Long-term Contracts and Efficiency in the Liquefied Natural Gas (LNG) Industry

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Motivation

- Many capital-intensive markets characterized by:
  - Large sunk cost investments
  - Small number of potential trading partners
  - Firms signing long-term contracts before investing
- Some illustrative examples
  - Automobile parts (Klein et. al., 1978)
  - Coal (Joskow, 1985)
  - Liquefied natural gas

Trade-offs

- Signing LT contracts *ex-ante* mitigates under-investment
  - More predictable revenue streams $\Rightarrow$ lower cost of financing
  - Without ex-ante contracting, trading partner may appropriate part of surplus in *ex-post* contract negotiations
- But long-term contracts less flexible than spot markets
  - Inhibit ability to respond to demand uncertainty
- Application: global LNG industry
  - Sellers make large upfront investments in export terminals ($\sim \$20bn$), typically *after* signing ex-ante long-term contracts
  - LNG subject to large demand fluctuations: but contracts are *rigid*: resale restrictions widely used

Research objectives

- How does the use of long-term contracts affect investment and allocative efficiency?
- Are there welfare gains from regulating the use of long-term contracting?
  - Evaluate the impacts of banning resale restrictions in long-term contracts

This Paper

- Develop multi-stage model of LNG investment, contracting and spot trade
  - Investment incentives affected by the *timing* of contracting
  - Contract rigidities inhibit flexibility, but contracts also have pro-competitive effects (Allaz and Vila, 1993)
- Estimate structural model using rich dataset of LNG contracts, universe of seller investments and LNG trade flows
- Preview of findings
  - Sellers reduce investment by 31% without long-term contracts; but sizeable allocative inefficiency from contract inflexibility
  - Banning resale restrictions in long-term contracts leads to reduced investment, but a 21% increase in welfare

Related Literature

- **Literature on long-term contracting & relationships**
  - e.g., Williamson, 1975; Grossman & Hart, 1986; Joskow, 1987; Edlin & Reichelstein, 1996; Blouin & Macchiavello, 2019; Ryan, 2022; MacKay, 2022; Dhingra et al., 2023; Darmouni et al., 2025; Fabra & Llobet, 2025; Harris & Nguyen, 2025
  - This paper: quantify the trade-off between under-investment and inflexibility when using long-term contracts
- **Contracts and allocative efficiency**
  - e.g. Allaz & Vila, 1993; Wolak, 2003; Bushnell, Mansur & Saravia, 2008; Ito & Reguant, 2016
  - This paper: measures misallocation from rigid contracts
- **Empirical bargaining literature**
  - e.g., Crawford & Yurukoglu, 2012; Grennan, 2013; Gowrisankaran, Nevo & Town, 2015; Ho & Lee, 2017, 2019
  - This paper: novel strategy for identifying bargaining power from the timing and size distribution of contracting and investment decisions

Overview of LNG Industry

- LNG market players
  - Sellers: national & international oil companies
  - Buyers: downstream users of natural gas (typically utilities)
- Trade requires investment in export (liquefaction) terminals
  - Time-to-build $\sim$ 5 years
- Two modes of LNG trade
  - Long-term contracts (75% of trade), typically lasting 20 years
    ◂ Contract Details
    - Contract specifies annual quantity and pricing formula
    - Often include *destination clauses* that prohibit resales
  - Short-term and spot trade (25% of trade)

Data

- Long-term contracts and LNG investments
  - Long-term contracts:
    - Observe signature date; start & end year; annual quantity
    - Contract prices are confidential and unobserved
  - Investments in export terminals:
    - Plant capacity; date of final investment decision; start-up year
- Yearly long-term & short-term trade flows for each country pair (2004-17)
- Spot prices and shipping costs: monthly from 2006-17 Summary Stats

Timing of contract signature and investment decision

Figure: Gap between contracting date and investment date

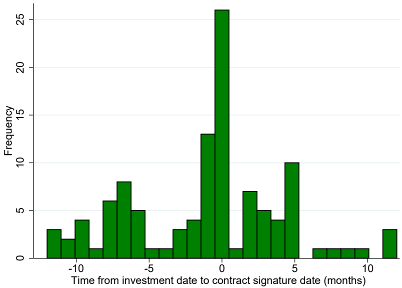
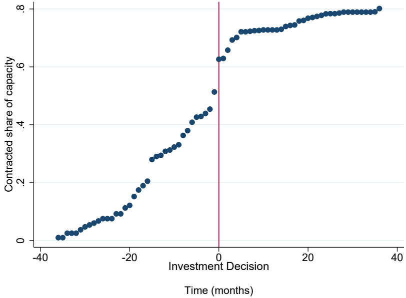


