The Green Paradox and Budgetary Institutions

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Motivation - do green choices generate green outcomes?

Micro foundation of inconsistent green behavior: Plastic bags and recycling

Macro-level inconsistent green behaviour: the green paradox

Nature of the problem: emission reduction is a public good

ATELIER POPULAIRE. (1968). *Je participe, tu participes, il participe, nous participons, vous participez, ils profitent*. Paris, s.n.

Motivation:
The Green Paradox (Sinn 2012, 2008)

- Why climate policy has failed to reduce emissions?
- Demand vs. supply measures
- Climate policy can lead to higher emissions by influencing fossil producers to increase production in the short and medium term
- How do oil producers react to the rise of heavily subsidised renewable energy?

Motivation:
The Green Paradox (Sinn, 2012, 2008)

- Insightful narrative, but lacks focus on:

I. Oil production strategies

II. The political economy of the oil industry – it is also subsidized!

III. Variant incentive structure across different producers

IV. In other words, an institutional (empirical) perspective

Quick main findings

Is there a green paradox effect? (Yes and no)

Saudi oil production-cut strategy in response to green regulations. *Why?*

- Procyclical fiscal policy prevents profit maximization

Green paradox U.S. oil production. *Why?*

- No evidence for procyclicality
- Budget surplus channels towards standard of living

Outline of the talk

- Research questions (RQs) and contribution of this study
- Data and comparative framework: Saudi Arabia vs. the United States
- Econometric specification: unified simultaneous equation model (SEM)
- Estimation results
- Conclusion

This study investigates…

- Oil production strategies in response to the rise of alternative energy: is there a green paradox effect? (RQ1)

- An institutional narrative based on the behaviour of budget balance in the macroeconomy (RQ2)

- A simultaneous equation model (SEM): Saudi Arabia vs. USA (1976-2015)

Contribution

I. Innovative (empirical) framework examining oil production in response to the rise of green regulations – in a comparative context

II. Bridge the gap between the green paradox and the natural resource curse literatures

III. The choice of modelling framework allows for endogeneity effects and cross market interaction *(Wang and Sun, 2017, Ahajji and Huettner 2000b)*

- Institutional narratives using macroeconometrics and comparative methods

Related literature

I. The green paradox (Sinn, 2012, 2008)

- Theoretically driven, less empirical context *(Lemoine, 2017, Zhang et al., 2017, Rezai and Van er Pleog, 2016, Grafton et al., 2014 , Marie et al. 2014, Ploeg and Withagen, 2012,Smulders et al.2012, 2008)*

