The Economics of LNG Export Contract Flexibility: a quantitative approach

Yichi Zhang, Chi Kong Chyong, Pierre Noël

EPRG, University of Cambridge

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- Introduction:
  - Gas market and long term contracts (LTC)
  - Research questions
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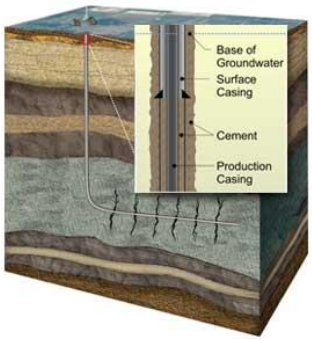
  - Value of LNG contracts flexibility
  - Gas market equilibrium model
- Results:
  - Impact of LTC flexibility on prices
  - Impact of LTC flexibility on producer profits and market efficiency.
  - Sensitivity analysis
- Conclusion

❑ Golden Age for Natural Gas?

IEA: Gas consumption could rise more than 50% over the next 25 years.

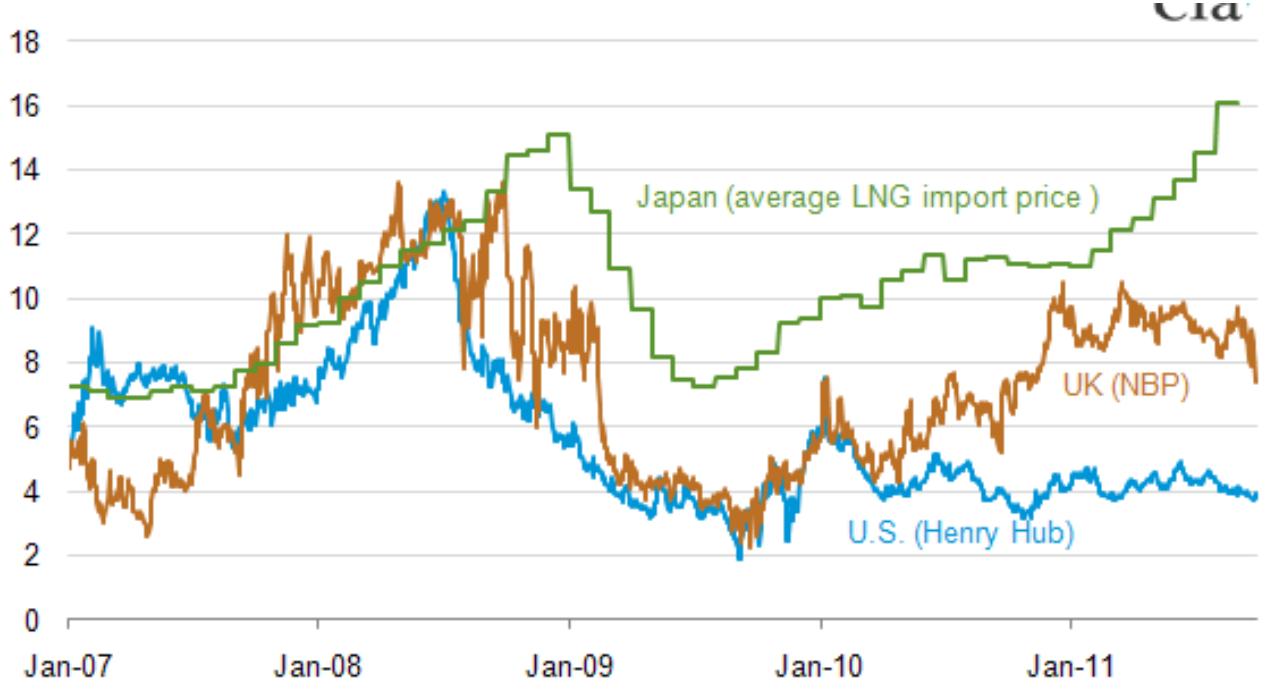
- ➢Massively expanding unconventional gas in North America.
- ➢Uncertainty about nuclear power after Fukushima
- ➢Surging gas demand, especially in emerging markets (e.g, China, India, Middle East)



Introduction: Gas market and long term contracts (LTC)

- Price divergence in the different regional markets

Figure: Trends in the Prices of Global Gas Market (US$/Mbtu)



- Japanese LNG buyers push for more flexible contracts

Introduction: Gas market and long term contracts (LTC)

- Long-term Contracts (LTC) - little flexibility
  - Length of 15-20 years
  - The price of LTC gas is linked to the price of oil
  - Take-or-pay (ToP) term (typical: 80%-120%)
- Spot Markets – fully flexible
  - Price decoupled from the oil price
  - Liberalisation of the gas markets
  - Henry Hub (HH, US) ; National Balancing Point (NBP, UK); Title Transfer Facility (TTF, EU); Japan Korea Maker (JKM, Pacific Asia)

Introduction: Research questions

- With more flexible LNG contracts,
  - will producers gain more profits?
  - will consumers have more surplus?
  - will the whole market efficiency increase?

