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Macroeconomic and Economic Integration
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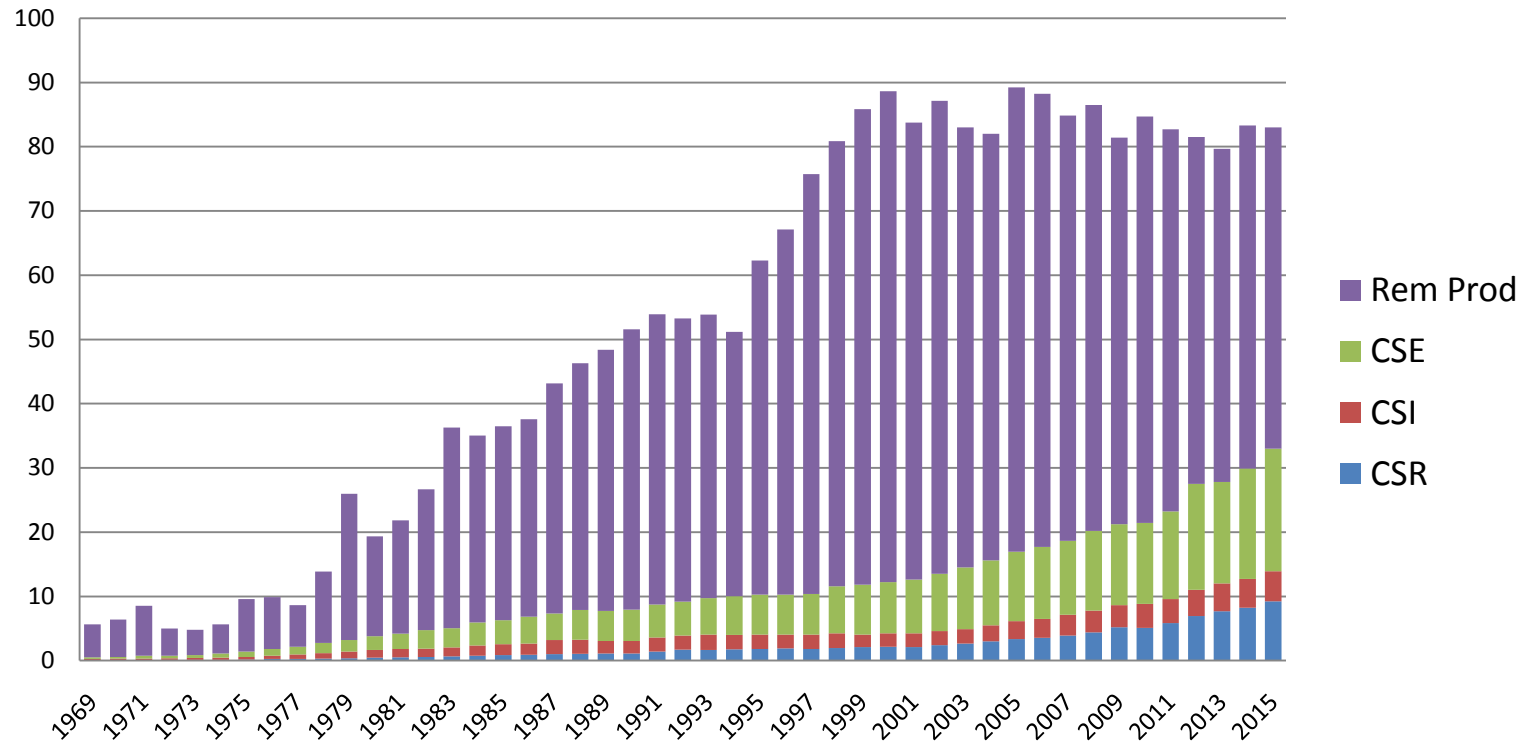
Natural Gas consumption-GDP nexus in Algeria:
Evidence from a Structural Time Series Analysis

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Natural Gas Consumption: *an Introductive Analysis*

Marketed Production Components (bcm). ONS



- The weakness of the production outlook contrasts with the strength of domestic demand.

- In the last decade, gas consumption has grown at 5.2%, while gas production appears to have stagnated at best.
- The domestic market has indeed become the major and sole growing component of the national gas balance.
- The structure of gas consumption has been evolving rapidly.
- The public distribution sector (household, public administration and commercial activities) took the lead in driving demand.
- The share of power sector has declined from 62% to 42%, but remains the dominant sector in the domestic gas market.

(Based on Ali Aissaoui, 2016. Algerian Gas: Troubling Trends, Troubled Policies. Oxford Institute for Energy Studies. Paper NG 108)

- The challenge for Algerian authorities become more intense:
 - ✓ With declining (stagnating at best) domestic production, exports have been contracting more rapidly than domestic consumption has been expanding.
 - ✓ At a level of 80 bcm in the futur, the domestic production could, probably, not be able to satisfy this demand.