Figure: Cumulative share of capacity signed under LT contracts



- On average, **60%** of capacity contracted before investment decision date; only **23%** of capacity contracted afterwards

Further Evidence on Ex-Ante Contracts & Investment

- **Geography and Bargaining Power:** Greater use of ex-ante contracts when sellers have low bargaining leverage relative to buyers ▸ Details
  - When sellers are *more* geographically isolated
  - Or when buyers are *less* geographically isolated
- **Financing:** Ex-ante contracts associated with lower cost of investment (which includes cost of financing) ▸ Details

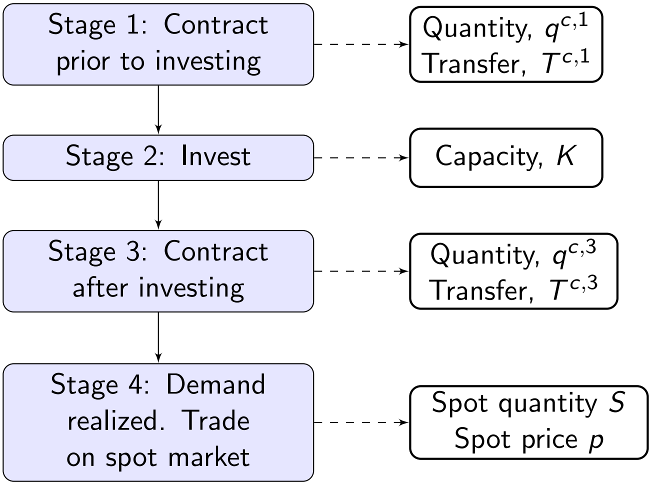
Evidence for contracting rigidities

Dependent variable: Share of seller i's output sold to buyer j		
	Est.	S.E.
Net price, p_{ijt}	1.52***	(0.16)
Net price $\times$ Share Contracted	-1.59***	(0.24)
Fixed Effects	Seller-Year, Seller-Buyer	
N	3,122	
Pseudo-R^2	0.40	

Note: Net price = Destination spot price - Shipping cost

- Sellers with a greater share of capacity committed under long-term contracts are *less* responsive to short-run price differentials

Model Overview



Demand, production costs and spot market

- Spatially differentiated sellers and buyers participate in a single global spot market every period
- Buyers have downward-sloping, volatile demand for LNG
- Sellers incur two kinds of short-run costs:
  - Production cost (depends on capacity K_i built by seller)
  - Shipping cost (depends on distance between seller and buyer)
- Sellers compete in quantities (Cournot)
  - In equilibrium, this results in spatial price discrimination

Details Demand Estimation Cost Estimation

Contracting and investment

- Sellers choose investment to maximize expected net PV of investing
  - Sunk cost of investment
    $C^K(K_i, \nu_i) = (\gamma_1 + \nu_i)K_i + \frac{\gamma_2}{2}K_i^2 + \gamma_3 K^{\text{uncommitted}_i}$
  - γ_3: Increase in financing cost if ex-ante contracts not used
- Sellers & buyers Nash bargain over contract quantity & transfer for both ex-ante and ex-post contracts ▸ Details
  - Contract quantity q chosen to maximize joint surplus
  - Lump-sum transfer T chosen to split surplus
  - $\tau \in [0, 1]$ denote's seller's Nash bargaining weight
- Bargaining leverage depends on the *timing* of contracting
  - Stage 3, investment sunk $\rightarrow$ seller's bargaining leverage weak
  - Stage 1, pre-investment $\rightarrow$ seller's bargaining leverage strong

▸ Bargaining power

Estimation of investment cost and bargaining parameter

- Use the first-order conditions of the contracting and investment problems, solving the game via backward induction
- Bargaining weight identified from variation in *outside options* of buyers and sellers across space and over time
  - Intuition: the lower the seller's bargaining power, the stronger the incentive to sign contracts ex-ante
- Computational challenge: need to solve for spot market equilibrium many times in order to compute expected payoffs
  - Use parametric approximations of payoff function (Sweeting, 2013; Barwick and Pathak, 2015)

Estimated parameters

Non-linear least squares estimates	Coeff	SE
Seller bargaining weight, τ	0.63	(0.09)
Investment cost (linear), γ_1	31.95	(7.77)
Investment cost (linear) $\times$ $\mathbb{1}\{\text{Greenfield}\}$, γ_1^{GF}	10.25	(7.77)
Investment cost (quadratic), γ_2	-0.16	(0.13)
Financing cost, γ_3	3.50	(4.66)

- Seller bargaining power of 0.63 $\rightarrow$ buyers have sizeable bargaining leverage

  - On average, sellers' marginal return on investment is 38% lower than the joint return on investment by buyers and sellers