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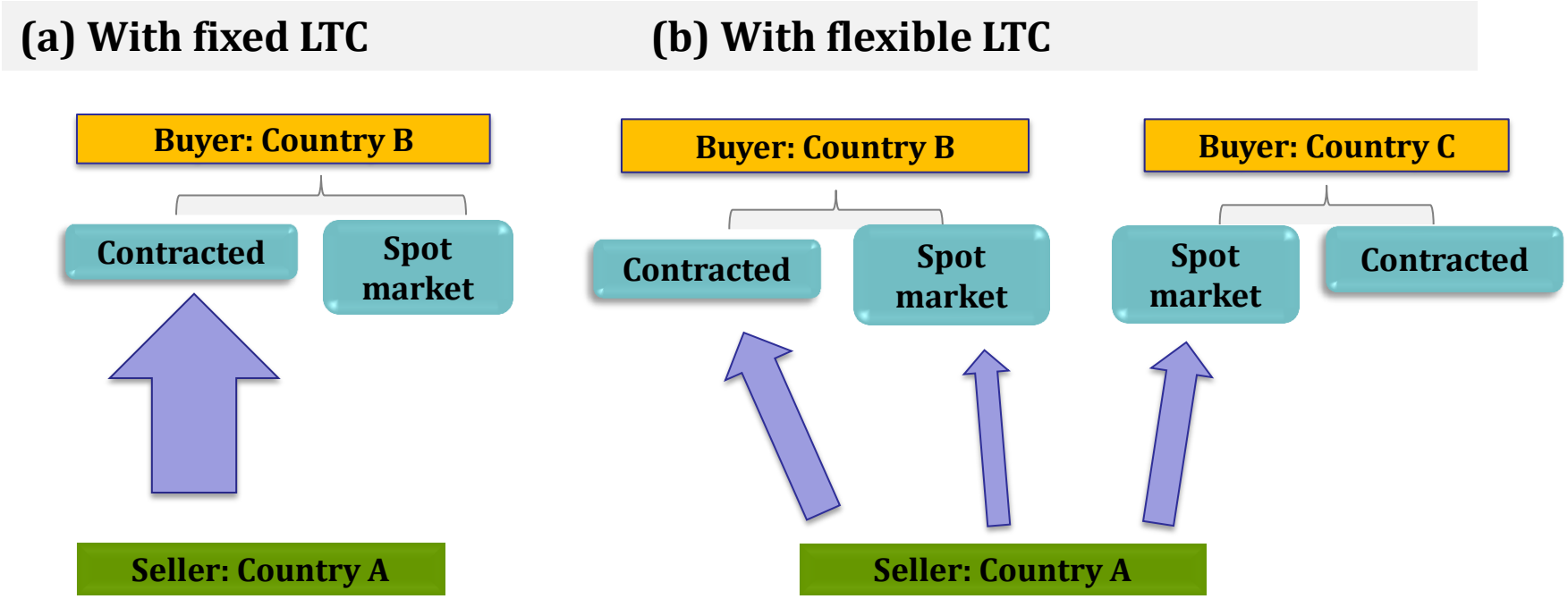
Methodology: Value of LNG contract flexibility



- **Value of LTC flexibility:** differences in producer profits, consumer surplus and market efficiency between two scenarios
- **Time frame:** 2012-2020

Methodology: Global gas market model

❑ Concept:

Maximization of the profit of each market player (producers, suppliers, pipeline transmitters, LNG operators) under a series of constraints.

➢ Objective functions:

Max profit of producer =

$$Spot\ Price \times Spot\ sale + LTC\ price \times LTC\ sale - Cost\ of\ transportation, and\ production$$

➢ Constraints:

$$Production\ quantity \leq Production\ capacity$$

$$Sales\ from\ spot\ market + sales\ from\ LTC \leq shipping\ quantity$$

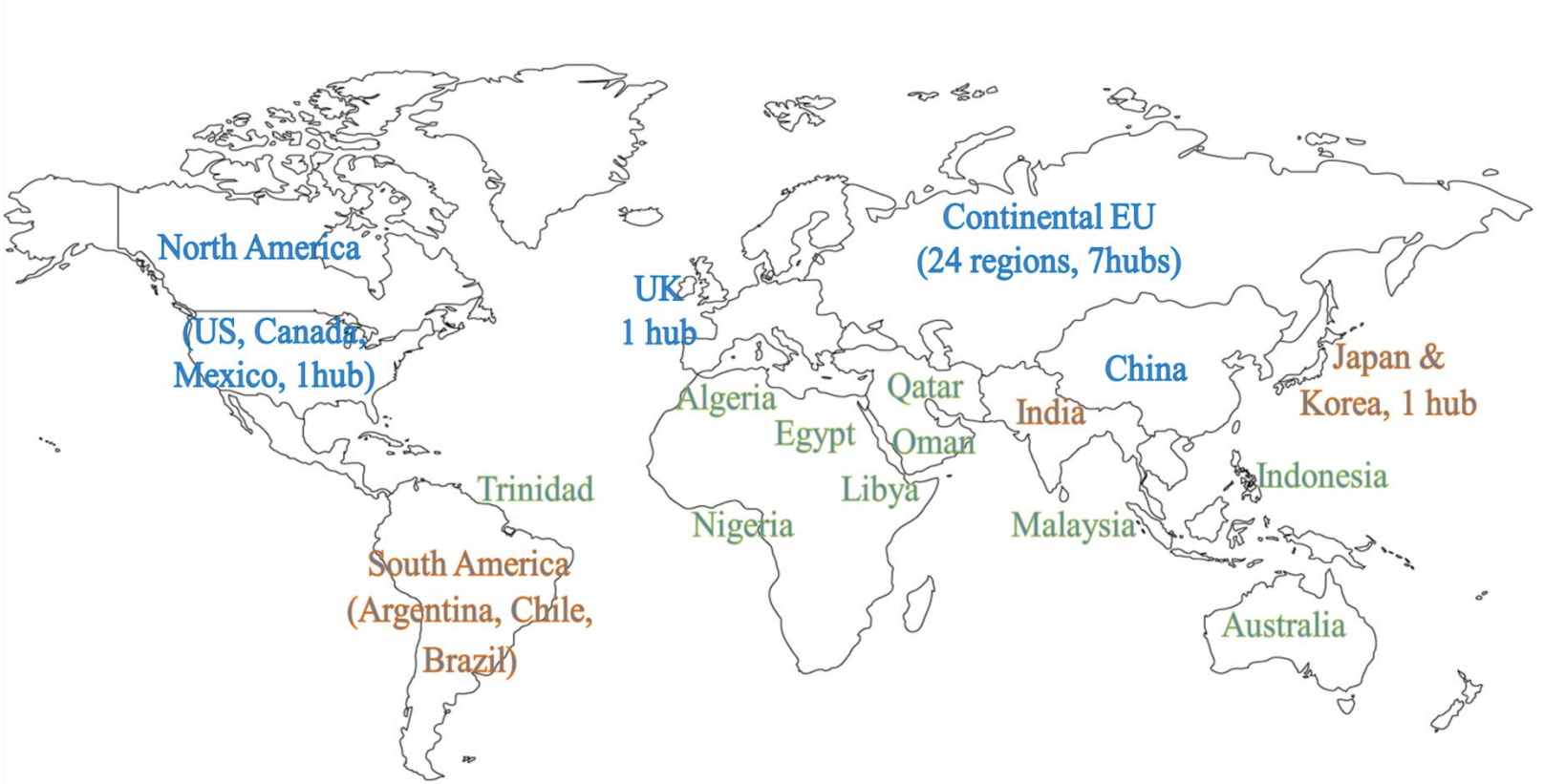
$$And\ more...$$

❑ Model assumptions:

- Demand curves for spot prices are calibrated at assumed elasticity and reference price-quantity pairs;
- LTC price linked with oil price;
- Producers are assumed with market power
- The LTC to North America and United Kingdom are already fully flexible,

Methodology: Global gas market model

- Extend the market in the model from Europe to worldwide
- Aggregate nearby markets into blocs of consumption regions



Red: net importers Green: net exporters Blue: exporters and importers

Methodology: Data source

Data	Source
Production Capacities	IEA World Energy Outlook (2011), BP Statistic Review (2011, 2012)
Liquefaction/Regasification capacities	IGU (2010, 2011)
LNG Shipping Cost	EIA (2003) and online distance voyage distance calculator
Production and other costs	Golombek (1995), Chyong and Hobbs (2011)
Reference Consumption	BP statistic Review (2011, 2012), IEA WEO (2010, 2011)
Long-term contract volumes	Bloomberg LNG contract database
Reference Price	Platts (Japan JKM), Bloomberg (NBP, TTF, Oil), IEA Energy Price and Tax 2004, 2007, 2012

