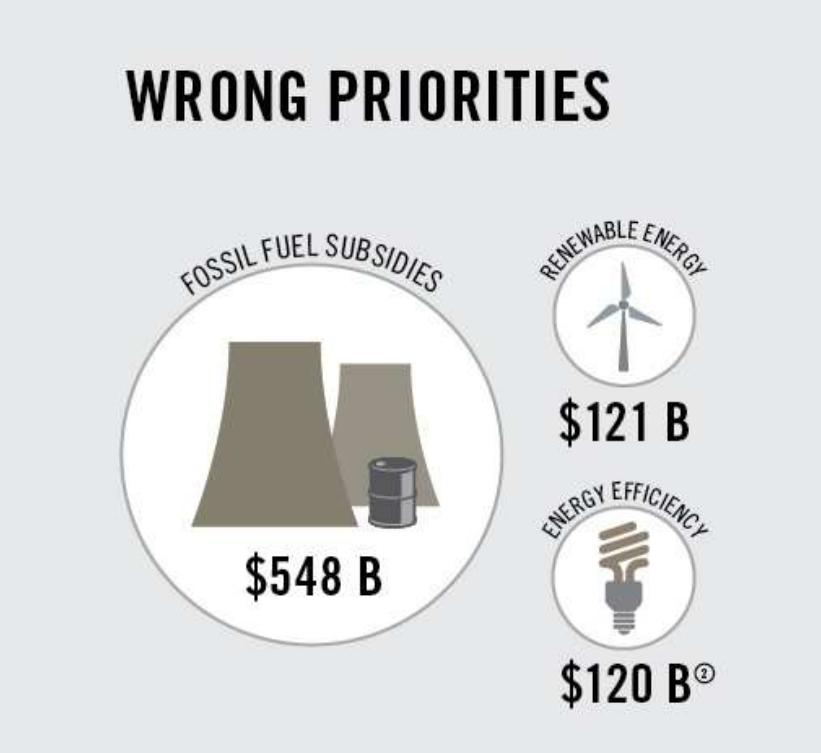
- IEA/OECD/OPEC/World Bank, 2010: “any government action … lowers the cost of energy production, raises the price received by energy producers or lowers the price paid by energy consumers”

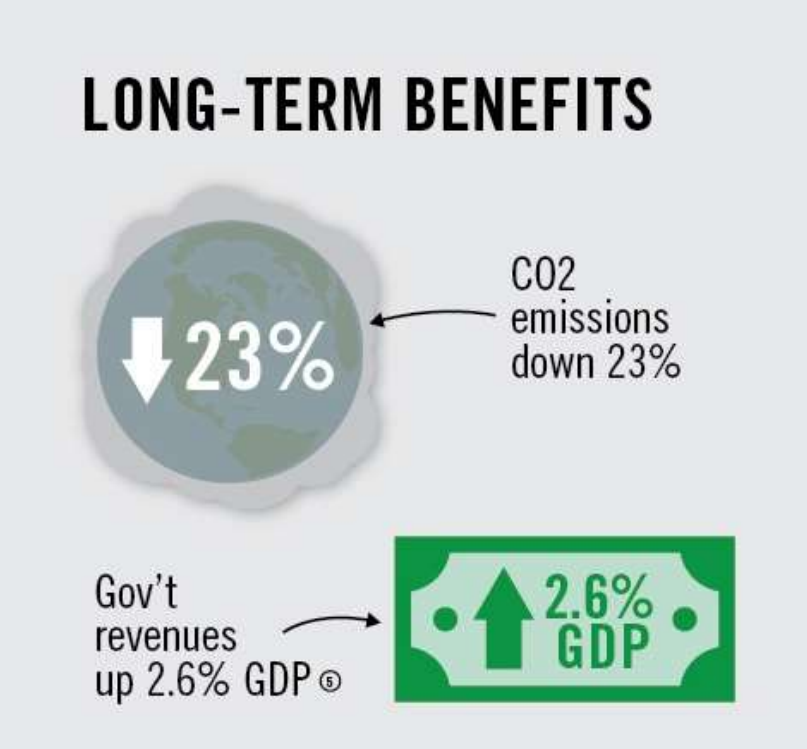
- **Direct** : cash payment, transferring credit, etc.
- **Indirect** : tax exemptions, limit on market access or trade restrictions for competitors, etc.

Background: Momentum

- One of the most agreed axis of world debate on climate change:
  - In 2009, G-20 & APEC leaders committed to reduce fossil-fuel subsidies.
  - According to the 2014 *World Energy Outlook* (IEA, 2014), at least 27 countries among the 40 fossil-fuel-subsidized economies have implemented partial reforms.
- more toward **supply** in OECD countries vs. **demand** in non-OECD

Background: Scale and Scope





IISD, 2015

Background: Scale and Scope

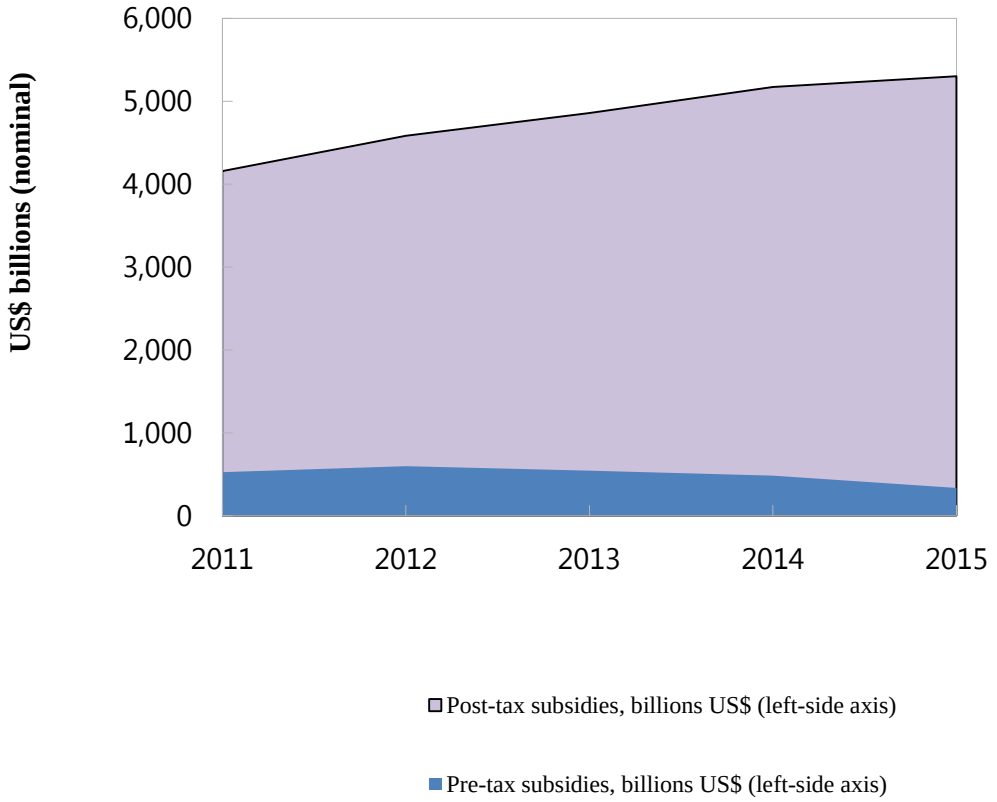
Price Gap = Reference Price - Local Subsidized Price

- Still an open research question! (ex. Canadian debate: McKenzie & Mintz, 2011)
- International energy carriers as oil vs. local ones like electricity
- Pre-tax or Post-tax: IMF estimates the global energy subsidies about 10 times more with second approach!