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- Average cost of building capacity estimated to be $2 bn per MT
    - Greenfield projects are more costly
    - Ex-ante contracts reduce investment costs by 6-7%

Roadmap for counter-factuals

- Quantify key trade-off involved in using long-term contracts, between contract rigidity and under-investment
    - (1) What is the effect of using contracts on allocative efficiency?
    - (2) What is the effect of using contracts on investment?
- (3) Evaluate effect of regulations banning the use of resale restrictions in long-term contracts

Contracts and Allocative Efficiency

- Holding capacity fixed, shut down use of long-term contracts
- Two competing effects
  - Increased flexibility
  - Greater deadweight loss from market power (Allaz and Vila, 1993)
- Flexibility effect dominates ⇒ Short-run surplus rises by 2.4%

Industry SR surplus ($ bn)	Benchmark	No Contracting	% change
Baseline Assumptions	**895**	**916**	**2.4%**
Competitive Spot Market	901	943	4.7%
No Demand Uncertainty	823	815	-0.9%

Contracts and Investment

- Examine investment in the absence of any long-term contracting
- On average, investment decreases by 31%
    - Mostly due to not being able to sign *ex-ante* contracts

	Average capacity (mtpa)	% change
Benchmark	6.84	
No contracting	4.72	*-30.9%*
No ex-ante contracting	4.94	*-27.8%*

Counterfactual: Remove Resale Restrictions

- Longstanding anti-trust concerns about destination clauses (resale restrictions) in long-term contracts
  - Both European Commission and Japan's FTC have attempted to prohibit destination clauses in new LNG contracts
  - But LNG exporters generally favor destination clauses
- Two effects of prohibiting resale restrictions
  - Gains in allocative efficiency through arbitrage
  - Reduces sellers' ability to price discriminate and therefore sellers' return to investment
- Counter-factual: prohibit destination clauses starting from the year 2012 Implementation

Counterfactual: Remove Resale Restrictions

- Investment decreases by 29.7%
- Despite this, net welfare gains of 21.2%
  - Buyers gain substantially, but sellers made worse off
  - Unsurprising that regulators in EU/Japan have found it difficult to persuade sellers to give up on resale restrictions

	Benchmark	No resale restrictions	% change
Welfare ($ bn)	1,534	1,860	*21.2%*
Seller surplus ($ bn)	244	233	*-4.5%*
Buyer surplus ($ bn)	1,289	1,626	*26.1%*
Avg. capacity (mtpa)	7.15	5.03	*-29.7%*
Avg. contract price ($/MMBtu)	7.92	7.66	*-3.4%*
Avg. spot price ($/MMBtu)	9.42	8.86	*-6.0%*

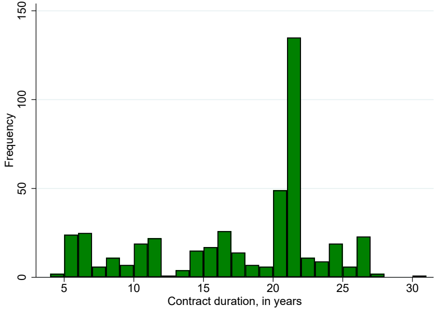
Conclusion

- I develop an empirical model to quantify the effect of long-term contracts on investment and allocation in the LNG industry
    - Buyer bargaining power impedes sellers' incentives to invest, leading to incentive to sign long-term contracts
    - Sellers reduce investment by 31% if they cannot sign contracts
- Removing resale restrictions leads to reduced investment but a 21% increase in welfare, due to greater allocative efficiency

Thank you!

Long-Term Contracts: Structure

- Typical contract specifies:
  - Annual quantity (observed)
    - Exact timing of shipments within-year left unspecified, allowing adaptation to weather shocks (Thomas et al., 2023)
  - Pricing formula (unobserved): typically indexed to oil price
  - Duration (observed)
  - Take-or-pay provision (unobserved): buyer must take (or pay for) at least $X\%$ (90-100%) of the agreed volume



Long-Term Contracts: Destination Clauses

- Long-term contracts often include *destination clauses* that prohibit resales
  - Facilitating price discrimination by sellers
  - Some contracts include a "diversion" clause that allows the parties to negotiate cargo diversions to a third destination
- These clauses have come under challenge from antitrust authorities in LNG importers in recent years
  - European Commission has attempted to prohibit destination clauses, with mixed success
    - Recent Total-Qatargas LT contracts reported to feature destination clauses
  - Japan's Fair Trade Commission prohibited destination clauses in new LNG contracts in 2017