Our purpose is to estimate and produce projections of domestic gas consumption, regarding that energy consumption is considered as an indicator of socio-economic development along with its role in production function, and to get an outlook for a future natural gas policy.

Literature review

• *CREG's Projections*

	Actual 2014 (bcm)	CREG base year estimate for 2014 (bcm)	CREG projected annual demand from 2014 estimate (bcm)			Corresponding annual average growth by period (%)		
			2017	2020	2023	2014-2017	2017-2020	2020-2023
Power Generation	15.7	14.5	15.9	18.3	21.4	3.1	4.8	5.4
Sonatrach's transformative industry	7.9	7.3	10.2	12.9	13.1	11.8	8.1	0.5
Other industries	3.5	3.2	4.2	5.3	5.9	9.5	8.1	3.6
Utilities' public distribution	10.4	9.6	11.5	13.1	14.2	6.2	4.4	2.7
Total demand	37.5	34.6	41.8	49.6	54.6	6.5	5.9	3.3

Source: CREG 2015 (Power generation demand in 2017 and corresponding growth rates corrected from source)

- Rébha Ghedamsi et al (2016): based on bottom-up approach to forecast energy consumption. They conclude that Residential sector final energy in Algeria will grow to over double in 2040.

Empirical Review

- According to the theories, energy demand is based on economic activity and energy prices.
- Numerous studies have focused on the causality between energy consumption and economic growth, but the results remain inconclusive.
- Hunt et al(2003a, 2003b), Hunt and Ninomiya (2003), Dimitropoulos et al (2005), Dilaver and Hunt (2011) provide a number of reasons. They argue that the previous empirical studies based on only observable factors (such GDP) and ignore the unobservable factors.

- Energy consumption depends on energy efficiency, technological progress, consumer preference and economic structure.
- Hunt et al (2003b) argue that it is unrealistic to capture the impact of unobservable factors through a simple deterministic trend
- Hunt et al (2003a), Hunt and Ninomiya (2003), Dimitropoulos et al (2005), Dilaver and Hunt (2011) argue that the Structural Time series model (STSM) approach developed by Harvey (1989, 1997) is the appropriate methodology to capture the effect of unobservable factors.

- Harvey et al. [2005] argue that the structural time series model consists of a stochastic trend component and an irregular term. This approach consists of subdividing the dependent variable into explanatory variables and including recurrent and irregular components. Harvey and Shephard [1993], Durbin and Koopman [2001], Harvey and Proietti [2005], and Dilaver and Hunt [2011] reported that the STSM allows for the estimation of a nonlinear UEDT that can be negative, positive or zero over the estimation period.

Table: Trend Specifications

	Fixed Level	Stochastic Level
No Slope	i. Conventional regression model with fixed level no time trend	iv. Local Level
Fixed Slope	ii. Conventional regression model with a deterministic trend	v. Local Level with a Drift Model
Stochastic Slope	iii. Smooth Trend Model	vi. Local Trend Model

Source: Hunt et al, (2003a).

Methodology

It is assumed that Algeria's natural gas demand is identified by:

$$G_t = f(GDP_t, P_t, UEDT_t) \dots \dots \dots (1)$$

With

G_t	Natural gas consumption
GDP_t	Real Gross Domestic Product
P_t	Real natural gas price
$UEDT_t$	Underlying Energy Demand Trend

For the econometric estimation of Eq. (1) the dynamic autoregressive distributed lag specification is utilized as follows:

$$A(L)g_t = B(L)gdp_t + C(L)p_t + UEDT_t + \varepsilon_t \dots \dots \dots (2)$$

With

$$g_t = \ln(G_t) \quad gdp_t = \ln(GDP_t) \quad p_t = \ln(P_t)$$

where

A(L) is the polynomial lag operator $1 - \lambda_1 L - \lambda_2 L^2 - \lambda_3 L^3 - \lambda_4 L^4$;

B(L) is the polynomial lag operator $1 + \phi_1 L + \phi_2 L^2 + \phi_3 L^3 + \phi_4 L^4$;

C(L) is the polynomial lag operator $1 + \alpha_1 L + \alpha_2 L^2 + \alpha_3 L^3 + \alpha_4 L^4$

The UEDT is stochastic and can be estimated by the STSM, consisting of level and slope components with the following formulation:

$$\mu_t = \mu_{t-1} + \beta_{t-1} + \eta_t; \quad \eta_t \sim NID(0, \sigma_\eta^2) \dots \dots \dots (3)$$

$$\beta_t = \beta_{t-1} + \xi_t; \quad \xi_t \sim NID(0, \sigma_\xi^2) \dots \dots \dots (4)$$

Where;

μ = Level of the UEDT

β = Slope of the UEDT

Data

Natural gas prices are fully regulated in the case of Algeria, and are removed from the equation(1), while their effect will be included in the estimate of the UEDT

We used annual data from 1969 to 2015 for the empirical analysis. All the Data are obtained from the database of ONS. Real Private consumption expenditure (DPM) is used as a proxy for real economic activity in the residential sector. A number of Low pressure subscribers (BPG) is introduced as an observable explanatory variable. Real Industrial Added Value (VAI) is used as a proxy for GDP in the industrial sector. Electricity production (PRD) is used under its different voltage as the observable explanatory variable in power sector.