Background: Scale and Scope

Pre-Tax vs. **Post-Tax**

Figure 1- Global trend of pre-tax and post-tax subsidies since 2011. Reprinted from www.imf.org, by Y. Lue & A. Asamoah. (2016), retrieved from http://www.imf.org/external/np/fad/subsidies/.



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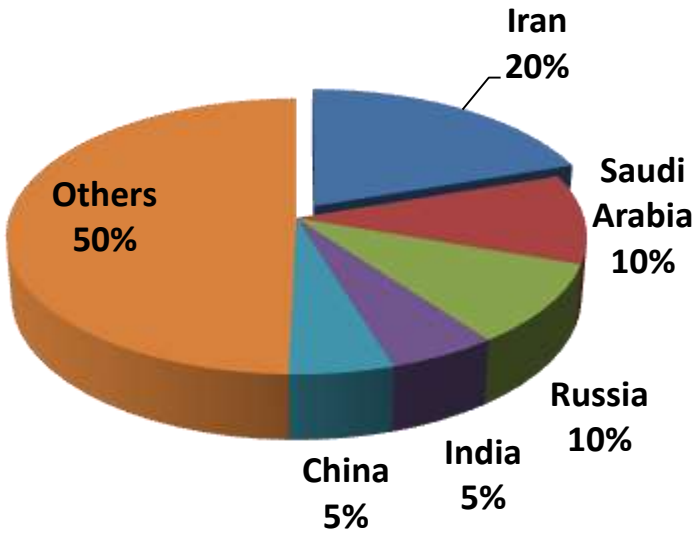
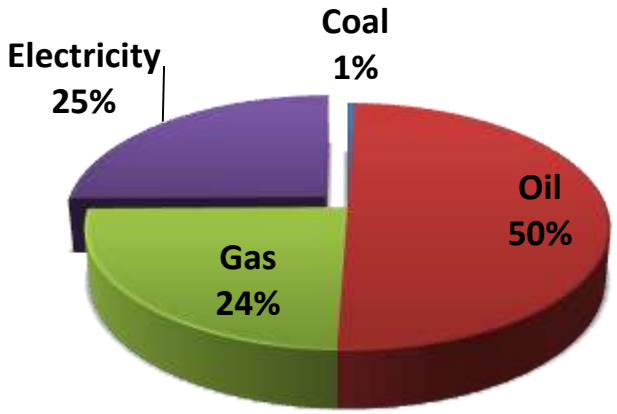




Source: World Energy Outlook 2011, IEA

Background:

Affected countries

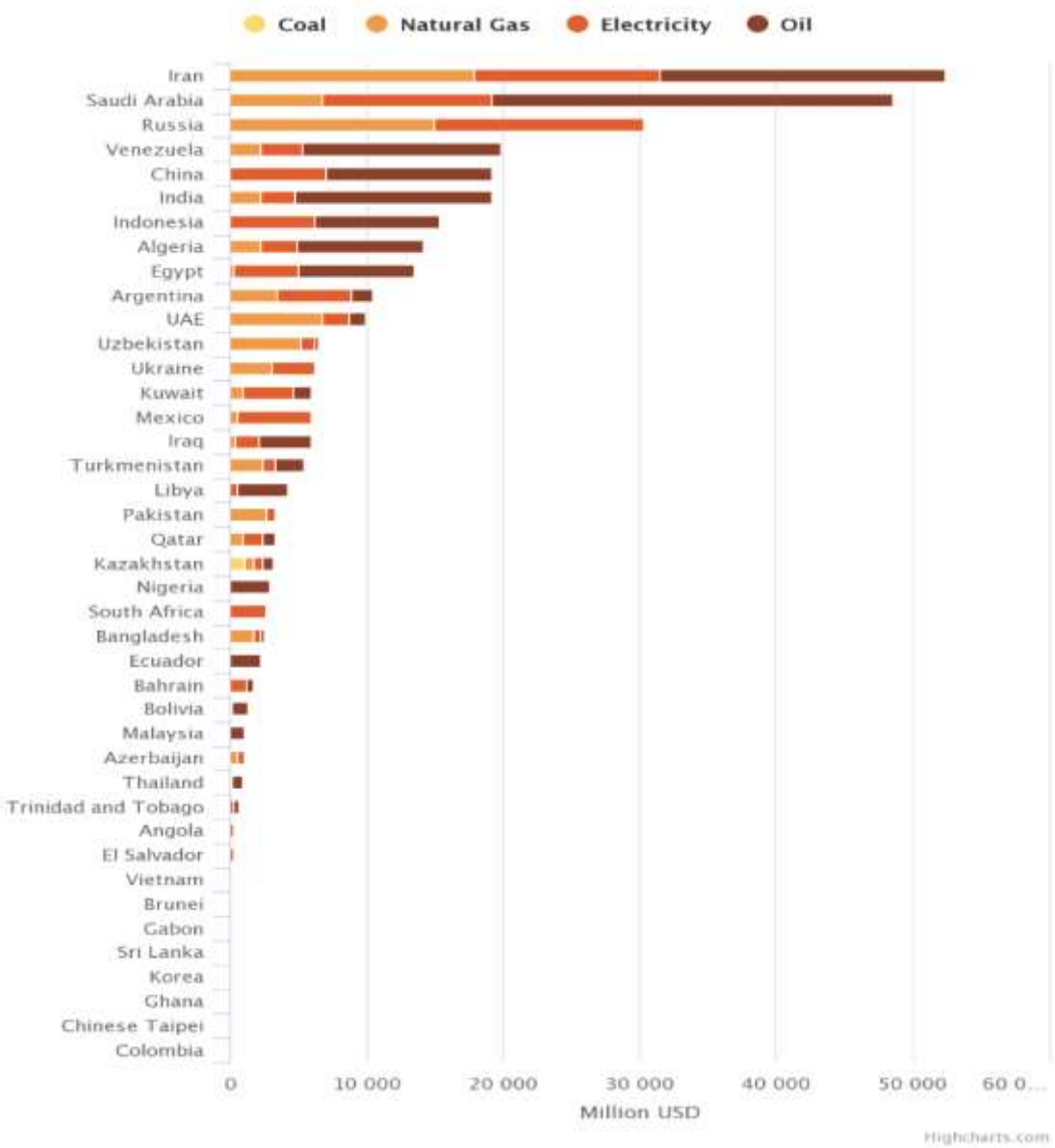


Figure 2 - Iran's top ranking in most energy subsidizing countries after 5 years of reform, 2015. Reprinted from World Energy Outlook, IEA (2016), retrieved from http://www.worldenergyoutlook.org/resources/energysubsidies/.