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Summary Statistics

	Obs.	Mean	S.D.	Min	Max
Panel A. Exporter-Importer-Year					
Spot Trade (mt)	6,406	0.10	0.39	0	7.70
Contracted Trade (mt)	6,406	0.35	1.47	0	23.90
Shipping Cost (US$/MMBtu)	9,812	1.30	0.87	0.06	5.08
Panel B. Importer-Year					
Total Imports (mt)	359	8.24	15.45	0	89.19
Spot Prices (US$/MMBtu)	317	8.65	3.65	2.52	16.59
Panel C. Contract-level					
Quantity (mtpa)	464	1.28	1.10	0.04	5.20
Duration (years)	464	17.23	6.41	4	42
Years from signature to start	464	3.61	2.17	0	12
Panel D. Investment-level					
Capacity (mtpa)	74	6.94	5.02	0.50	28.90
Years from FID to start	74	4.30	1.32	2.00	9.08
Investment Cost ($bn/mtpa)	53	0.87	0.74	0.12	3.33

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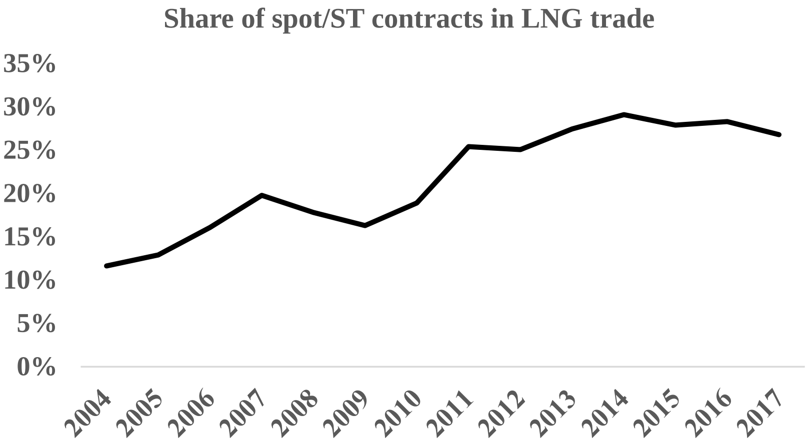
Share of spot trade over time



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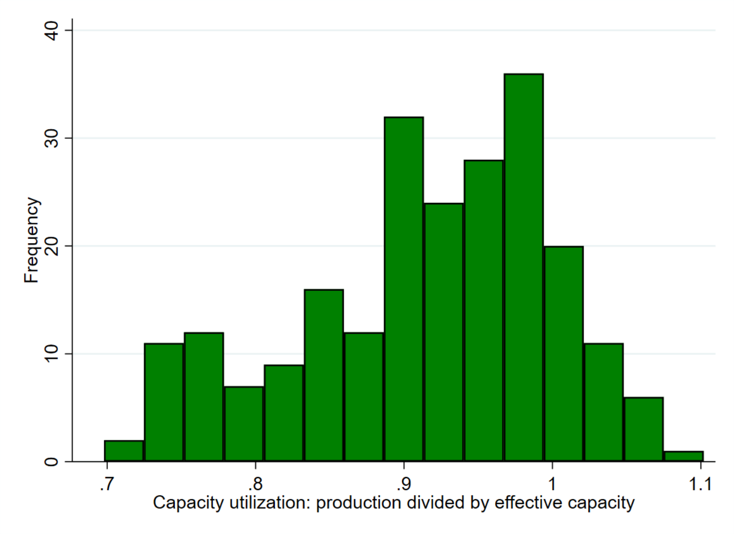
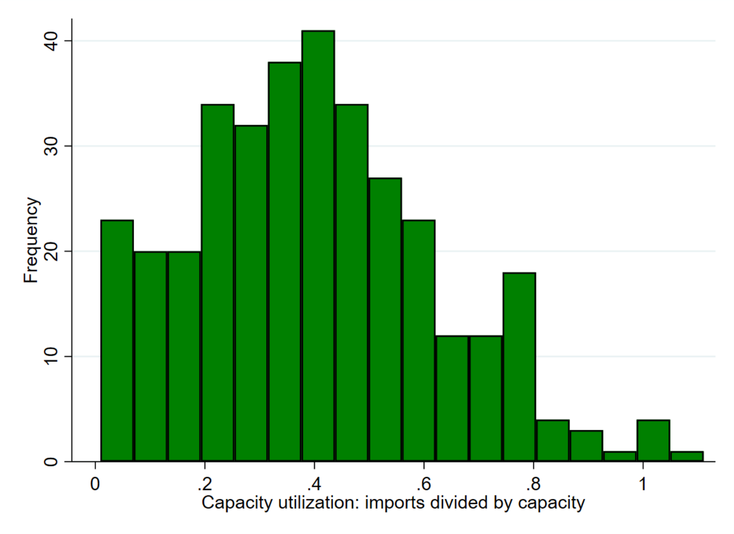
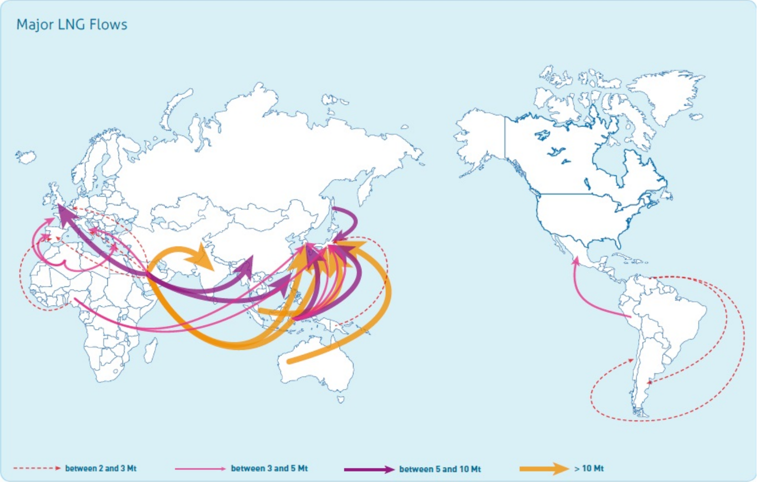
Seller capacity utilization