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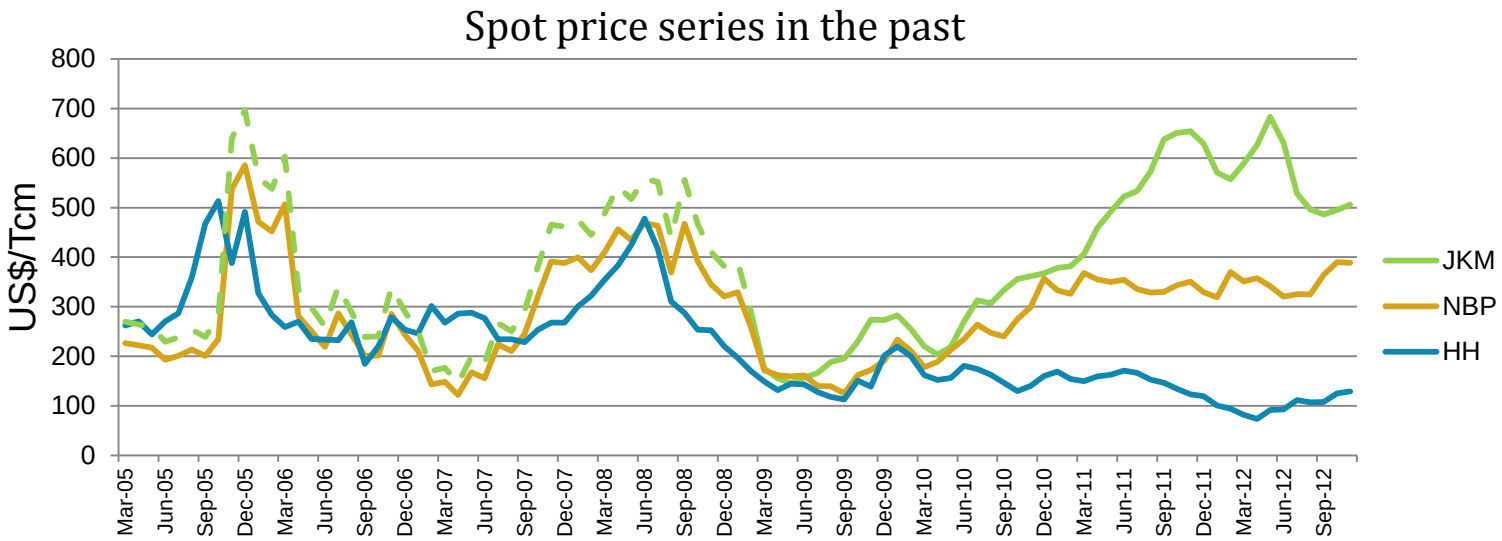
