

A Natural Gas Model for North America: Impact of Cross-border Flows of Natural Gas with Mexico

Felipe Feijoo, Daniel Huppmann, Larissa Sakiyama, and Sauleh Siddiqui

Systems Institute
The Johns Hopkins University

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Goal and outline

•This presentations aims at analyzing the impacts that the 2013 Energy Reform in Mexico will have in North America.

•Outline

- Introduction: 2013 Mexican energy reform
- Objectives the research project
- Modeling framework
- Results
- Conclusions

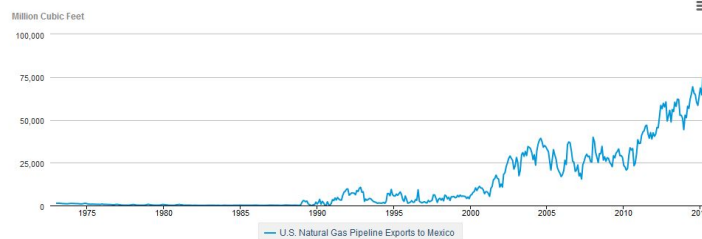


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Background about Mexico

- Mexico is the United States' second largest export of natural gas after Canada.
- Natural gas demand grew 60% in Mexico between 2008 and 2013.
- Production did not increase at the same pace as demand due to lack of investment incentives.
- On December 20, 2013, the Mexican government promulgated the Energy Reform, which was implemented on August 11, 2014.

U.S. Natural Gas Pipeline Exports to Mexico



http://www.eia.gov/naturalgas/weekly/archive/2015/10_22/index.cfm#itn-tabs-2

Background about Mexico

- Mexico's national territory is divided into five market regions: Northwest, Northeast, Interior-West, Interior, and South-Southeast.
- The Southeast and Northeast natural gas consumption are the highest in the country.
- On an assessment made by the EIA, national shale resources in Mexico are ranked as the 6th largest in the world [2].
 - The Burgos Basin in the Northeast of Mexico
 - Between 2012 and 2027 about 75% of production growth is predicted to be in the electric sector.

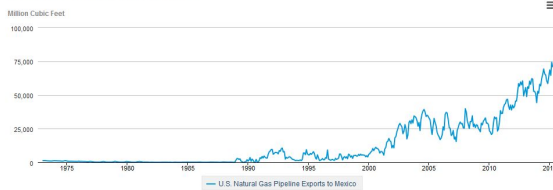


Source: Secretaría de Energía SENER, *Prospectiva de Gas Natural y Gas L.P. 2013-2027*, Page 116, Figure 3.21; Sistema de Información Energética, *Distribución de gas seco*

Background about Mexico

- The Northwest and Northeast regions receive all natural gas imports from the U.S
- Limited future LNG importing capacity. Hence, pipeline imports from the U.S. are crucial to meet growing national demand. [4]
- Induced gas production in the U.S. to satisfy Mexico's demand growth may become an environmental issue in the future. [2]

U.S. Natural Gas Pipeline Exports to Mexico



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Source: Secretaría de Energía SENER, *Prospectiva de Gas Natural y Gas L.P. 2013-2027*, Page 116, Figure 3.21; Sistema de Información Energética, *Distribución de gas seco*



Main objectives

The main goal of this effort is to study the impacts that new energy regulations in Mexico will have in North America (U.S. and Canada) by analyzing the cost and benefits of cross-border flows on natural gas.

To address these questions, we developed the North American Natural Gas Model (NANGAM)

- MultiMod framework: a long-term partial-equilibrium model of the United States, Mexican, and Canadian gas markets. [Huppmann and Egging, 2014]
- We expand the granularity of Mexico in terms of geography, infrastructure, and connections with electricity.