Buyer capacity utilization

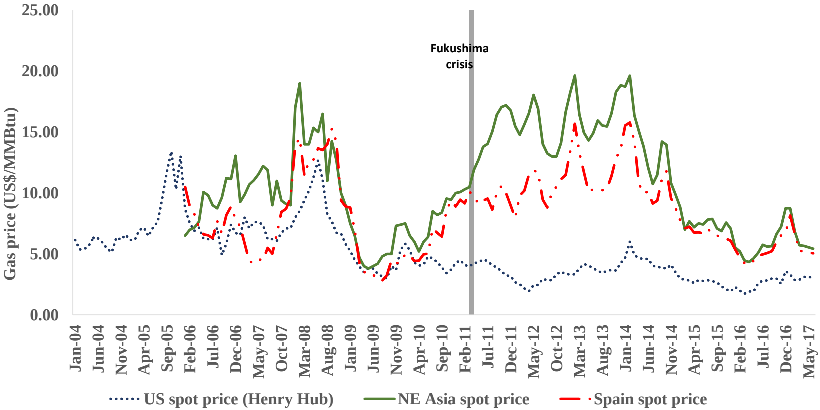


LNG Trade Flows, 2014



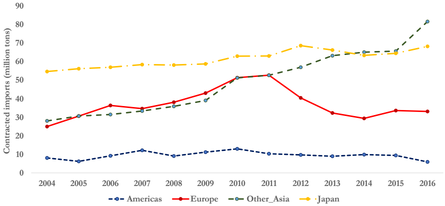
Source: GIIGNL, 2015

Spot price differentials across regions

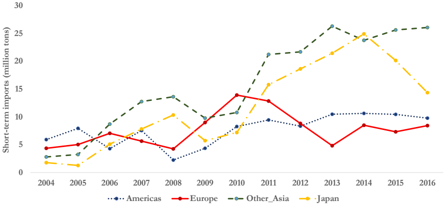


Trade Flows

Trade flows: long-run and short-run



(a) Imports under long-term contracts

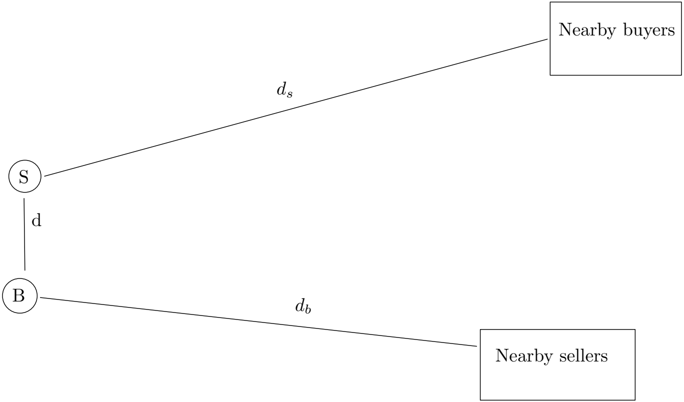


(b) Imports under short-term and spot contracts

Contract quantity and bargaining power

- Do sellers and buyers that are more geographically isolated sign larger ex-ante contracts?
  - Measuring geographic isolation
    - First, define *distance from nearby buyers* = 25th percentile of the distance from the seller to all buyers
    - Then, define *relative distance to nearby trading partners*: defined as distance to nearby trading partners divided by the distance to the contracted trading partner
- If relative distance to nearby trading partners is high, the contracted buyer has greater bargaining leverage $\Rightarrow$ incentive to sign larger ex-ante contract