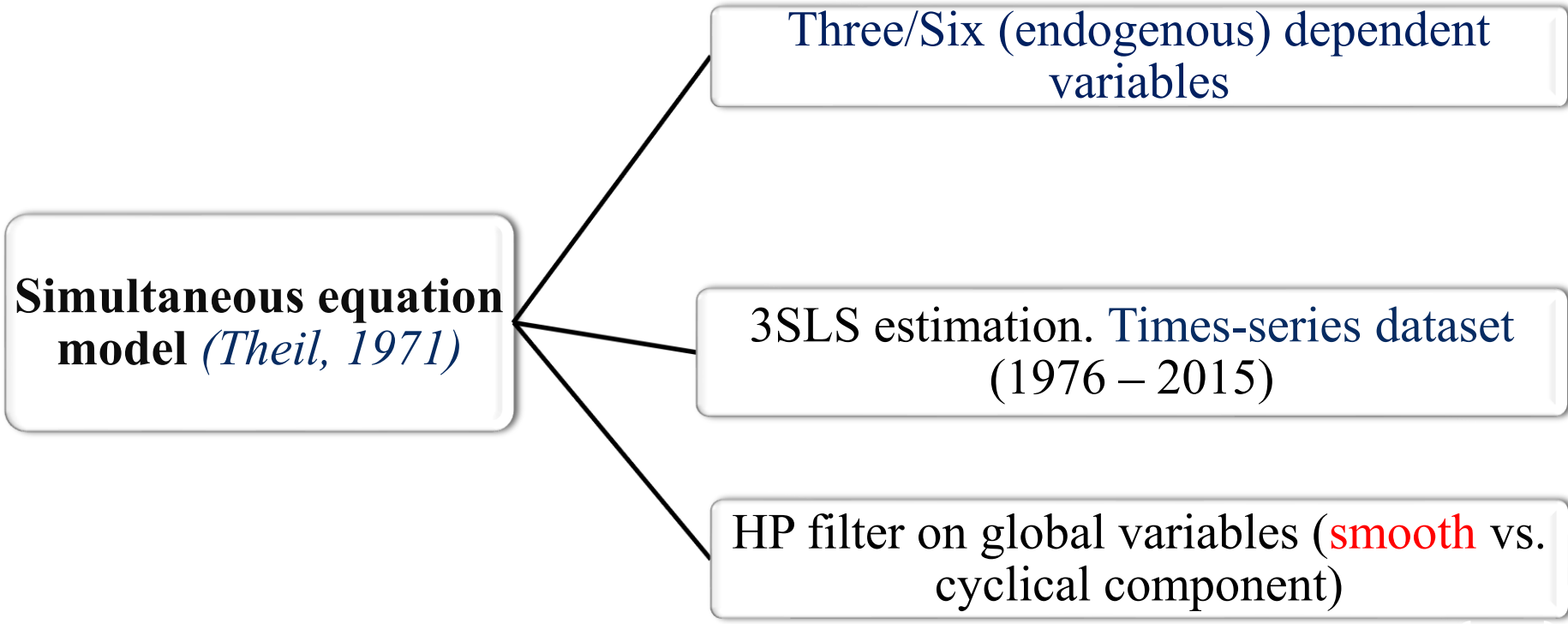
II. Natural resource curse

- Natural resources and nature of property rights *(Bohn and Deacon, 2000)*
- Economic growth and natural resource abundance *(Auty, 2001, Sachs and Warner, 2001)*
- Quality of institutions and fiscal policy behaviour *(Al-Kasim et al., 2013, Sala-i-Martin and Subramanian, 2013, Frankel, 2012)*

Empirical estimation framework

- Unit-root tests (Dickey-Fuller, KPSS, Zivot-Andrews)
- H-P filter on global variables: *smooth* vs. cyclical components
- Econometric framework: simultaneous equation model
- Diagnostic checks: identification, autocorrelation, heteroscedasticity tests

Econometric framework



Model step-up:
simultaneous equation model (SEM)

A general notation for L structural (behavioural) equations (Theil, 1971):

$$y_j = Z_j \partial_j + \in_j \qquad (1)$$

Where:

- j= 1, …, L
- y_j represents the vector of dependent variables
- *Zj* represents the matrix *(n x N_j)* that includes all independent variables
- N_j corresponds to the number of independent variables in equation *j*
- ∂j represents a vector that includes the unknown parameters
- $\in j$: represents the disturbances in the corresponding equation

Econometric specification – SEM (6 equations)

$$p_{U(t)}=b_1 p_{U(t-1)}+b_2 pr_{(s)t}+b_3 pr_{(c)t}+ b_4 p_{SA(t-1)}+b_5 G_{(U)t}+\mathbf{b_6 A_{(s)t}} +b_7 A_{(c)t}+b_8 08_t + \epsilon_1$$

$$G_{U(t)}=\alpha_1 p_{U(t-1)}+ \alpha_2 pr_{(s)t}+\alpha_3 pr_{(c)t}+ \alpha_4 ca_{U(t)}+ \mathbf{\alpha_5 fis_{U(t)}}+ \alpha_6 exp_{U(t)}+ \epsilon_2$$

$$Ca_{U(t)}= \nu_1 pr_{st-1} +\nu_2 pr_{ct-1}+ \nu_3 A_{(s)t} +\nu_4 A_{(c)t} + \nu_5 pop_{U.S.t} + \mathbf{\nu_6 fis_{U(t)}} + \epsilon_3$$

Econometric specification – SEM (6 equations) cont.

$$p_{SA(t)}=\lambda_1 p_{SA(t-1)}+\lambda_2 pr_{(s)t}+\lambda_3 pr_{(c)t}+\lambda_4 p_{U(t-1)}+\lambda_5 G_{SA(t)}+\boldsymbol{\lambda_6 A_{(s)t}}+\lambda_7 A_{ct}+\lambda_8 86+\epsilon_4$$

$$G_{SA(t)}=h_1 p_{SA(t)}+h_2 pr_{(s)t}+h_3 pr_{(c)t}+h_4 ca_{SA(t)}+\boldsymbol{h_5 fis_{SA(t)}}+h_5 exp_{SA(t-1)}+\epsilon_5$$

$$Ca_{SA(t)}=E_1 ca_{SA(t-1)}+E_2 pr_{(s)t}+E_3 pr_{(c)t}+E_4 pop_{SA(t)}+\boldsymbol{E_5 fis_{SA(t-1)}}+E_6 A_{st}+E_7 A_{ct}+\epsilon_6$$