NANGAM description

MODL

Players in the model: MultiMod framework

- **Production (upstream)**
 - Suppliers of fuels (shale and non-shale)
- **Service providers & infrastructure operators (midstream)**
 - Arc operators (pipeline, ship, rail, LNG, etc.)
 - Transformation technology operators (power plant, refinery)
 - Storage operators (gas storage, pump-hydro storage)
- **Consumption (downstream)**
 - Final demand sectors (by sector)
- **The policy dimension**
 - Emission permit auctioneer
 - Government regulations (e.g., biofuel mandates, technology portfolio standards)



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NANGAM description

MODL

- A long-term partial-equilibrium model of the United States, Mexican, and Canadian gas markets
- There are a total of 17 nodes in the model
 - U.S. census regions 1-9
 - Mexican regions 1-5 (Northwest, Northeast, Interior-West, Interior, and South-Southeast)
 - Canadian regions 1-2 (east and west)
- There are a total of 13 production nodes,
 - Eight correspond to census regions 2-9 for the lower-48 states and one for Alaska
 - Two for Canada (East and West)
 - Two for Mexico (North and south east)
- 7 time steps (2010 – 2015 – 2020 – 2025 – 2030 – 2035 – 2040)
- 3 seasons per year (low, high, peak)



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The current data set: base case data sources

MODL

Production and demand for the U.S.

- U.S. Energy Information Administration EIA, Natural Gas Gross Withdrawals and Production (Dry Production), Natural Gas Prices, Pipeline projects.
- Annual Energy Outlook 2015

Production and demand for Canada.

- National Energy Board, NEB Canada's Energy Future 2013: Supply and Demand Projections to 2035

Production and demand for Mexico.

- Secretaría de Energía SENER, Prospectiva de Gas Natural y Gas L.P.
- U.S. Energy Information Administration EIA
- Gas y Petroquímica Básica Pemex, Condiciones Generales para la Prestación del Servicio de Transporte de Gas Natural

Scenarios

MODL

The 2013 Mexican Energy reform seeks to create incentives for private investor in order to meet the increasing demand (energy and industry sectors mainly) and to help Pemex to recover production levels.

1. High demand in Mexico (failure of the energy reform and increasing Monterrey demand, Mexico region 2)

- i. Constant rate of 5 % increasing demand starting in 2020 for Mexico 1, 2, 3, and 5

2. High demand and low resources in Mexico (failure of the energy reform, Burgos and Sabinas are geologically complex)

- i. Constant rate of 5 % increasing demand starting in 2020 for Mexico 1, 2, 3, and 5
- ii. 5% increase in production cost starting in 2015 for Mexico 2 and 5.

3. High resources in Mexico (success of the energy reform)

- i. 10% reduction in investment production capacity
- ii. 5% reduction in production cost starting in 2020 for Mexico 2 and 5.

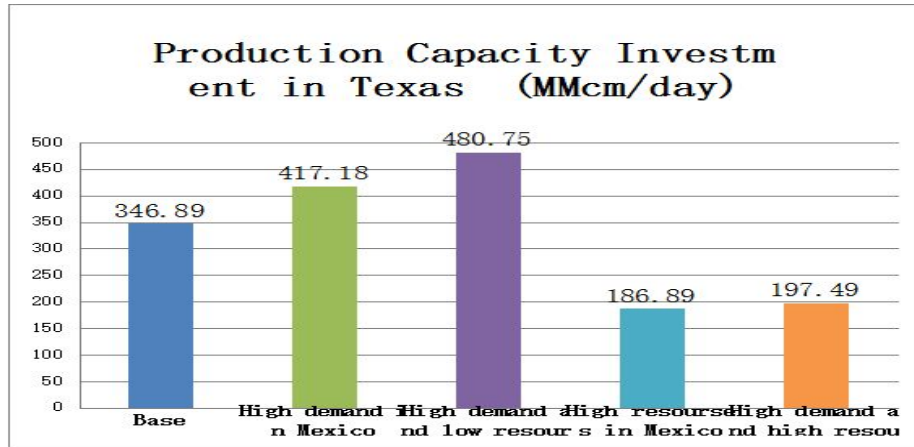
4. High demand and high resources in Mexico (success of the energy reform)

- i. Constant rate of 5 % increasing demand starting in 2020 for Mexico 1, 2, 3, and 5
- ii. 5% reduction in production cost starting in 2015 for Mexico 2 and 5.