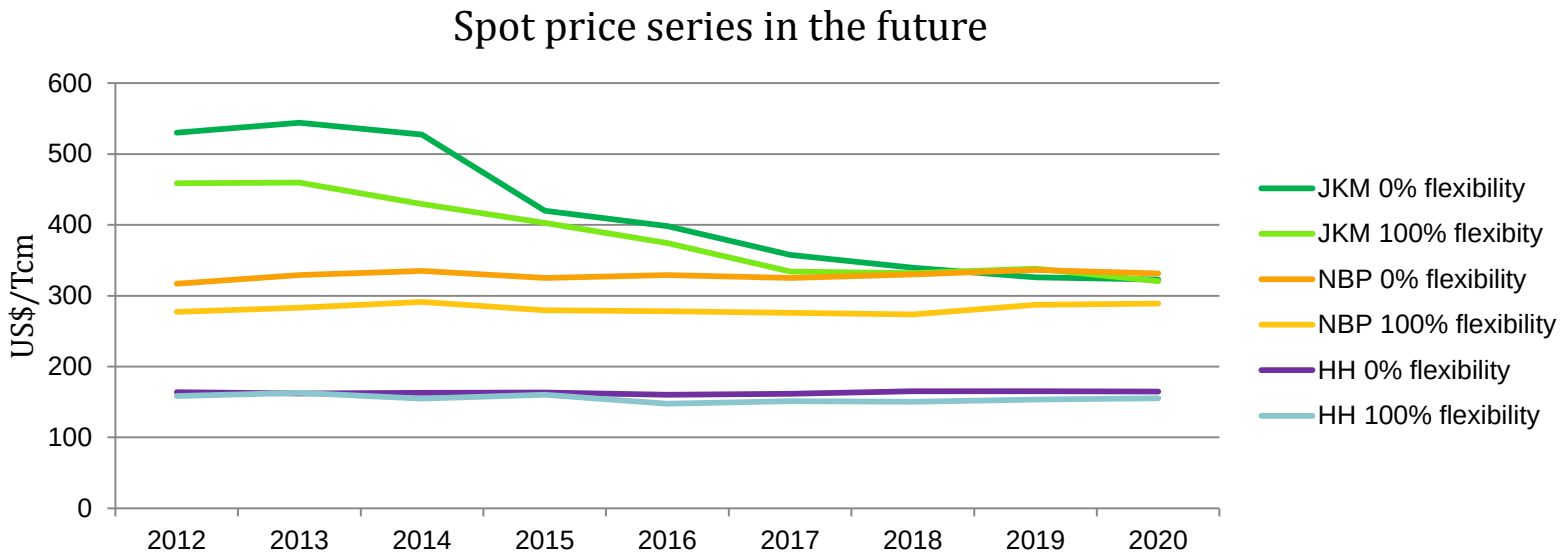
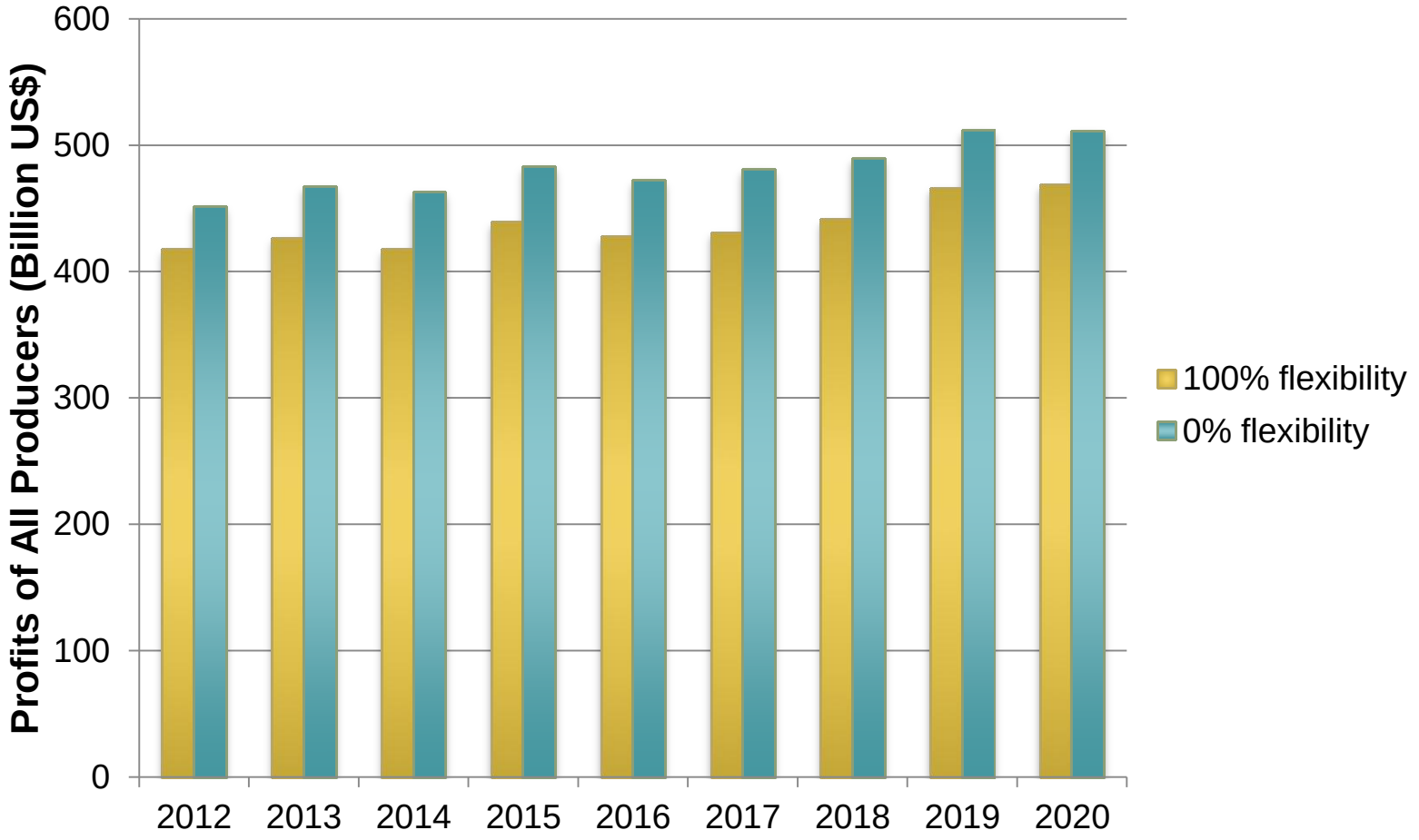
Results: Impact of LTC flexibility on prices