Data and variables

Data sources

Variable	Source
Oil-production	BP- annul statistical review (2016)
WTI oil-price	BP- annul statistical review (2016)
GDP, CPI	World bank
Budget balance	SAMA, FRED
Net-exports	SAMA, FRED
Alternative energy: - **Total other renewables (Mtoe): solar, biomass, wind, geothermal and waste.** - **Nuclear energy (Mtoe)** - **Hydro energy (Mtoe)**	BP- annul statistical review (2016)

Dependent Variables	Definition (proxy of)
$P_{SA,US}$	Growth-rate of the aggregate crude oil crude supply
$G_{SA,\ US}$	Real GDP growth rate
Ca	Per capita energy consumption: standard of living

Independent Variable	Definition (proxy of)
$A_{c,s}$	The cyclical/smooth component of alternative energy supply : renewables, nuclear, and hydro
Fis	The ratio of budget balance to GDP (surplus/deficit)
Pr	US dollars per barrel of WTI crude price
pr	The cyclical/smooth component of the US dollars per barrel of WTI crude oil price
Netexp	The ratio of net-exports
Ca	Per capita energy consumption (standard of living)
pop	Population growth

Independent variables of interest

I. As: the rise of alternatives on oil-production?

- Is there a green paradox effect? If not, why?

II. Fis: healthier budget on *growth* and *standard of living*?

- Fiscal policy behaviour and quality of institutions
- Procyclical fiscal policy = (lower commitment to budget rules) (lower quality of institutions?)
- Countercyclical redistribution = income inequality or market based incentives?

Estimation results

Dependent variable: oil production	US	Saudi Arabia
L. production	0.333 (0.02)	-0.320 (0.001)
L.oil-price	-0.431 (0.014)	-0.972 (0.119)
GDP	0.585 (0.018)	0.363 (0.00)
Alernative$_s$	**0.658** **(0.012)**	**-5.359** **(0.007)**
2008	0.069 (0.00)	-
1986	-	0.458 (0.00)
Production $_{(US)}$	-	-0.326 (0.285)
Production $_{(SA)}$	-0.179 (0.00)	-
Constant	-0.046 (0.00)	-0.471 (0.00)

Dependent variable: GDP growth	US	Saudi Arabia
Oil-price (smooth) (pr)	0.159	0.339
	(0.081)	(0.232)
Capita consumption (ca)	0.861	0.092
	(0.00)	(0.026)
Production (p)	0.054	0.157
	(0.258)	(0.06)
Budget balance (fis)	**0.001**	**0.003**
	(0.353)	**(0.014)**
Net exports (nexp)	-0.0001	-
	(0.008)	
lag net exports (nexp)	-	-0.045
		(0.002)
Constant	0.023	-0.131
	(0.00)	(0.073)

Dependent variable: std of living	US	Saudi Arabia
l. capita consumption (ca)	-	-0.525 (0.00)
Alternative(smooth) (al)	0.151 (0.262)	0.151 0.859
Pop	1.204 (0.416)	0.822 (0.464)
l.oil-price (smooth) (pr)	-0.038 (0.675)	0.534 (0.027)
budget balance $_{(US)}$ (fis)	**0.006** **(0.00)**	**-**
l. budget balance $_{(SA)}$ (fis)	**-**	**-0.001** **0.059**
Constant	-0.014 (0.331)	0.006 (0.849)

Main findings

- Different variables behave differently under different institutional settings – the role of incentive constraints
- In contrast to Saudi production strategies:
- Green paradox effect in the US context
- US strategies behave closer to a profit maximiser
- Why?