Background: Need for Reform

- **Environmental**: higher energy consumption increasing GHG emissions and celebrating local pollution (Baumol and Wolf, 1981; Dernbach and Koplow, 2001)

- **Economic:** wasteful and inefficient resource allocation lowering growth rate, export, R&D in Green technologies etc. (Von Moltke et al. 2004)

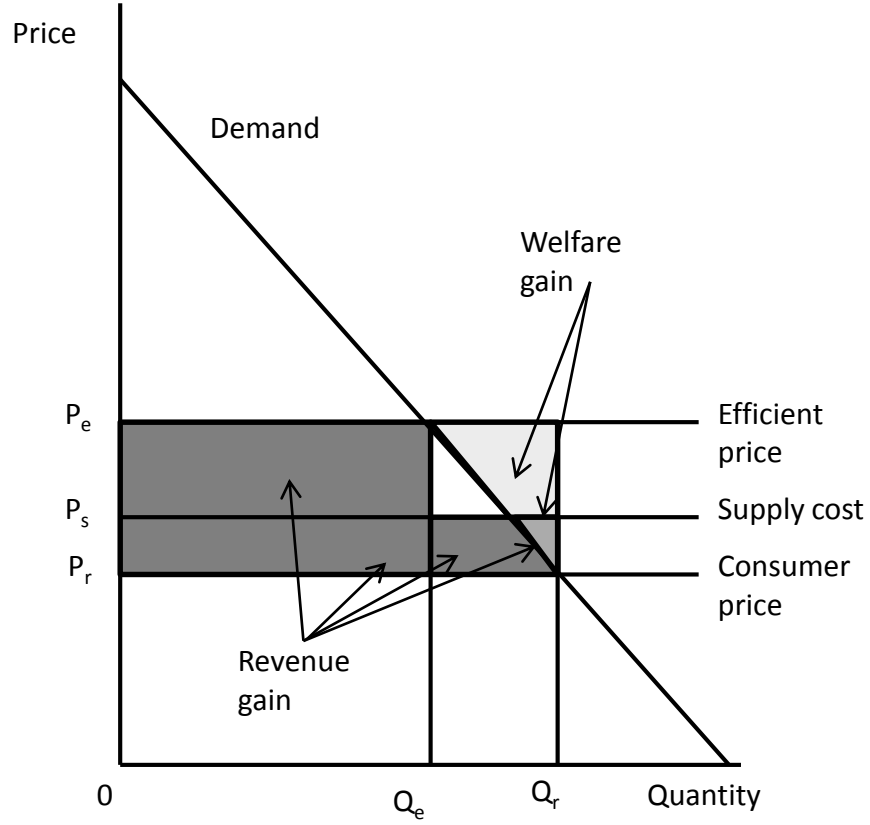
- **Social**: Controversially more beneficial to rich (Coedy et al. 2006); opportunity cost of energy subsidies as a part of national budget could be spent for healthcare and education

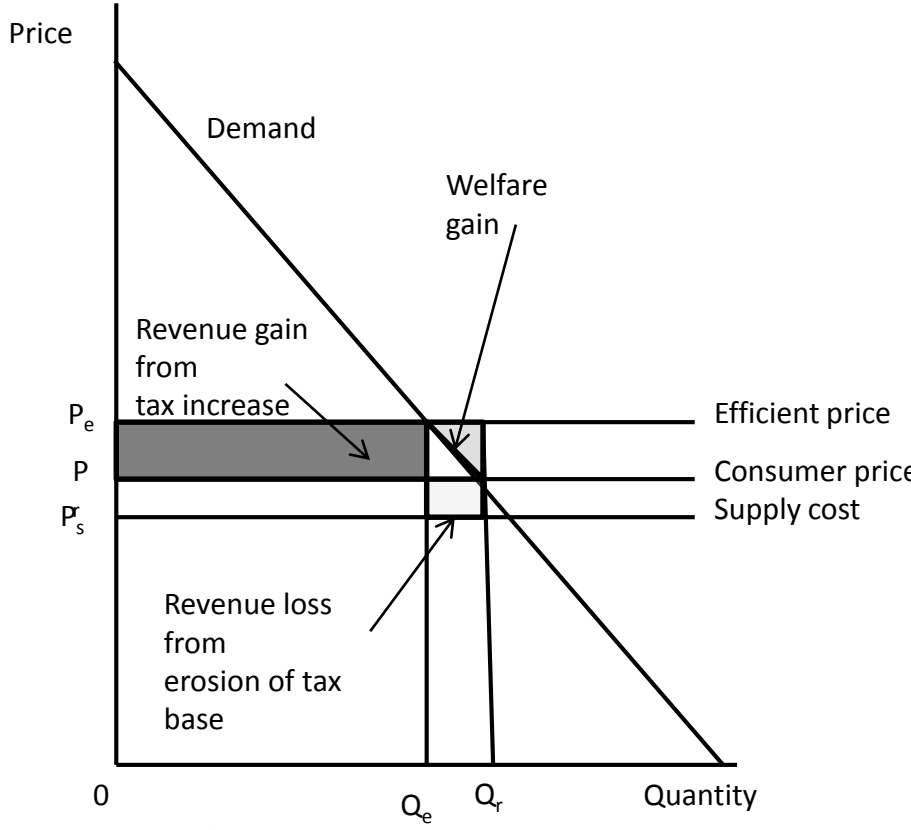
Background: Need for Reform

- **Political**: composition of a formal or informal interest group (Victor 2009); Rent seeking, decisions violating sustainable development, resistance against environmental movements and even buying votes with subsidies

- **Cultural:** overconsumption, corruption and smuggling along the distribution chain; misuse and bad habits