Results: Impact of LTC flexibility on producer profits

Figure: Profits of All Producers with 0% Flexibility and 100% Flexibility from 2012 to 2020



Results: Impact of LTC flexibility on producer profits

Figure: Profit of Producers with 0% Flexibility

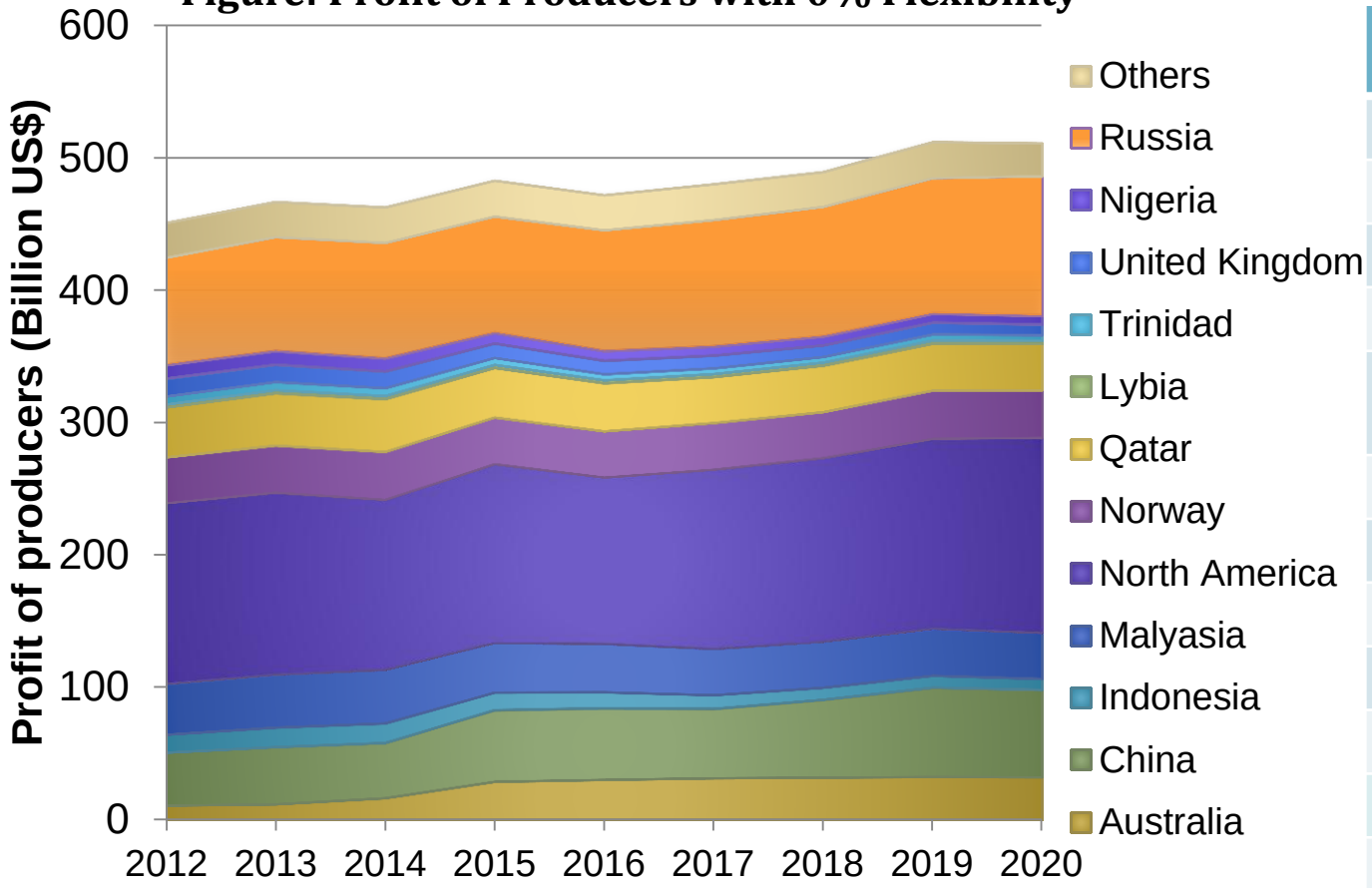


Table: Average Change in Profits as LTC flexibility becomes 100%

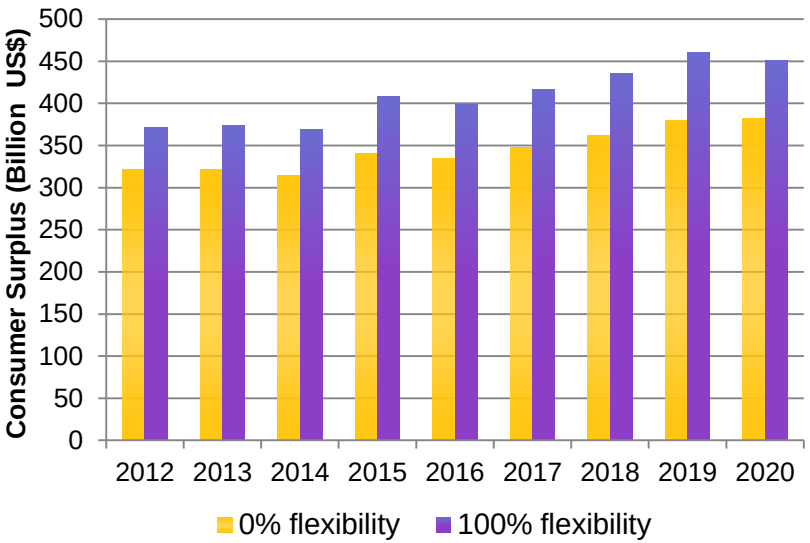
Country	Average Change
Australia	-29.73%
China	-10.30%
Indonesia	-16.17%
Malyasia	-26.06%
North America	-2.08%
Norway	-7.95%
Qatar	-26.06%
Lybia	-8.59%
Trinidad	-10.25%
UK	-11.93%
Nigeria	-5.24%
Russia	-3.45%
Others	5.02%