Estimate Results

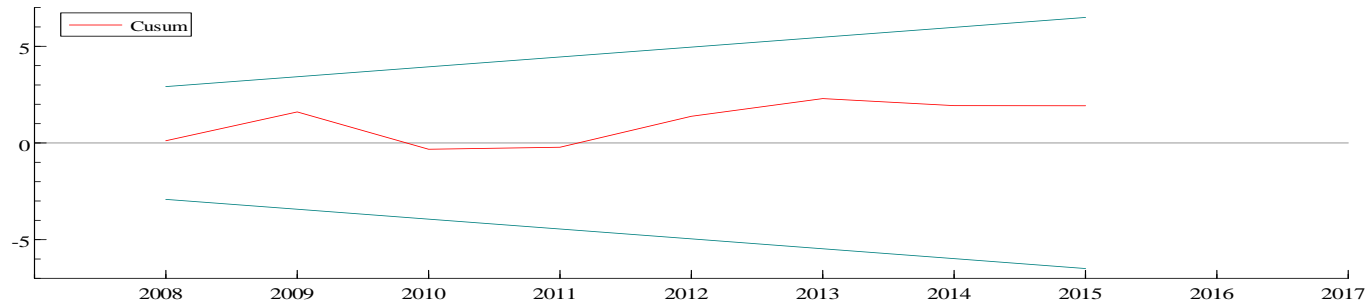
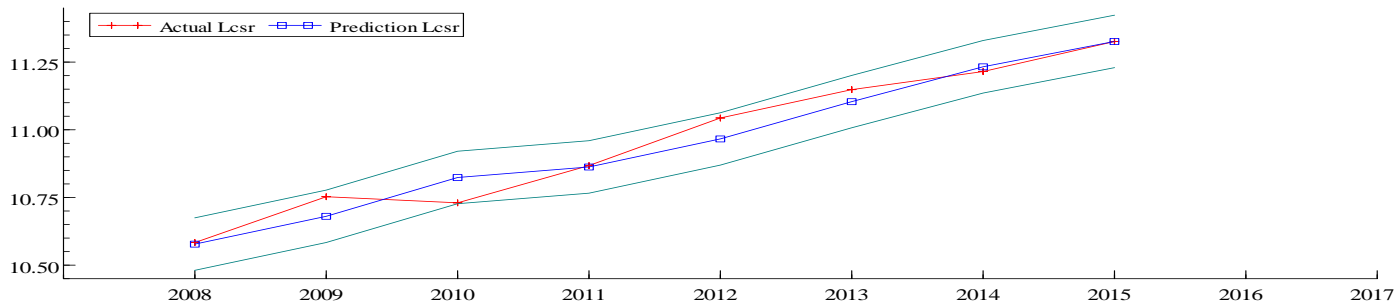
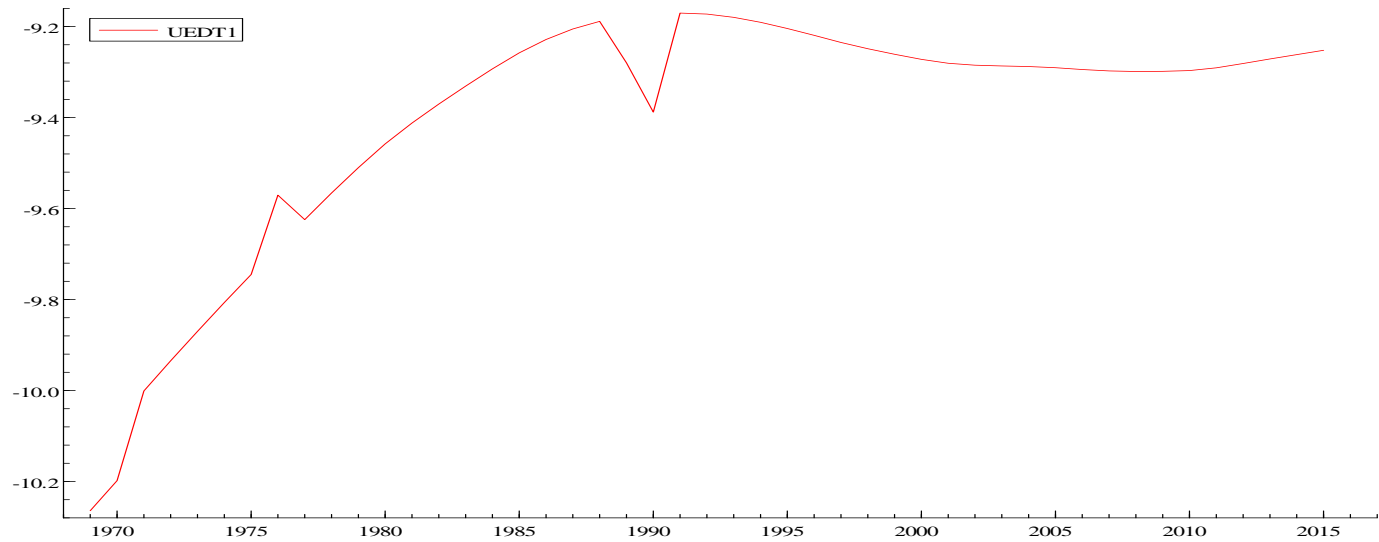
We have followed a general to specific approach in our study. Initially, we select two lags on the basis of the Akaike information criterion (AIC) , and after eliminating the insignificant variables and including interventions, the preferred estimated equations (Residential, industrial, power generation) are given by:

$$gr_t = 0.41Ldpm_{t-1} + 0.92Lbpg_t + UEDT_t \dots\dots\dots(5)$$

$$gi_t = 0.35Lvai_t + UEDT_t \dots\dots\dots(6)$$

$$gr_t = 0.82Lhp_t + 0.20Lhp_{t-1} - 0.43Lhp_{t-3} + 0.49Lmp_t + 0.54Lmp_{t-1} + 0.26Llp_t - 0.42Llp_{t-1} \\ + 0.22Llp_{t-4} + UEDT_t \dots\dots\dots(7)$$

Residential sector Model



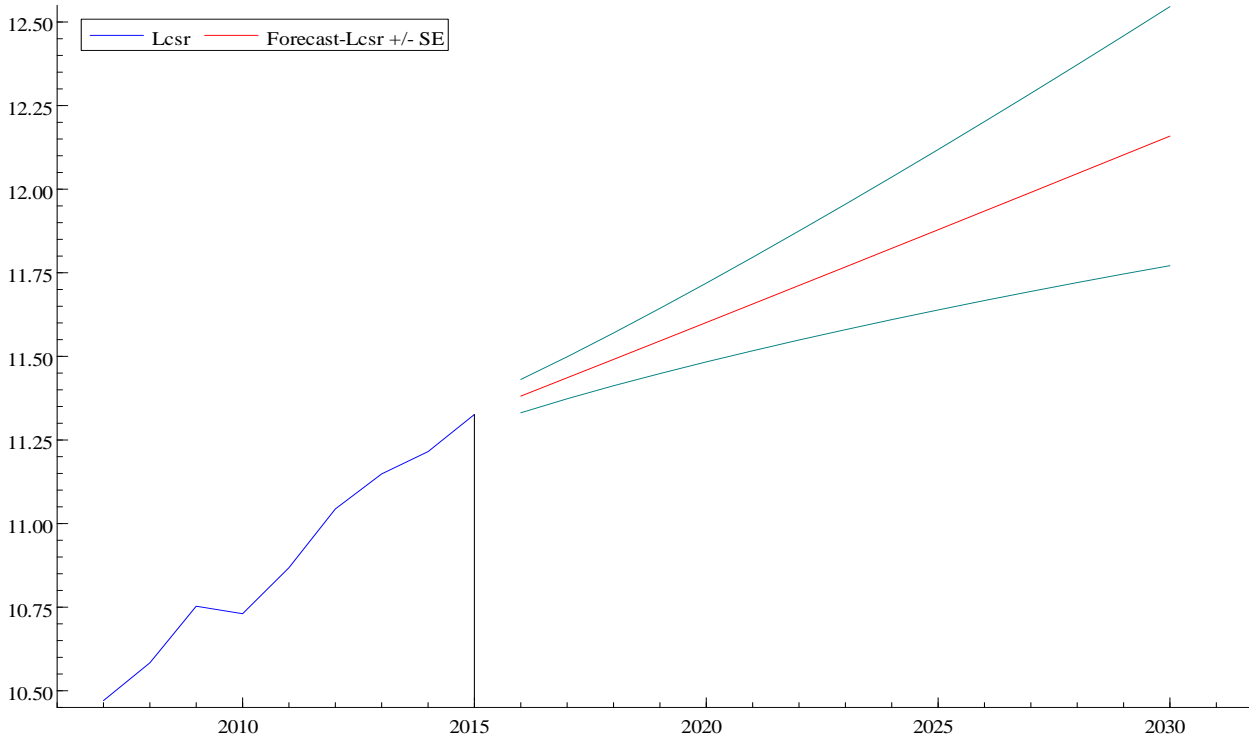
Following from Eq(5), the estimated annual changes per annum contributions are approximated as follows:

Period	Contribution			Total change in gas demand
	Expenditure	Suscribers Number	UEDT	
1970-1988	0.48	7.70	5.97	14.15
1989-2001	-0.76	4.60	-0.70	3.14
2002-2015	0.02	7.50	0.20	7.72

Contribution share

Period	Average Share of Contribution (%)		
	Expenditure	Suscribers Number	UEDT
1970-1988	18.74	45.31	35.95
1989-2001	14.64	58.30	27.06
2002-2015	8.42	86.21	5.37