Background: Theoretical Gain of reform





Background: Risks of Reform

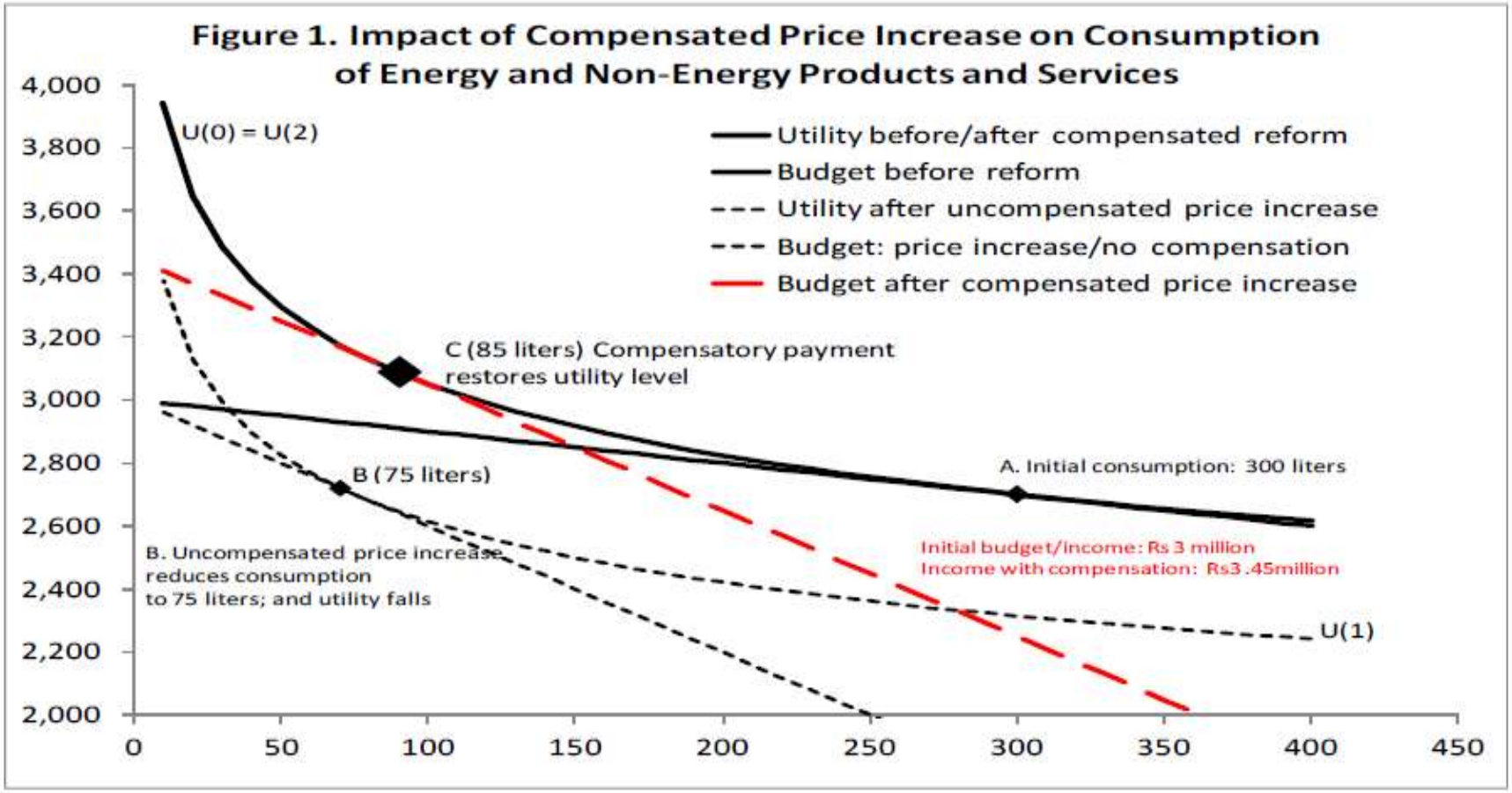
Economic:

- Focus only on energy prices (Birol et al., 1995)
- Estimation of the extra energy cost of producing other goods (Jenson & Tarr, 2002)
- Expectation of an extra inflation (Saboohi, 2001)

Socio-political:

- Selling the reform by direct deposit (Jenson & Tarr, 2002; Pineau, 2008; 2010) **or**
- Investment in healthcare, education and green technologies (Laan and Beaton, 2010).

Background: Compensated reform



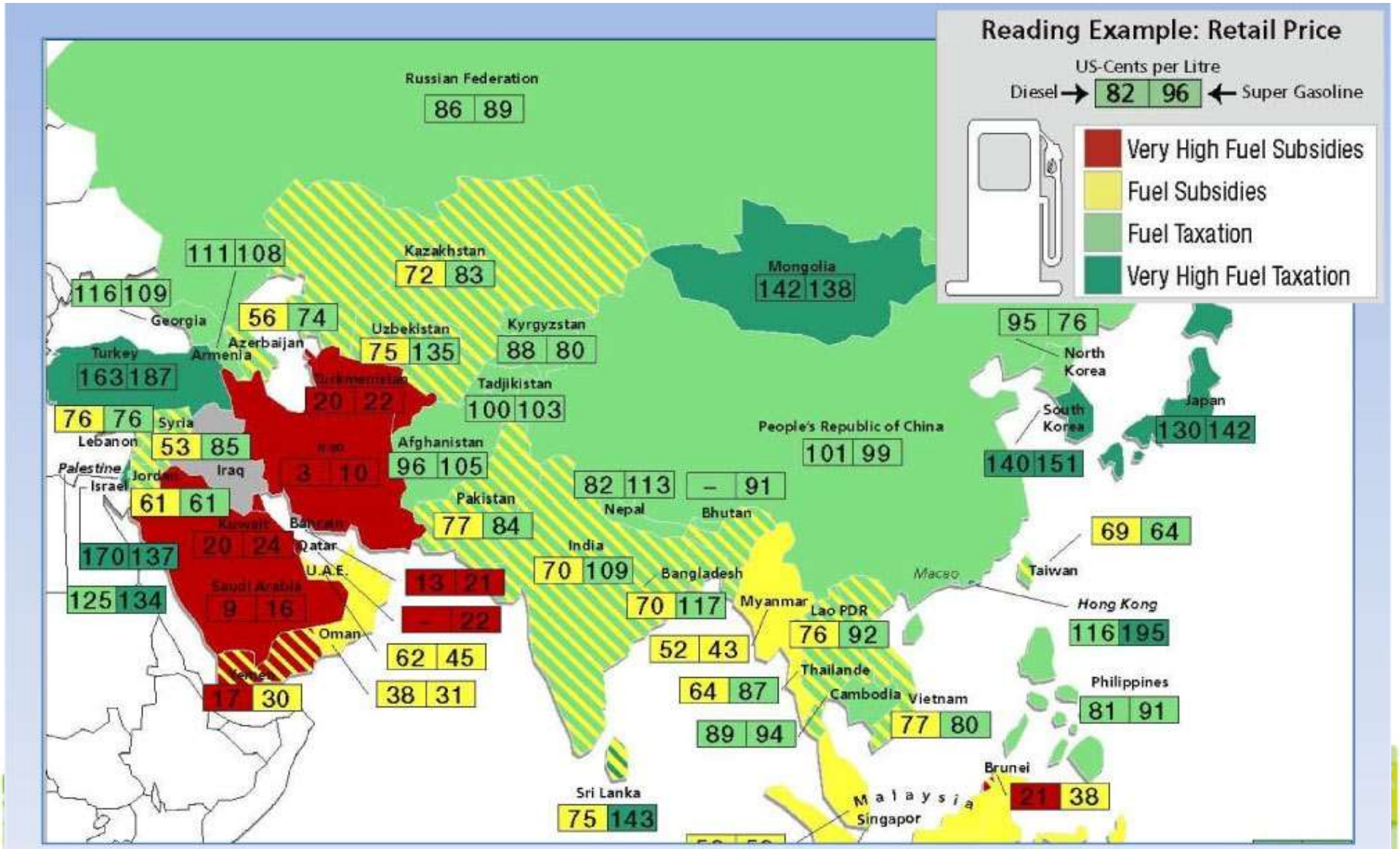
Guillame et al, IMF paper, 2011

2. Empirical Evidences in Iran's Practice

Iran's reform: Oil dominant economy

- Oil export and its derivatives: up to 80% of the export
- About 75 Million population consumed 82 Billion USD fossil fuel subsidies in 2010
- 3 times higher energy intensity than global average

Iran’s energy prices vs. neighbors



Iran's reform: **Chronic**

Several failed attempts to reform since more than two decades

Fuel rationing plan as a successful initial reform in 2007

- Two-tariff pricing providing a minimum access to cheep gasoline for everybody

Reform plan legitimated in 2009 accompanied by serious debates of government and parliament:

- One-shot price adjustment or gradually?
- How to redistribute the reform revenue?