Geography and bargaining power



Geography and Ex-Ante Contracting

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- If seller is relatively far from alternative buyers, then ex-ante contracts are larger
- If buyer is relatively far from alternative sellers, then ex-ante contracts are smaller

	Est.	S.E.
Ex-ante × Relative distance, seller	0.17***	(0.044)
Ex-ante × Relative distance, buyer	-0.15***	(0.037)
Relative distance, seller	-0.012	(0.017)
Relative distance, buyer	0.011	(0.0091)
Ex-ante contract	0.024	(0.035)
N	337	
R^2	0.29	

Dep. var.: Contract quantity as share of plant capacity. Relative distance = distance to alternative partners / distance to current partner. Other controls include distance, capacity, extension dummy, time trend and greenfield dummy. Unit of observation: long-term contract.

Ex-Ante Contracting and Financing Costs

- Projects with a greater share of capacity committed to ex-ante contracts have a lower average investment cost
- Consistent with the mechanism that securing ex-ante volume commitments lowers the risk profile of the project, enabling sellers to obtain cheaper financing

	Est.	S.E.
Share of ex-ante contracting	-0.792**	(0.367)
log(Capacity)	-0.178	(0.148)
Other Controls	Exporter FE, Time Trend, Greenfield	
N	53	
R^2	0.61	

Dep. var.: Average investment cost (USD bn/mtpa), includes capitalised cost of external finance. Unit of observation: investment project.

Demand

- Each buyer j has a downward sloping demand curve for gas,

$$Q_j = Q_d(p_j, x_j, \varepsilon_j)$$

  - p_j: spot price paid by j
  - x_j: demand shifters
  - ε_j: demand shock
- Demand uncertainty
  - ε_j realized *after* parties sign contracts/invest, but *before* parties trade on spot market
  - ε_j assumed to be i.i.d. over time, for tractability
    - Implies agents have perfect foresight over future contracting and investment decisions

Production and Trade Costs

- Each seller i has capacity K_i
- LNG sales from i to j:

$$q_{ij} = \underbrace{q_{ij}^c}_{\text{Contracted}} + \underbrace{S_{ij}}_{\text{Spot}}$$

- Seller i's total LNG sales:

$$q_i = \sum_j q_{ij}$$

- Two components of costs
  - Cost of production $= C(q_i, K_i)$
  - Shipping cost from i to j equals $d_{ij} q_{ij}$

Spot Market

- Sellers compete in quantities (Cournot)
  - Each seller i chooses vector of spot quantities, $\{S_{ij}\}_{j=1}^{J}$, to sell in each market j
  - All markets clear simultaneously
- FOC:

$$\underbrace{p_j^* + S_{ij}\frac{\partial p_j^*(S_{ij}, S_{-ij})}{\partial S_{ij}}}_{MR \text{ from market } j} - \underbrace{\left(\frac{\partial C(q_i, K_i)}{\partial S_{ij}} + d_{ij}\right)}_{MC \text{ of selling to market } j} \leq 0$$

- Features
  - Capacity constraints create spatial interdependence across markets
  - Sellers engage in spatial price discrimination

Demand estimation

- We estimate the following demand curve for importing country j:

$$ln(Q_{jt}) = \alpha - bp_{jt} + x_{jt}\theta_{dx} + \theta_j + \theta_{quarter} + \varepsilon_{jt} \qquad (1)$$

  - x_{jt}, demand shifters: electricity consumption from fossil fuels, minimum temperature (to capture heating demand), oil price
  - Include country (θ_j) and quarter ($\theta_{quarter}$) fixed effects
  - ε_{jt}: unobserved demand shocks

- Instrument for price p_{jt} using demand shifters in other countries (minimum temperature in rival countries; rival electricity consumption from fossil fuels, and rival electricity generation from baseload sources)

Demand Curve Estimates

Dep. Var: log(total LNG imports)	
Spot Price	-0.106
	(0.055)
log(Electricity Consumption)	1.115
	(0.201)
Min. temp. (standardized)	-0.092
	(0.027)
Oil Price	0.018
	(0.0056)
N	815
1st-stage F statistic	10.1

- Price elasticity of demand: -0.95 for median observation

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Estimating production costs

- Production cost: $C(q_{it}, K_{it}) = c\, q_{it}$ for $q_{it} \leq K_{it}$
    - Constant marginal cost c up to binding capacity constraint
    - Estimate c via non-linear least squares
- We use the seller's FOC for estimation:

$$\underbrace{p_j^* + S_{ij} \frac{\partial p_j^*(S_{ij}, S_{-ij})}{\partial S_{ij}}}_{MR} - \underbrace{\left(\frac{\partial C(q_i, K_i)}{\partial S_{ij}} + d_{ij} \right)}_{MC} \leq 0$$