Forecasts



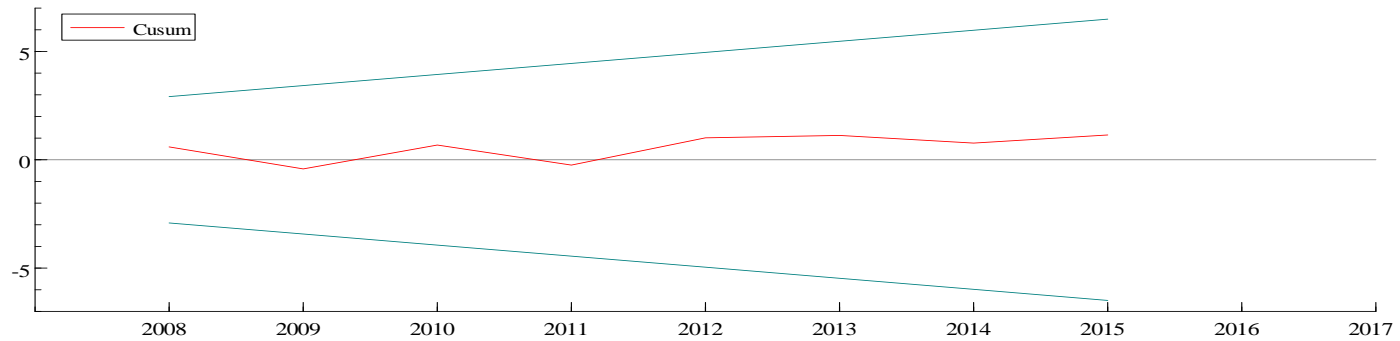
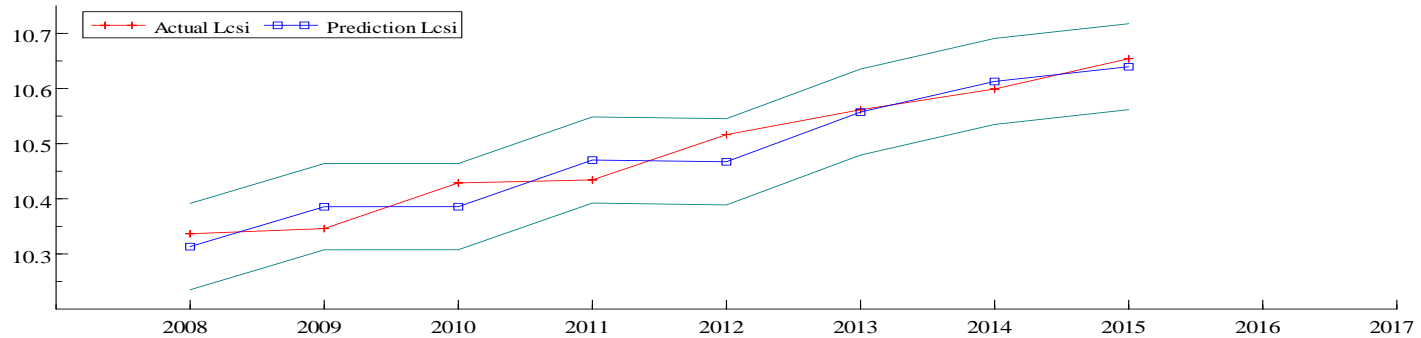
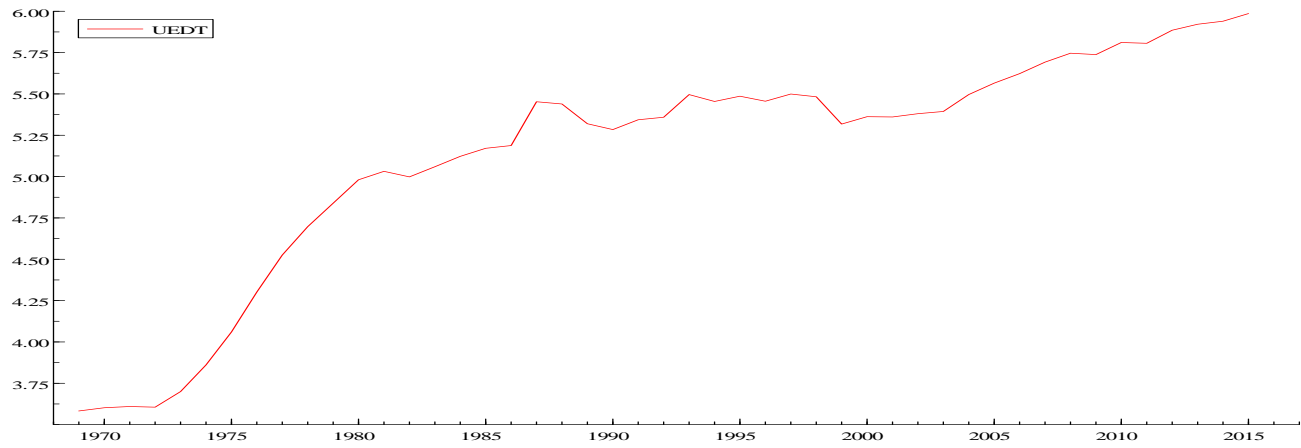
H: 8.4%
M: 5.6%
L: 3.0%