Iran's reform: **Approved Plan**

- Gradual price adjustment in 5 years
- Maximum 20% of subsidies removal in 1st year of reform
- Allocation of reform revenues to: Households (50%), Industry (30%), Government (20%)
- Definition of price gap for each energy carrier based on:
  - Marketable fuel (ex. gasoline): FOB Persian golf
  - Non-marketable carriers (ex. electricity): average total cost

Iran's reform: **Initial Price Adjustments**

Commodity	Price before reform	Price after reform
Gasoline	10 cents/liter, 40 cents/liter (beyond the quota of 60 liters/month)	40 cents/liter; 70 cents/liter (beyond the quota of 60 liters/month)
Diesel	1.5 cents/liter	15 cents/liter, 35 cents/liter on the free market
Natural Gas (NG)	1-1.3 cents/m3 for households and 0.5 cents/m3 for power plants	On average 7 cents/m3 for households and industry and 8 cents/m3 for power plants
LPG	Free (only a small fee for testing the cylinders)	10 cents/liter
CNG	4 cents/m3	30 cents/m3
Fuel oil	1 cent/liter	20 cents/liter
Kerosene	1.5 cents/liter	10 cents/liter
Electricity	On average 1.7 cents/kWh for households	On average 4.5 cents/kWh for households and 4 cents/kWh for industry

Iran's reform: **Launched in December 2010**

Monthly direct deposit of 455,000 IRR ($45 dated value) per capita worth up to 50% revenue of some low income families, equal for all applicants

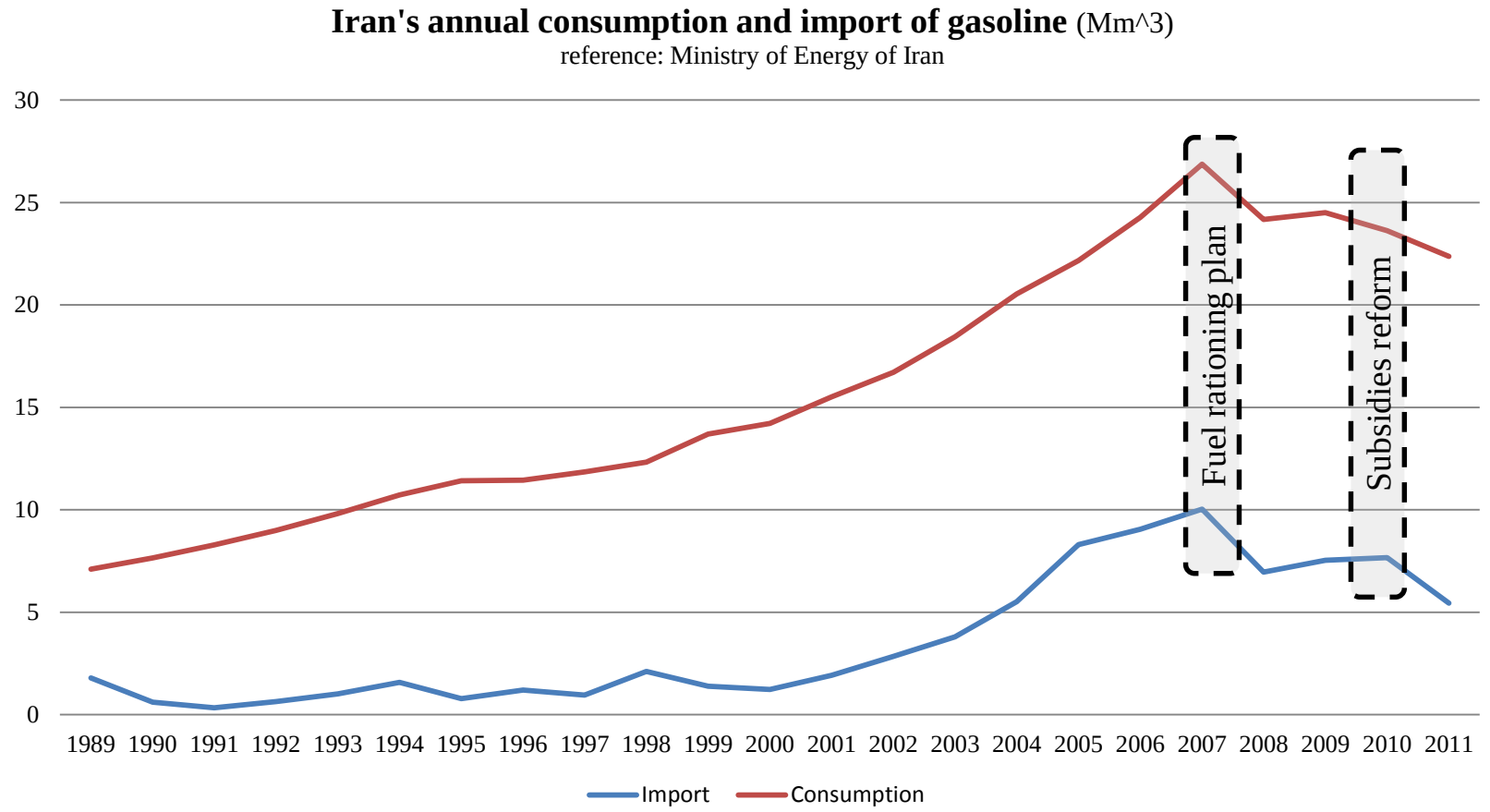
Dramatic price hike with no pre-announcement

Reform started much more peaceful than the most optimistic predictions as no specific unrest was reported

Energy consumption Restrained: 8% electricity consumption drop during the first 9 months reversing the 6% annual growth

Welfare distribution improvement reflected on Gini index

Iran's reform: **Short-term Result**



Challenges

Reform was officially suspended in 2012

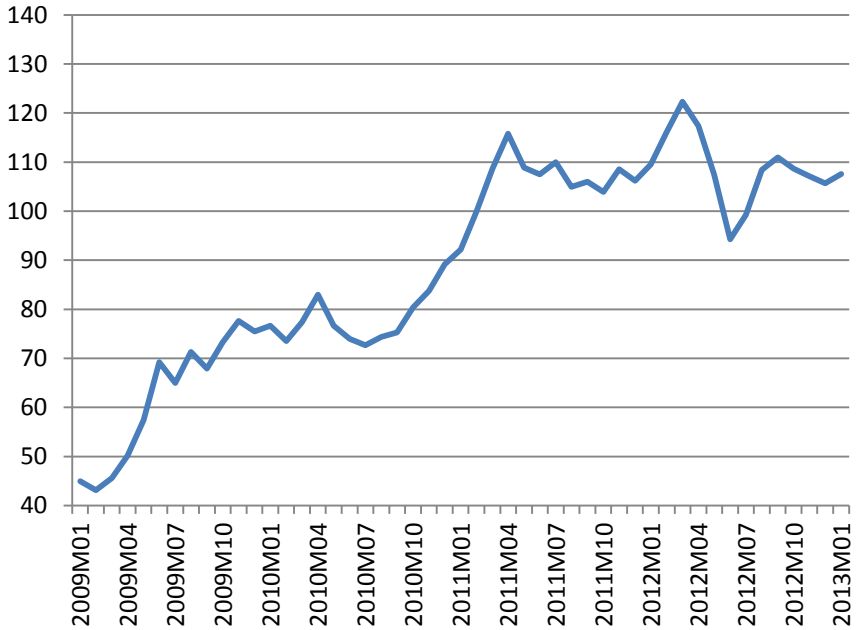
- **Political**: sanctions due to the Iran`s nuclear case
- **Economic**: Compensatory payments exceeded the reform revenue (up to 110% of total budget allocated only to households)