Results: Impact of LTC flexibility on welfare

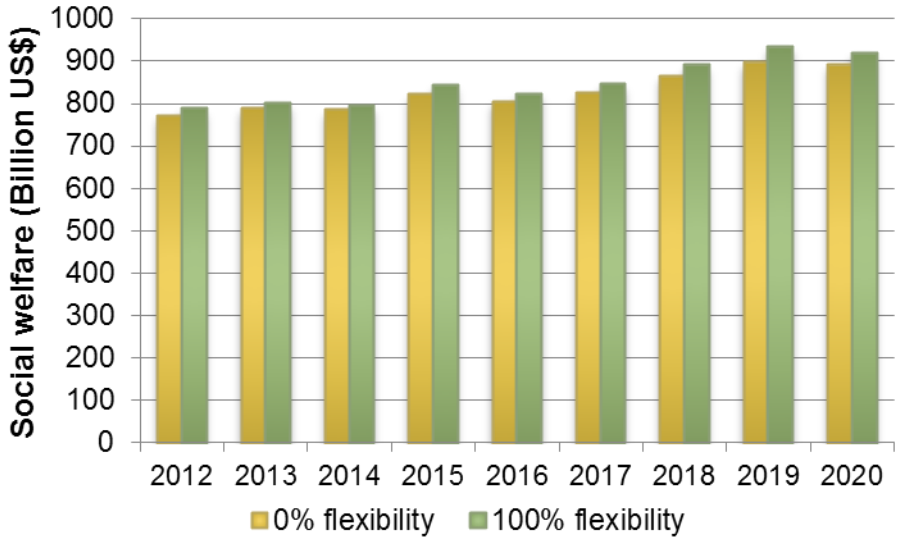
Consumer surplus : the difference between the total amount that consumers are prepared to pay and the total amount that they actually pay.

Social welfare= Profit of all producers + Total consumer surplus

Figure: (a) Consumer Surplus and (b) Social Welfare with 0% Flexibility and 100% Flexibility



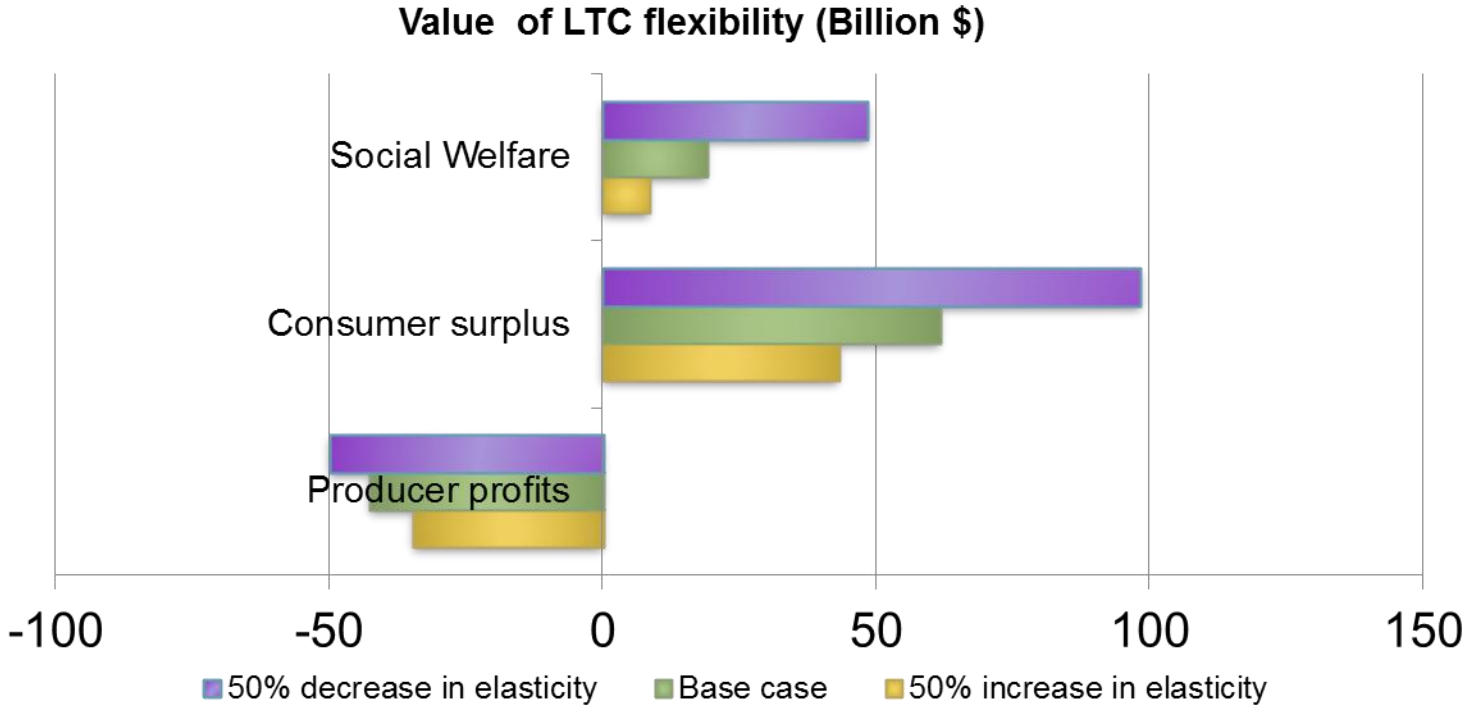
(a)