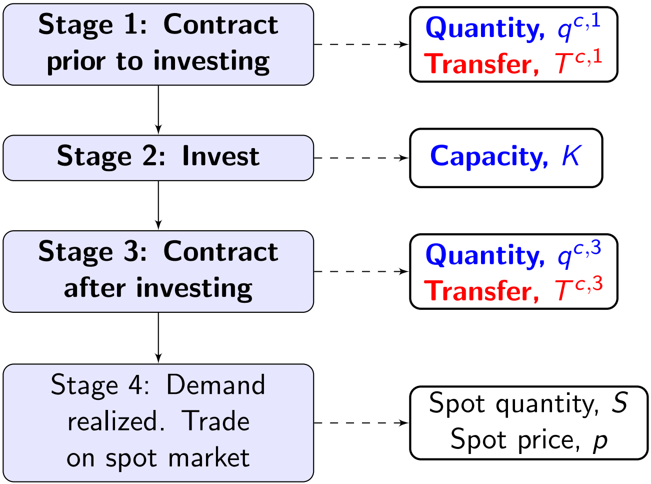
- Identified by variation in capacity utilization as demand changes

Cost estimates

Marginal cost, c	5.42
	(0.0068)
N	3245
Buyers	40
R^2 for prices p_j	0.87
R^2 for production q_i	0.98
R^2 for spot trade flows S_{ij}	0.22
R^2 for regional spot trade flows S_{ij}	0.51

- Marginal cost of $5.42/MMBtu, consistent with practitioner estimates Back

Contracting and Investment Model



Decisions

- $q^{c,1}$: contract quantity in Stage 1 (ex-ante)
- $T^{c,1}$: lump-sum transfer in Stage 1 (ex-ante), paid by buyer to seller
- K: investment in Stage 2
- $q^{c,3}$: contract quantity in Stage 3 (ex-post)
- $T^{c,3}$: lump-sum transfer in Stage 3 (ex-post), paid by buyer to seller

Payoff components

- Seller's lifetime expected payoff at the end of Stage 3:

$$V_i^3(q^{c,1}, q^{c,3}, K) = \sum_t^{\infty} \beta^t \underbrace{\pi_{it}^s(q^{c,1}, q^{c,3}, K)}_{\text{Expected profits}}$$

- Buyer's lifetime expected payoff at the end of Stage 3:

$$W_j^3(q^{c,1}, q^{c,3}, K) = \sum_t^{\infty} \beta^t \underbrace{\pi_{jt}^b(q^{c,1}, q^{c,3}, K)}_{\text{Expected consumer surplus}} + \underbrace{(\theta_1 + \eta_{ij}^1)q^{c,1} + \frac{\kappa_1}{2} {q^{c,1}}^2}_{\text{Contract premium in Stage 1}} + \underbrace{(\theta_3 + \eta_{ij}^3)q^{c,3} + \frac{\kappa_3}{2} {q^{c,3}}^2}_{\text{Contract premium in Stage 3}}$$

- Allow buyers to value contracted LNG and spot LNG differently (e.g. supply assurance, transaction costs, trading frictions)

$$\text{Per-unit contract premium in Stage 1} = \theta_1 + \kappa_1 q_{ij}^{c,1} + \eta_{ij}^1$$

$$\text{Per-unit contract premium in Stage 3} = \theta_3 + \kappa_3 q_{ij}^{c,3} + \eta_{ij}^3$$

Stage 3: contracting after investment

- Seller and buyers bargain over contract quantity and lump-sum transfer (Nash-in-Nash), similar to Chipty and Snyder (1999)
- First, choose contract quantity $q_{ij}^{c,3}$ to maximize joint surplus

$$q_{ij}^{c,3} = argmax_{q_{ij}} \left[\underbrace{V_i^3(q^{c,1}, q^{c,3}, K)}_{\text{Seller's payoff}} + \underbrace{W_j^3(q^{c,1}, q^{c,3}, K)}_{\text{Buyer's payoff}} \right]$$

  - Taking sunk capacity K as given
- Second, Nash bargain over transfer $T_{ij}^{c,3}$

$$T_{ij}^{c,3} = argmax_T \Big(\underbrace{V_i^3(q^{c,1}, q^{c,3}, K) - V_i^3(q^{c,1}, q_{\setminus ij}^{c,3}, K) + T}_{\text{Seller's gains from trade}} \Big)^{\tau} \Big(\underbrace{W_j^3(q^{c,1}, q^{c,3}, K) - W_j^3(q^{c,1}, q_{\setminus ij}^{c,3}, K) - T}_{\text{Buyer's gains from trade}} \Big)^{1-\tau}$$