1. **Costly departure:** government politically bounded to initial exaggerated payment
2. **Increased number of beneficiaries:** 10% increase in applicants since the 1st payment and failure to recognize needy entities

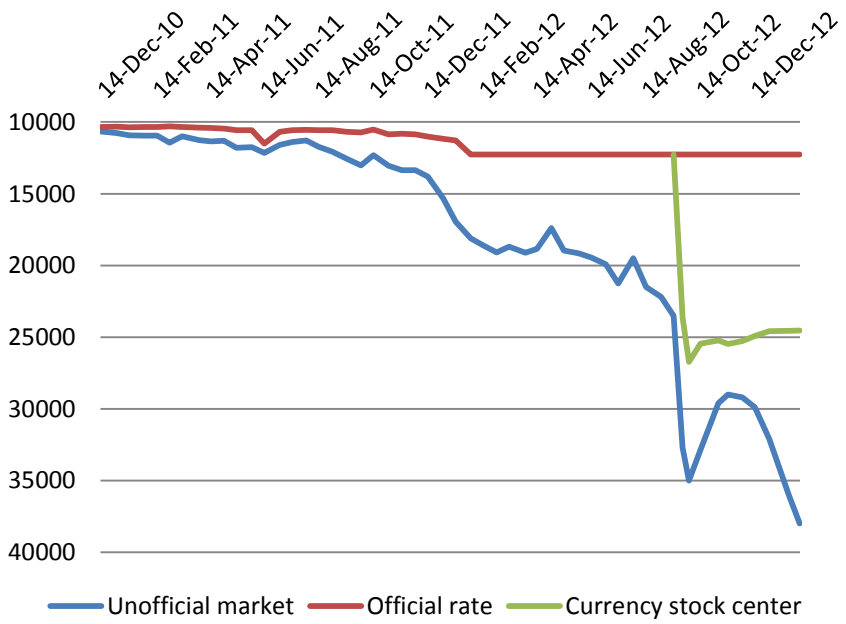
Challenges: **Set back**

Reference Price ↑ = Market Price ↑ * Exchange Rate ↑

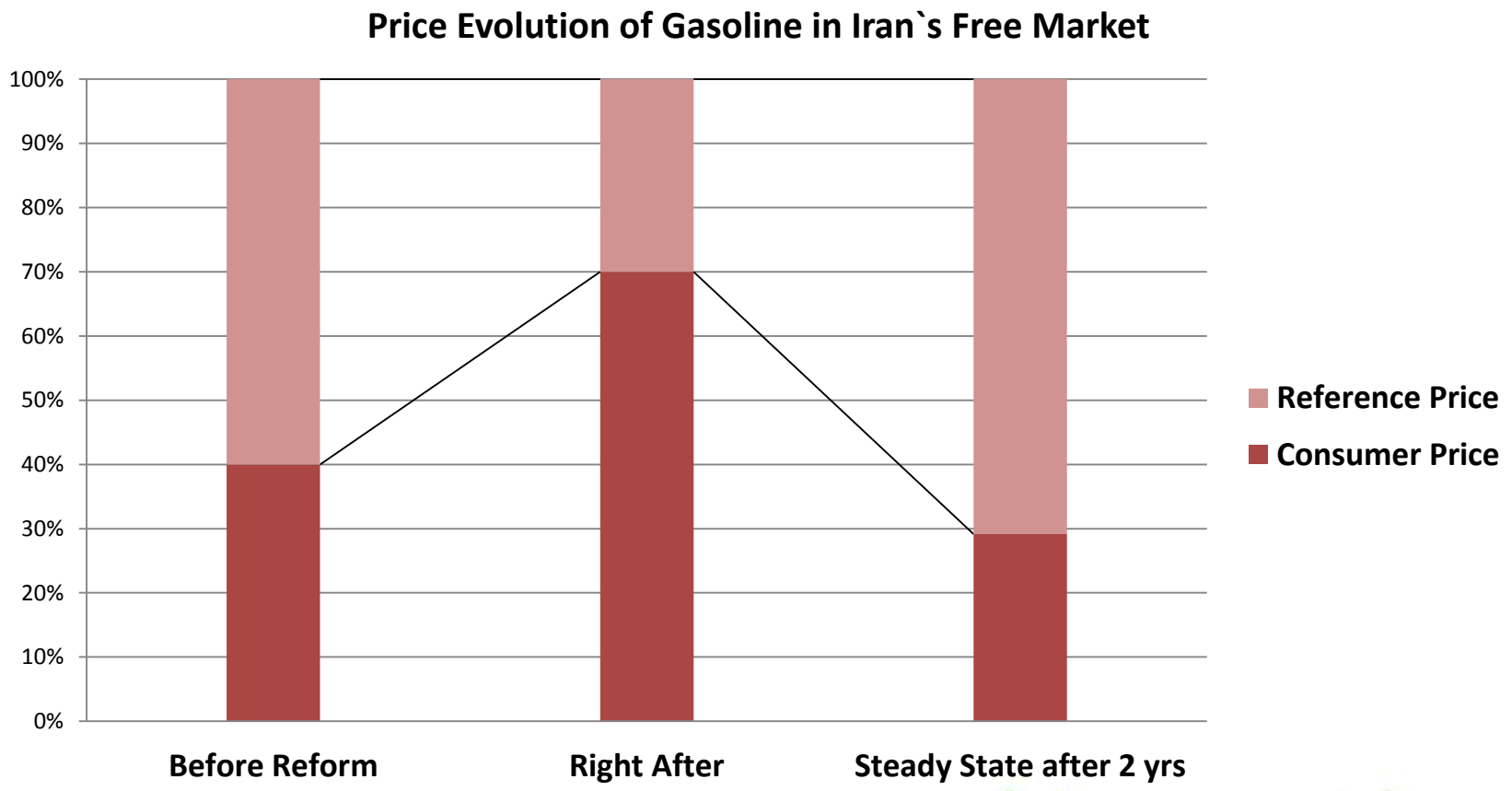
FOB price of Dubai crude oil - US $ per barrel (IMF, 2009-2013)



IRR/USD **Exchange rate** in three parallel markets after reform



Challenges: **Set back**



3. The Model

Reform characteristics

Reference-price:

- Marginal cost for non-tradables ex. electricity and natural gas
- International market price for tradable energy carriers such as oil and coal × exchange rate of local currency

Subsidization-rate: ratio of domestic subsidized price vs. ref. price

Reform-policy: scale of price modifications, one shot or gradual

Compensation-mechanism: how government would save the utility of consumers

Three different scenarios of reform in our model based on the literature:

Scenario	Assumption in the Literature	Implication in our model
1	no extra cost of OG	m = price of OG after reform/price of OG before reform= 1
2	increased energy cost of producing OG	λ = non-energy cost of OG after reform / non-energy cost of OG before reform= 1
3	indirect side effect of reform on production cost	λ > 1

Players in Our Model

Consumer

Max. $U(E,G) = E^{\alpha} G^{1-\alpha}$
st. $Ep + Gg \leq r$

Supplier of other goods (OG)

price of other goods: $g = c_0 + p\mu$

Reformist government

Maximizes welfare of reform as
$W = (p_1 - \overline{p})(E_1 + \mu G_1) - (p_0 - \overline{p})(E_0 + \mu G_0) - (r_1 - r_0)$