Assumptions:

Average Annual Growth rate (2015-2030): Private consumption expenditure (3.5%)

A number of Low pressure subscribers (3.5%)

Industrial sector Model



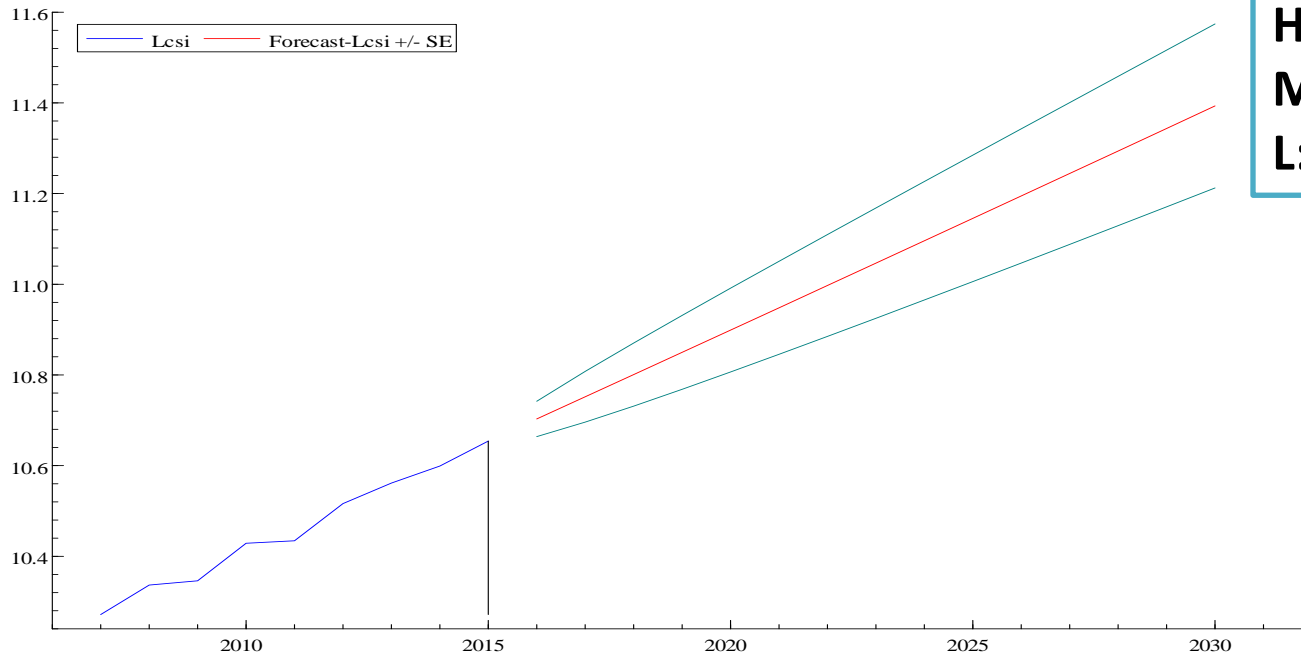
Following from Eq(6), the estimated annual changes per annum contributions are approximated as follows:

Period	Contribution		Total change in gas demand
	Added Value	UEDT	
1970-1988	2.62	9.44	12.06
1989-2001	0.29	1.71	2.00
2002-2015	1.24	4.45	5.69

Contribution share

Period	Average Shares of Contribution	
	Added Value	UEDT
1970-1988	31.34	68.65
1989-2001	37.20	62.79
2002-2015	28.63	71.36

