STUDYING BOOM-BUST CYCLES IN NATURAL GAS PRODUCTION ASSETS INVESTMENTS
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Global Natural Markets are facing significant upheavals…

- LNG global oversized investments
- Shale gas revolution in the US
- Doubts on the Chinese natural gas demand

Global natural markets are arguably out of a medium and long-term equilibrium
... nevertheless, most of forecast models assume a static market equilibrium

The starting point: VISIONs, an ENGIE in-house global gas model similar to the US Energy Information Administration’s (EIA) International Natural Gas Model (INGM).

- **Static analysis**: the role of time is not considered.
- **Perfect foresight**: every agent foresees the future correctly.
- **Market equilibrium**: the market price is established through competition such that the amount of goods or services sought by buyers is equal to the amount of goods produced by sellers.
Moving from market optimization to market simulation

VISIONs, the classical static market equilibrium paradigm

Integrating VISIONs into a dynamic simulation architecture

[Graphs and charts showing marginal cost and runs over time]
An endogenous development plan emerges from the irreversible decisions in production assets investments.
The simulation architecture allows a dynamic representation of the depletion of existing production capacities.
3 structural consequences on natural gas markets modeling

• A causality loop emerges from the simulation architecture

A. Market evolutions
Production and consumption in temporal dimension [1]

Path-dependence

B. Evolution of expectations
Market forecast in temporal dimension [2]

C. Decision-making
Assessment of irreversible investment opportunities

• Dual mechanisms associated with differentiated economic regimes
  ▪ Allocation market: variable cost regime
  ▪ Investment committee: full cost regime

• Heterogeneous and independent agents
  ▪ Physical traders assure an optimal flow allocation in the short term
  ▪ Business developers study production projects independently one from another

Agent-Based Modeling
An easy dataset to meet complex objectives

**Objectives:**
- Modeling a series of Boom-Bust cycles in natural gas production assets investment.
- Identifying the best/worst times to invest in natural gas production assets within these cycles.

**Assumptions:**
- One single node
- Gas demand: static, steady increasing
- Gas supply: declining awarded production + a series of projects available for investment
The model generates endogenous Boom-Bust cycles

- **Achieved price**: temporal dimension [1]
- **Forecasted price**: temporal dimension [2]

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<td>Y0</td>
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1. Price forecasts are not high enough  
2. Projects are postponed from year to year  
3. Under-capacity: the price increases

1. The price forecast is high enough  
2. Huge number of projects FIDed  
3. Over-capacity: the price collapses

**Expected vs achieved NPV (M$)**
- **Expected NPV**
- **Achieved NPV**

**Counter-cyclical investments**  
Achieved NPV > Expected NPV

**Pro-cyclical investments**  
Achieved NPV << Expected NPV

Counter-cyclical investments  
Pro-cyclical investments

1. Price forecasts are not high enough  
2. Projects are postponed from year to year  
3. Under-capacity: the price increases
Production profiles are fully consistent with the price evolution.
Conclusion

• **Moving from optimization to simulation**
  - A causality loop emerges from the simulation architecture.  
  - Dual mechanisms associated with differentiated economic regimes.
  - Heterogeneous and independent agents.

• **Demonstration on a limited dataset**
  - Modeling a series of Boom-Bust cycles in natural gas production assets investment.
  - The model shows that in those conditions, counter-cyclical investments are highly profitable whereas pro-cyclical investments are fatal.

• **Next steps**
  - Test on an extended dataset.
  - Additional dynamic functions: elasticity of demand, market power,…
Joël ENDERLIN (joel.enderlin@engie.com)
Center of Expertise in Economic and Modeling Studies
ENGIE Strategy Division