Results



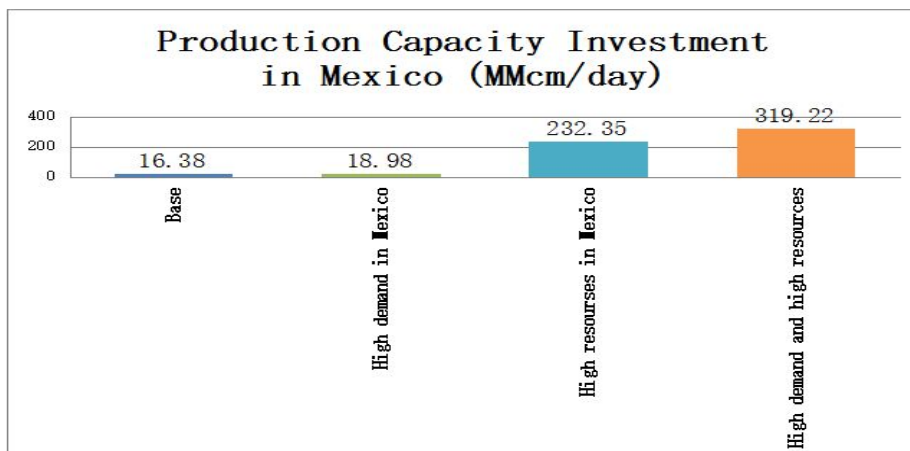
- The region US7 (Texas mainly) is highly impacted by different scenarios in Mexico. Primarily as it is the main exporter. (endogenous)



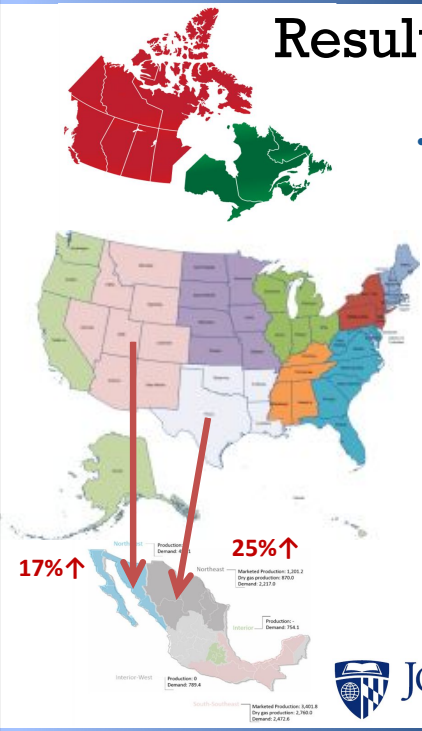
Results



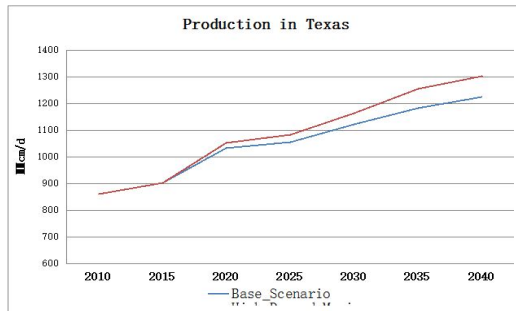
- The Mexican government needs to attract investments in infrastructure (high resources in Mexico)