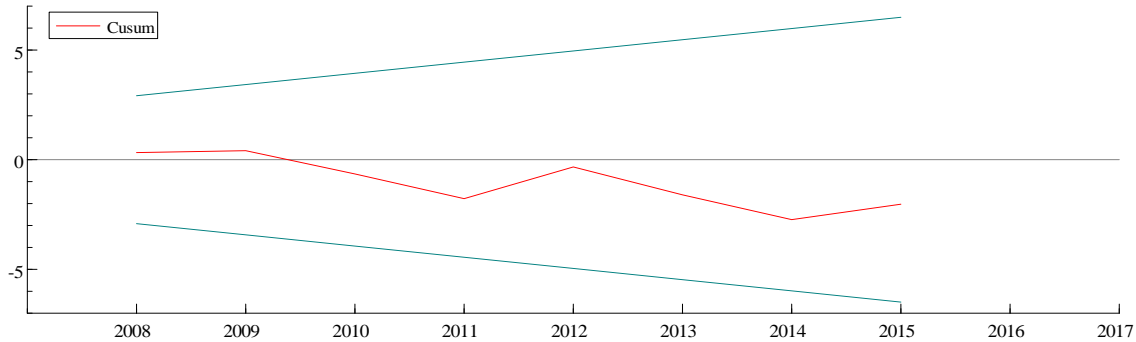
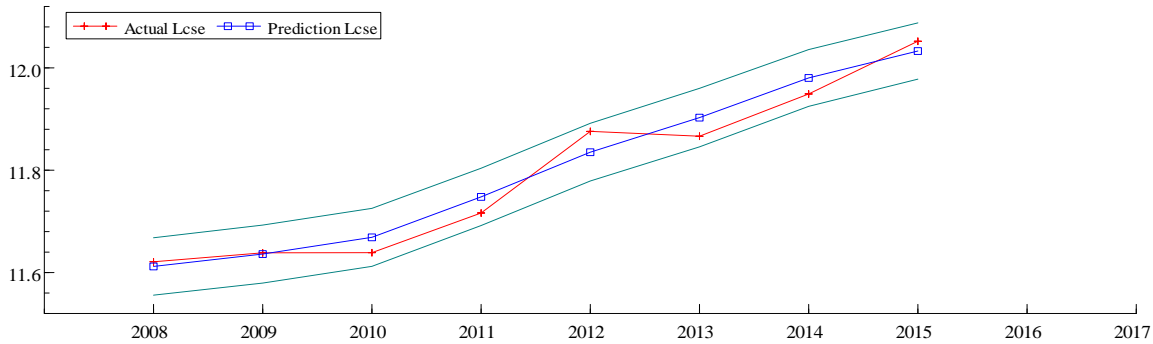
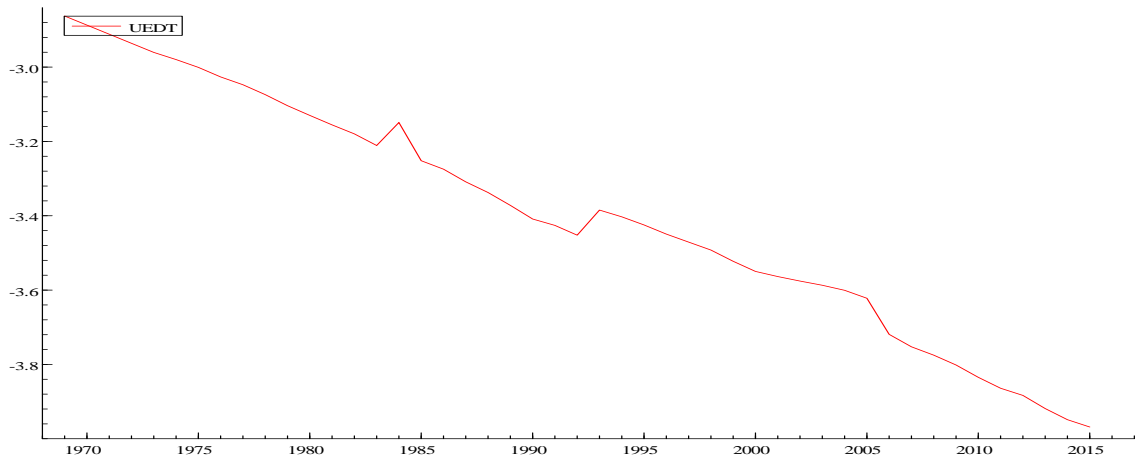
Forecasts



Assumptions:

Average Annual Growth rate (2015-2030): Industrial Added Value (5%)