Optimization Problem

Definition

$r_1 = s.r_0$, $p_1 = k.p_0$, $g_1 = m.g_0$, $\overline{p} = \gamma.p_0$

- To satisfy the consumer's utility constraint: $U_1 = U_0$

$$\Rightarrow s = k^{\alpha} m^{1-\alpha}.$$

- One variable opt. problem: Max.$_{k \in (1,\gamma)}$

$$W = r_0 \left(\alpha \left(-1 + \gamma + \left(\frac{k}{m} \right)^{\alpha - 1} (k - \gamma) \right) \right)$$
$$+ \frac{\mu p_0 (\alpha - 1)}{g_0} \left(1 - \gamma + \left(\frac{k}{m} \right)^{\alpha} (-k + \gamma) \right) - (k^{\alpha} m^{1-\alpha} - 1)$$

Scenario 2: Increasing only the direct energy cost of producing OG

$$g_1 = c_0 + p_1\mu = g_0 + \mu p_0 (k-1)$$

$$m = \frac{g_1}{g_0} = 1 + \mu p_0 \frac{k-1}{g_0} = (k\theta - \theta + 1)$$

Where $\theta \equiv \mu \frac{p_0}{g_0} < 1$

$$\Rightarrow w'(k) = \left(\frac{k}{m}\right)^{\alpha} \alpha(1-\alpha)\left(\frac{\gamma - k}{m}\right)\left(\frac{m}{k} - \theta\right)^2$$

Theorem

The optimal reform in 2nd (as 1st) scenario is $k = \gamma$ and any $k > 1$ is welfare increasing since $w(1) = 0$ and $w'(k) > 0$ for $k \in (1, \gamma)$

Scenario 3: Expecting inflation of non-energy cost of producing OG

$$g_1 = c_1 + p_1\mu = \lambda c_0 + kp_0\mu = \lambda g_0 + \mu p_0 (k - \lambda)$$
$$\lambda = k\delta - \delta + 1$$
$$m = k\theta + (\delta - k\delta - 1)(\theta - 1)$$

$$\Rightarrow w'(k) = (Ak^3 + Bk^2 + Ck + D) \cdot f(k^\alpha)$$

Theorem

If $\delta < \frac{\alpha(1-\theta)(\gamma-1)}{\alpha(1-\theta)(\gamma-1)+1}$, *then there exist reform ratios such that the reform is profitable, else no feasible reform policy!*

Scenario 3: Cont'd

If one production factor of OG is supplied by an oligopolistic industry of ***n*** firms, its price is given by

$$p_{G1} = \frac{p_{G0}\left(n(1-\theta)-1\right) + np_E\mu}{n-1}$$

where c is the average unit production cost of the factor.

and the dilatation coefficient by

$$\delta = \frac{1}{n-1}\frac{\theta}{(1-\theta)}.$$

Scenario 3: Cont'd

Theorem

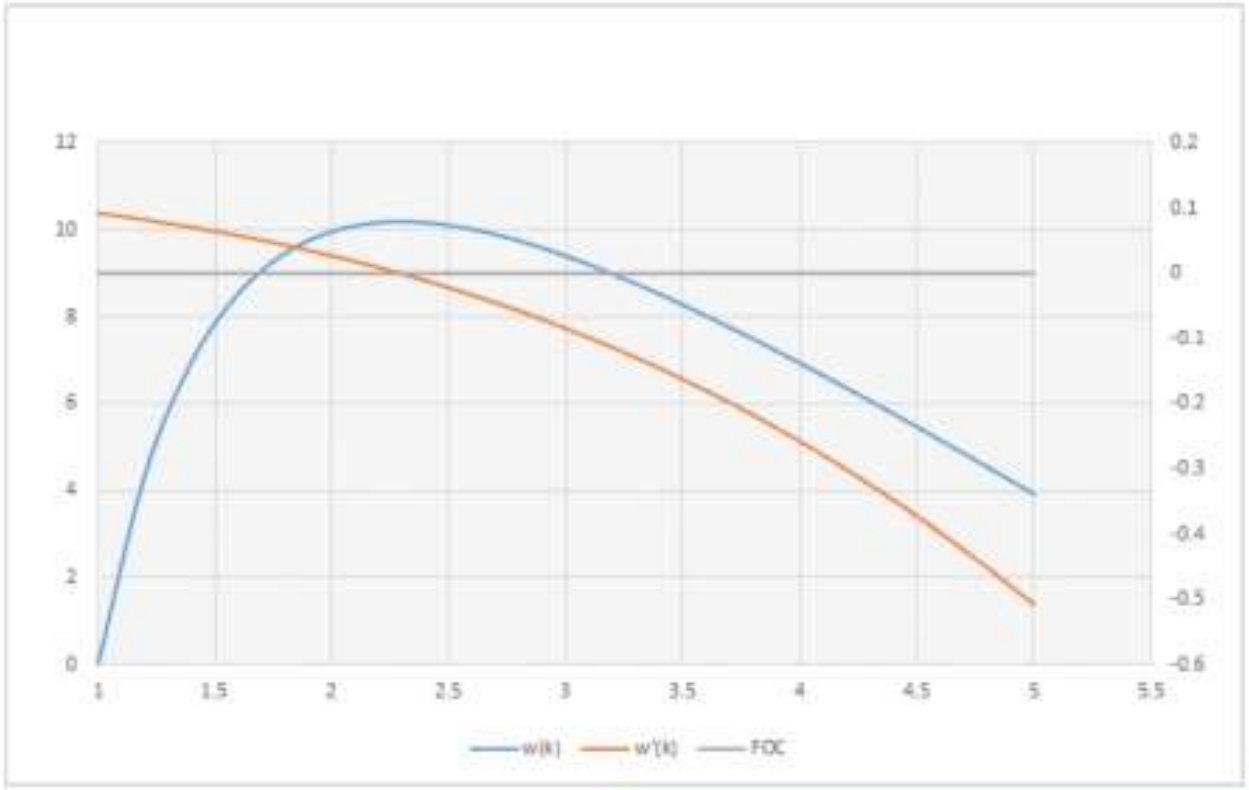
In 3rd scenario, a full reform is not optimal. The optimal reform is obtained by solving FOC as the following cubic equation for k:

$$-k^3\delta(\delta+\theta V)-k^2\delta VT(\alpha+1)+Tk\alpha V(-V+\gamma\delta)+T\alpha\gamma V^2=0$$

where $T=1-\theta$ and $V=1-\delta$.