  - $\tau \in [0, 1]$ is seller's bargaining power

Stage 2: investment

- Seller i's payoff from building capacity $K = V_i^2(q^{c,1}, K)$
  - V_i^2 equals the sum of V_i^3 and any transfers received in Stage 3
- Sunk cost of investment
  $C^K(K_i, \nu_i) = (\gamma_1 + \nu_i)K_i + \frac{\gamma_2}{2}K_i^2 + \gamma_3 K^{\text{uncommitted}_i}$
- Seller i solves the following maximization problem:

$$K_i = argmax_K \left[V_i^2(q^{c,1}, K) - C^K(K, \nu_i)\right]$$

Stage 1: contracting before investment

- First, choose contract quantity $q_{ij}^{c,1}$ to maximize joint surplus

$$q_{ij}^{c,1} = argmax_{q_{ij}} \Big[\underbrace{V_i^1(q^{c,1})}_{\text{Seller's payoff}} + \underbrace{W_j^1(q^{c,1})}_{\text{Buyer's payoff}} \Big]$$

- Second, Nash bargain over transfer $T_{ij}^{c,1}$

$$T_{ij}^{c,1} = argmax_T \Big(\underbrace{V_i^1(q^{c,1}) - V_i^1(q_{\setminus ij}^{c,1}) + T}_{\text{Seller's gains from trade}} \Big)^{\tau} \Big(\underbrace{W_j^1(q^{c,1}) - W_j^1(q_{\setminus ij}^{c,1}) - T}_{\text{Buyer's gains from trade}} \Big)^{1-\tau}$$

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Model features

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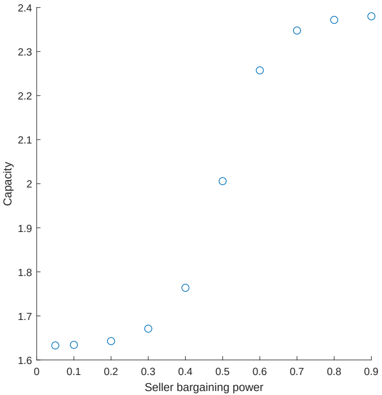
- If sellers and buyers *cannot* commit to ex-ante contracts
  - Sellers under-invest
  - The lower the seller's bargaining power, the more severe the under-investment Picture
- If sellers and buyers *can* commit to ex-ante contracts
  - Ex-ante contracts used to increase investment
  - Greater share of ex-ante contracting if:
    - The seller's Nash bargaining weight is lower Picture
    - The seller's outside option is less attractive Evidence

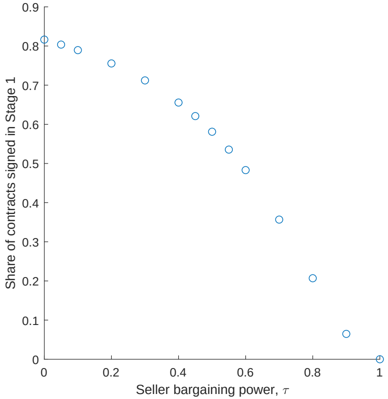
Sellers underinvest if they cannot pre-contract

- If sellers and buyers *cannot* sign contracts prior to investment
  - Sellers under-invest
  - The lower the seller's bargaining power, the more severe the under-investment Back



Seller bargaining power and pre-investment contracting

- If sellers and buyers *can* commit to ex-ante contracts
  - Ex-ante contracting used to increase investment
  - Greater share of contracting takes place ex-ante if sellers have limited bargaining leverage Back



Estimation of investment cost and bargaining parameter

- Computational challenge: need to solve for spot market equilibrium many times in order to compute expected payoffs
- Instead, use parametric approximations of the payoff functions
- Strategy:
  - Forward simulation to obtain expected lifetime payoffs
  - Approximate payoff function with a parametric, differentiable function of contract quantities and capacity
- Estimate parameters via non-linear least squares

Remove Resale Restrictions: Implementation Details

- Counter-factual: prohibit destination clauses starting from the year 2012
- Implementation:
  - Assume buyers can freely resell contracted LNG
  - Assume sellers compete in a Cournot game faced with the threat of arbitrage, so that the spatial allocation of LNG is competitive
  - To simplify computation, assume each seller contracts with only one buyer

Back

Implementation of counterfactuals

- Solving full equilibrium of the game is computationally difficult, so I make the following simplifying assumptions
  - Each seller negotiates with only one buyer (pre-investment)
  - Assume policy implemented in T: only projects built after period T can adjust investment/contracting
- Solve for equilibrium investment and contracting via a Gauss-Jacobi algorithm
  - At each iteration, solve for the subgame perfect equilibrium choices made by the buyer and seller involved in each investment project, taking as given choices made by other buyers and sellers

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