Implications: U.S. context

- Green Paradox effect → environmental challenge
- Closer to a rational optimisor behavior?
- Green paradox effect suggests inconsistency between environmental and energy policies
- Thriving (shale?) oil industry seems to offset negative impact of oil-prices
- Deceasing impact of oil-shocks on the macroeconomy (Kilian, 2016, 2014)

Implications: Saudi context

I. Production behavior should rather be contextualized (Sem, 2017)

II. Procyclical fiscal behavior is branched across the economy

- Inefficient patterns of energy demand - high subsides?
- Fiscal policy behavior seems to deteriorate standards of living
- Massive oil-wealth, but high poverty…

Overall implications

- Evidence against conventional wisdom of the green paradox – not all producers are profit maximisers
- In other words, different producers may face different discount rates
- Different budgetary institutions generate identifiable oil production strategies
- An institutional perspective is needed in the green paradox literature
- Need for further coordination between:
  - Environmental and energy initiatives
  - Macroeconomic and institutional aspects between energy regulators

QUESTIONS?

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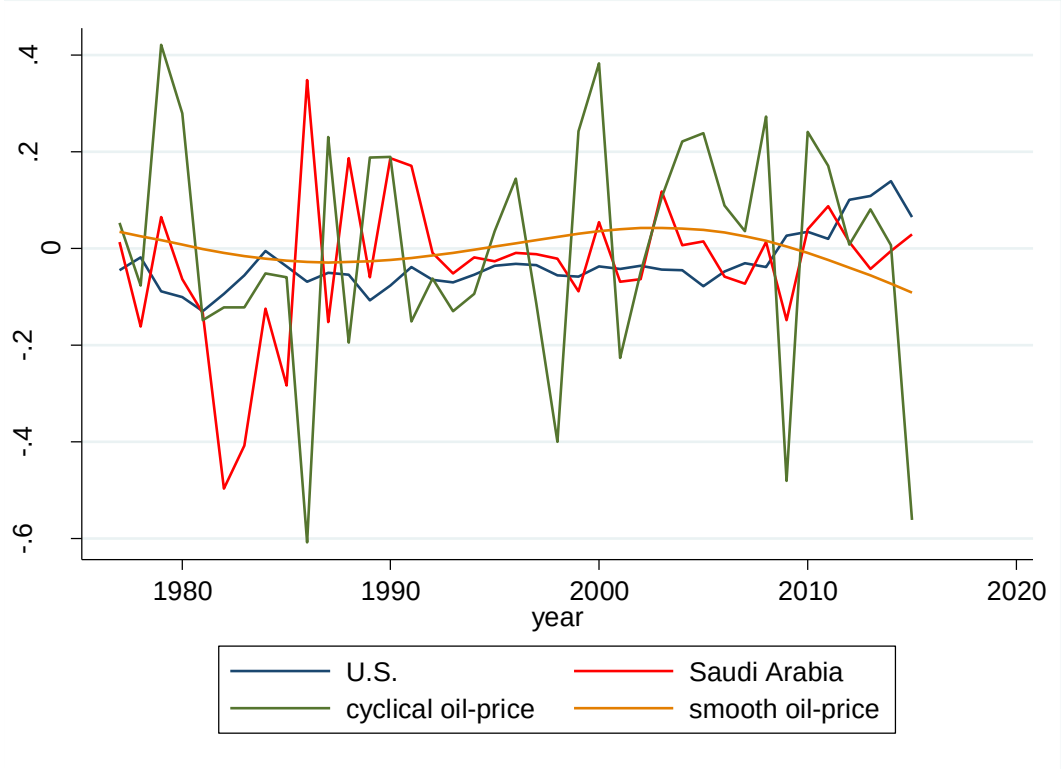
Oil-production growth ad price



Landscape of global oil production (BP, 2015)

Country	OPEC share	Global share	INDC Climate performance
OPEC			
Saudi Arabia	31.46%	13.03%	Inadequate
Iraq	10.9%	4.51%	-
Iran	10.1%	4.18%	-
UAE	9.71%	4.02%	Inadequate
Kuwait	8.25%	3.41%	-
Venezuela	7.48%	3.09%	-
Nigeria	6.25%	2.59%	-
Angola	4.9%	2.03%	
Qatar	4.38%	1.81%	-
Libya	1.11%	0.46%	-
Algeria	3.79%	1.57%	-
Ecuador	1.61%	0.66%	-
Non-OPEC			
U.S.	-	13%	Medium
Russia	-	12.39%	Inadequate
Canada	-	4.93%	Inadequate
China	-	4.91%	-
Brazil	-	3.02%	-
Norway	-	2.01%	Medium
***Intended Nationally Determined Contribution (INDC) performance target**			

Oil-production growth (1976-2015)