Scenario 3: Cont'd

$k \simeq 2.3$ for $\delta = 0.01$ if $\alpha = 0.0345$, $\theta = 0.25$ and $\gamma = 5$

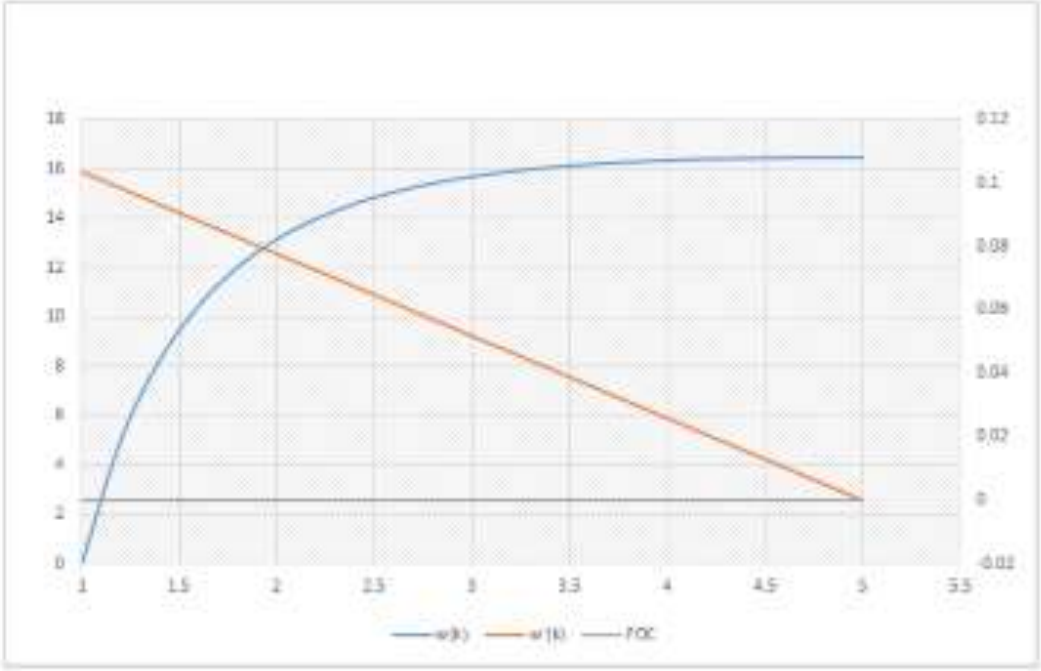


Empirical Analysis: Case of Iran

Official statements:

$\gamma = 5, \alpha = 3.45\%, \theta = 25\%, \delta = 0$

$\Rightarrow W \simeq \$13.12$ billion for $k = 2$



Empirical Analysis: Case of Iran

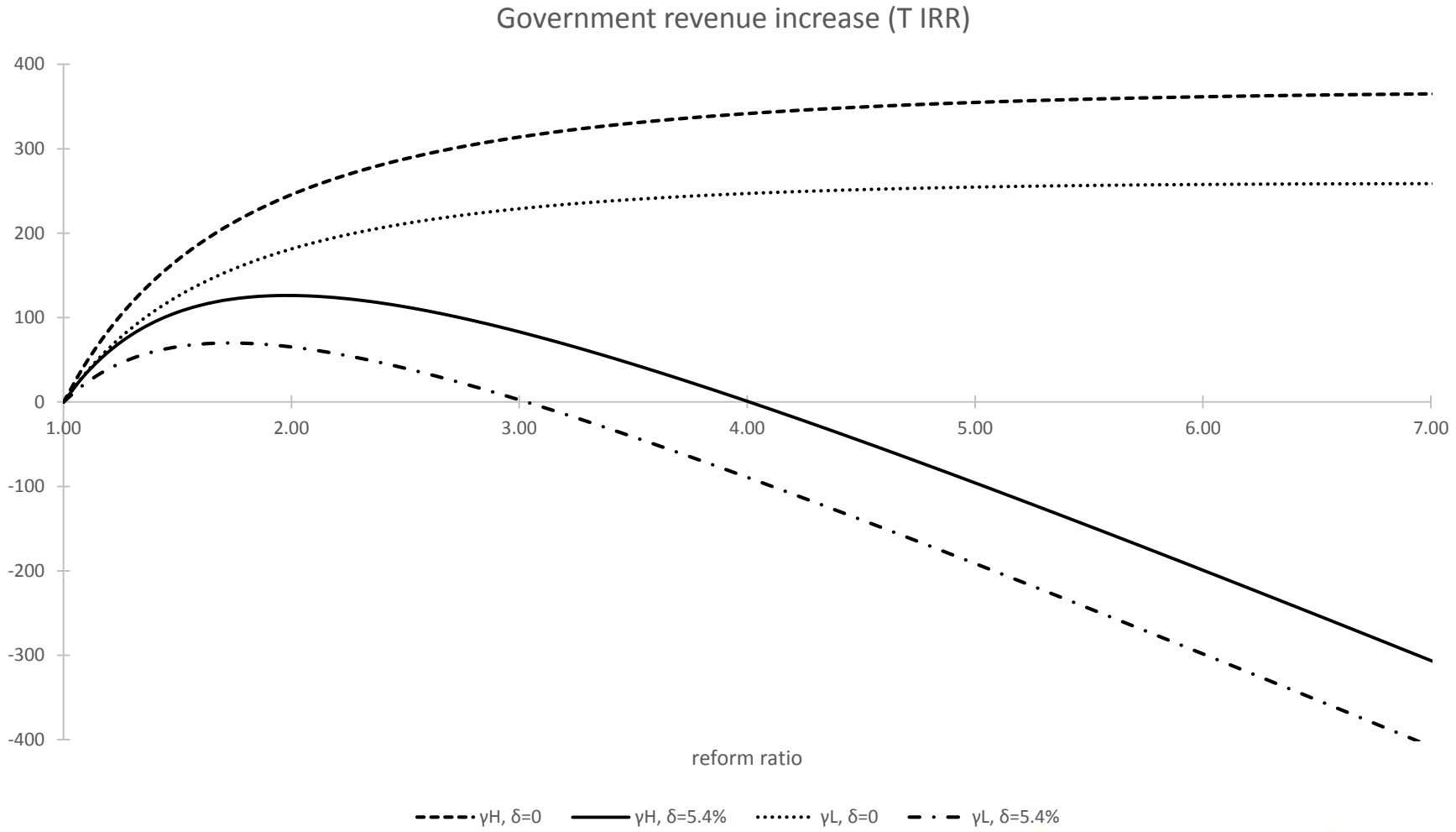
Critics:

$\gamma = 5, \alpha = 3.45\%, \theta = 25\%, \delta = 12.58\%$

$\Rightarrow W \simeq -\$26.84$ billion for $k = 2$

Estimated deficit is about the 150% of reported data from the case.

Empirical Analysis: Case of Iran



Empirical Analysis: Other affected countries

Threshold **value of δ** for selected countries, assuming α=0.05 & θ =0.1

Country	Threshold δ
Algeria	13.42%
Argentina	1.86%
China	0.12%
India	1.11%
Indonesia	2.01%
Nigeria	1.79%
Russia	1.15%
Saudi Arabia	13.29%
Venezuela	36.36%

Conclusion

- **If we incorporate only the extra energy cost of OG:** it is optimal and feasible to remove the price gap in one shot
- **In a more realistic context where the suppliers of OG decides on their new price knowing the reform ratio:** there is an upper threshold for non-energy inflation factor to have a feasible reform, depending on:
  - share of energy in the expenditure of consumers (α)
  - energy intensity of suppliers (θ)
  - initial subsidization rate (γ) .

Potential extensions

- To unfold the exogenous parameter of supply side by adding storage and/or production capacity
- To incorporate uncertainty in the reference price, ex. international oil price and local exchange rate
- To add the targeting compensation mechanism with associated errors
- To study the politically-robust solution and compare it with the optimal policy

Thanks for your attention