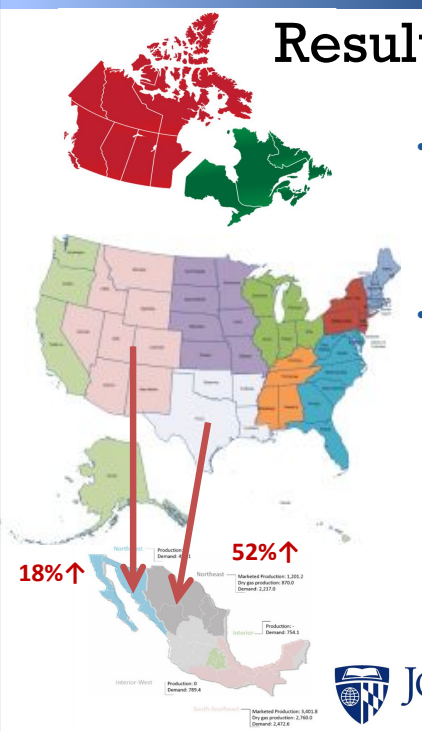
Results



- High demand in Mexico
 - Increased flows from Texas, New Mexico and Arizona to Mexico (Monterrey area)
 - Increased production in Texas (~6% through 2040)

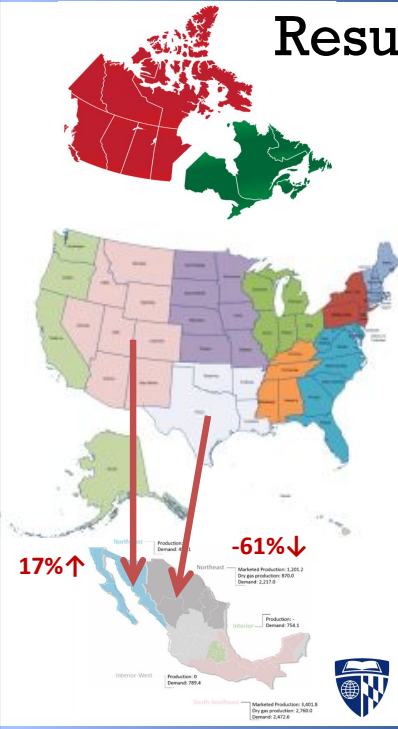


Results



- High demand in Mexico
 - Increased flows from Texas, New Mexico and Arizona to Mexico (Monterrey area)
 - Increased production in Texas (~6% through 2040)
- High demand in Mexico and low resources
 - Increased flows from Texas, New Mexico and Arizona to Mexico (Monterrey area)
 - Increased production in Texas (~11% in 2040)

Results



- **High demand in Mexico**
 - Increased flows from Texas, New Mexico and Arizona to Mexico (Monterrey area)
 - Increased production in Texas (~6% through 2040)
- **High demand in Mexico and low resources**
 - Increased flows from Texas, New Mexico and Arizona to Mexico (Monterrey area)
 - Increased production in Texas (~11% in 2040)
- **High demand in Mexico and high resources**
 - Less flows from Texas to Mexico**
 - Reduced production in Texas (~12% less in 2040)**

Results

Production levels compare with base case (deviation)

- US4, US5, US6, US7, and ALK are the most affected nodes if the scenarios for the Mexican demand and resources change
- Flows from ALK to US8 increase when there are low resources in Mexico (needed to meet increasing demand in Mexico)

High resources

	2010	2015	2020	2025	2030	2035	2040
ALK	1.00	1.00	1.00	0.98	0.95	0.94	0.94
CAE	1.00	1.00	1.00	1.00	1.00	0.99	0.97
CAW	1.00	1.00	1.00	0.99	0.99	0.99	0.98
US2	1.00	0.99	0.99	0.99	0.99	0.99	0.99
US3	1.00	1.00	1.00	1.00	1.01	1.00	1.00
US4	1.00	1.00	0.99	0.97	0.97	0.97	0.97
US5	1.00	1.00	0.98	0.91	0.91	0.92	0.90
US6	1.00	1.00	0.97	0.90	0.90	0.91	0.89
US7	1.00	1.00	0.95	0.93	0.88	0.87	0.87
US8	1.00	0.99	0.99	0.99	0.99	0.99	0.99
US9	1.00	1.00	1.00	0.99	1.01	1.01	1.01
MEX2	1.00	0.99	1.13	1.66	2.39	2.44	2.49
MEX5	1.00	1.09	1.56	1.88	2.20	2.44	2.53