(b)

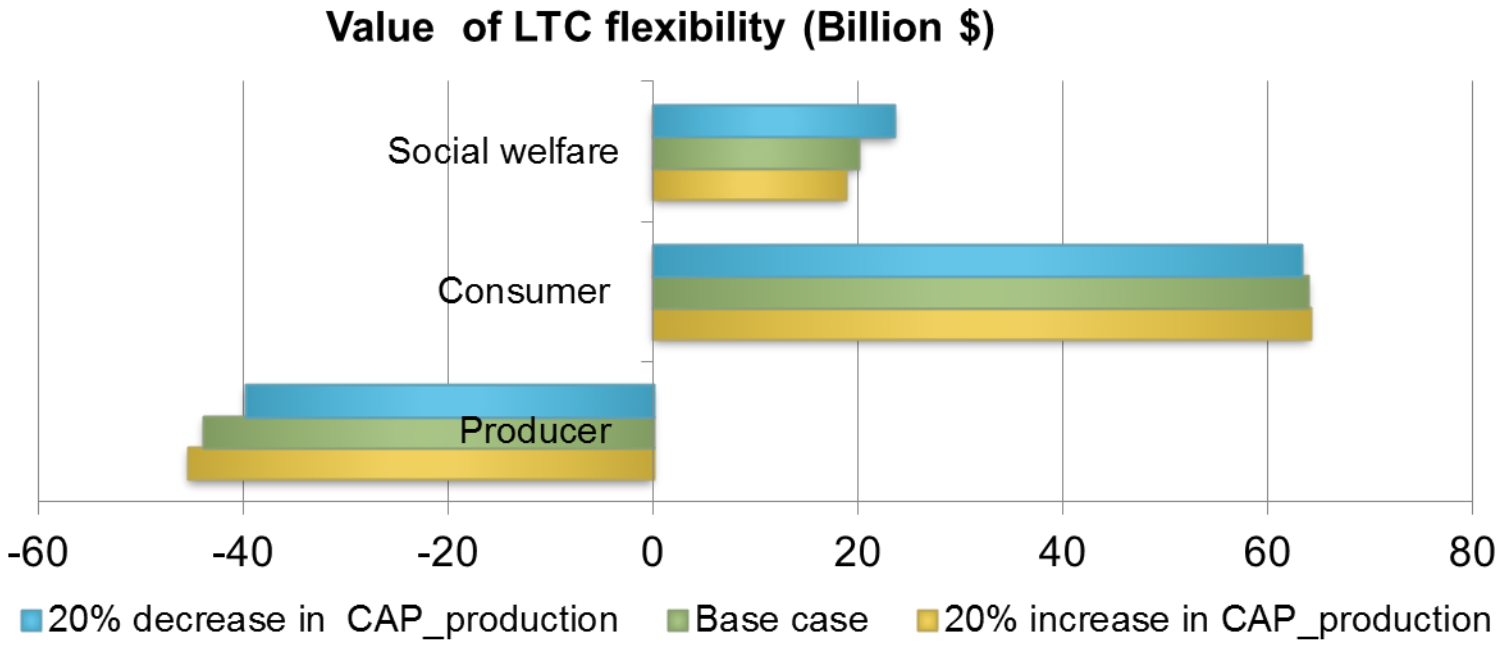
Results: Sensitivity analysis on elasticity of spot gas markets

- With higher elasticity of demand
  - the negative change in producer profit brought by LTC flexibility is smaller;
  - the positive change in consumer surplus brought by LTC flexibility is smaller;
  - LTC flexibility has a smaller value on social welfare increase.
- With lower elasticity of demand, changes have the opposite directions.



Results: Sensitivity analysis on production capacity

- Increasing production capacity by 20%
  - the negative impact of LTC flexibility on producer profits is larger;
  - the positive change in consumer surplus is larger;
  - LTC flexibility has a smaller value in increasing social welfare.
- Decreasing production capacity by 20%,
  - Changes have the opposite directions.



Conclusion

- **With more flexible LNG contracts,**
  - will producers gain more profits? No
  - will consumers surplus increase? Yes
  - will the whole market efficiency increase? Yes

- **Open questions and future work:**
  - The liquefaction and regasification capacities are considered but not the LNG shipping capacities.
  - More detailed modelling in the North America market.

Many Thanks!

Contact: y.zhang74@lse.ac.uk