Power sector Model



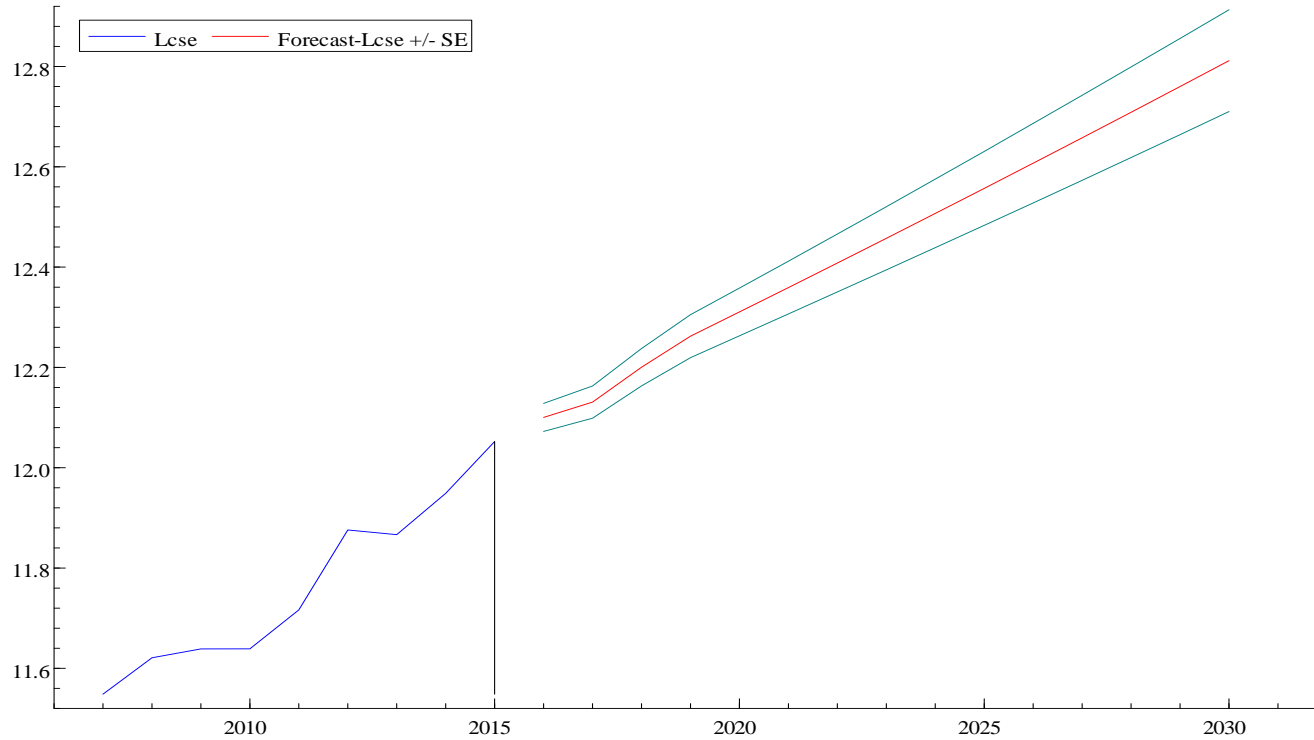
Estimated annual changes per annum contributions

Period	Contribution				Total change in gas demand
	High Voltage	Medium Voltage	Low Voltage	UEDT	
1970-1984	16.86	4.67	3.18	-1.91	22.8
1985-1993	3.22	2.56	2.49	-2.61	5.66
1994-2005	2.69	2.18	1.49	-1.97	4.39
2006-2015	3.73	2.78	2.12	-3.46	5.17

Contribution share

Period	Average Shares of Contribution			
	High Voltage	Medium Voltage	Low Voltage	UEDT
1970-1984	51.65	21.27	18.9	8.17
1985-1993	19.91	36.04	27.65	16.4
1994-2005	36.28	21.65	28.24	13.82
2006-2015	32.6	23.10	24.45	19.84

Forecasts



H: 5.9%
M: 5.2%
L: 4.5%

Assumptions:

Average Annual Growth rate (2015-2030): Electricity production for the three type of pressure (4.5%)

Aggregate Forecasts

	Residential Sector (bcm)			Industrial Sector (bcm)			Power Sector (bcm)			Aggregate Level (bcm)		
	2015	2030	GR (%)	2015	2030	GR (%)	2015	2030	GR (%)	2015	2030	GR (%)
Low Scenario	9.2	14.3	3.0	4.7	8.2	3.7	19.05	36.7	4.5	33	59.2	3.9
Median Scenario		21.0	5.6		9.8	5		40.6	5.2	33	71.4	5.2
High Scenario		31.0	8.4		11.7	6.3		44.9	5.9	33	87.6	6.7

Conclusion and Policy Implications

- The existence of some interventions might be a sign of structural break and instability over the estimated period, lies to the different development plans and the changes in the country's gas policy
- For the residential sector:
 - ✓ In order of importance, UEDT, number of subscribers, and private expenditure are all factors that shape natural gas demand
 - ✓ The growing number of consumers through the housing policy of Algerian authorities, the low introduction of energy efficiency, the fully regulated price, and consumers preferences, contribute to the upward UEDT of this sector

- For the industrial sector:
 - ✓ The UEDT and Industrial added value are the main factors that shape the natural gas demand
 - ✓ The structure of Algerian economy over different period between 1969-2015, especially the energy-intensive industrialization , contributed mainly to the upward UEDT. The recovery of the UEDT between 1989-2001 due to the structural crisis of Algerian economy.

- For the power sector:
 - ✓ Electricity production (Needs), mainly the high and medium voltage are the main factors which affect gas consumption
 - ✓ The downward shape of estimated UEDT reflects the use of the energy efficient appliance such as gas turbine and more recently the combined cycle (since 2005).
- Given its relative importance, UEDT should be taken into account when modelling Algeria's natural gas demand. It has important information that is of value of Algerian decision makers when developing gas security

- Based on plausible hypothesis, the aggregate gas demand could be situated at 59, 71 and 87 bcm in 2030.
- If the Algeria's gas production remains at the current level, it could still satisfy future domestic gas consumption but largely to the detriment of gas exports
- If the Algeria's gas production declines below 70 bcm, the country could face an energy crisis. Therefore, the development of alternative energies such as renewable energies, combined to the energy efficiency development, and the practice of economic energy prices, constitute some solutions to maintain the sustainability of the country's energy supply.

Many Thanks for listening

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