High demand and low resources

	2010	2015	2020	2025	2030	2035	2040
ALK	1.00	1.00	1.01	1.02	1.04	1.04	1.04
CAE	1.00	1.00	1.00	1.00	1.01	0.99	1.00
CAW	1.00	1.01	1.00	1.00	1.01	1.00	1.00
US2	1.00	1.02	1.01	1.00	1.00	1.00	1.00
US3	1.00	1.00	1.00	1.00	1.01	1.01	1.01
US4	1.00	1.01	1.02	1.02	1.03	1.02	1.03
US5	1.00	1.01	1.05	1.07	1.08	1.07	1.09
US6	1.00	1.01	1.06	1.07	1.09	1.08	1.10
US7	1.00	1.01	1.05	1.07	1.08	1.11	1.11
US8	1.00	1.01	1.01	1.01	1.01	1.01	1.01
US9	1.00	1.00	1.01	1.02	1.01	1.01	1.01
MEX2	1.00	0.83	0.87	0.82	0.78	0.71	0.75
MEX5	1.00	0.82	0.65	0.61	0.54	0.45	0.49

Results



1. There is a need for increasing investment and development of infrastructure (pipelines and production capacity) in Mexico. Given the current energy reform, private sector is likely to take over this investment
 - i. Investment in pipelines from Texas and New Mexico will increase flows from the U.S. to Mexico to satisfy increasing demand. Flows will raise if there is not investment in Mexican production capacity.
 - ii. Demand in the U.S. is not highly impacted.
 - iii. Prices in the U.S. increase/decrease ~1-3% depending on the scenario.

2. High demand and low resources in Mexico
 - i. Flows from Texas (US7) to Monterrey (Mex2) **increase** by ~50%, but flows from Texas to connected nodes is **reduced** (~7%). Therefore, production increases in those nodes to satisfy demand.

High demand and low resources

	2010	2015	2020	2025	2030	2035	2040
ALK	1.00	1.00	1.01	1.02	1.04	1.04	1.04
CAE	1.00	1.00	1.00	1.00	1.01	0.99	1.00
CAW	1.00	1.01	1.00	1.00	1.01	1.01	1.00
US2	1.00	1.02	1.01	1.00	1.00	1.00	1.00
US3	1.00	1.00	1.00	1.00	1.01	1.01	1.01
US4	1.00	1.01	1.02	1.02	1.03	1.02	1.03
US5	1.00	1.01	1.05	1.07	1.08	1.07	1.09
US6	1.00	1.01	1.06	1.07	1.09	1.08	1.10
US7	1.00	1.01	1.05	1.07	1.08	1.11	1.11
US8	1.00	1.01	1.01	1.01	1.01	1.01	1.01
US9	1.00	1.00	1.01	1.02	1.01	1.01	1.01
MEX2	1.00	0.83	0.87	0.82	0.78	0.71	0.75
MEX5	1.00	0.82	0.65	0.61	0.54	0.45	0.49

Conclusion



NANGAM is a first-of-its-kind “proof of concept” towards a more comprehensive approach of energy modelling

1. We developed a North American Natural Gas Model that includes the U.S., Canada, and Mexico.

2. The model is used to study the impacts that the Mexican Energy Reform will have in North America.

3. Results show that Mexico highly depend on infrastructure investment to reduce dependence from the U.S.

4. Failure of this reform will increase production capacity investment in the U.S. in order to satisfy demand in Mexico.

Any Questions?

Felipe Feijoo

ffeijoo@jhu.edu

Postdoctoral fellow
The Johns Hopkins University

Illustration of the supply chain in an energy system model

Supply chain illustration in a two-node, four-fuel setup

