" When things go wrong: do US gas regional prices move in the aftermath of pipeline incidents?"

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WORK IN PROGRESS

Chaire d'Economie du Gaz Naturel

The Economics of Natural Gas: New Research Perspectives for a Rapidly-Changing World

DAUPHINE UNIVERSITÉ PARIS

Outline

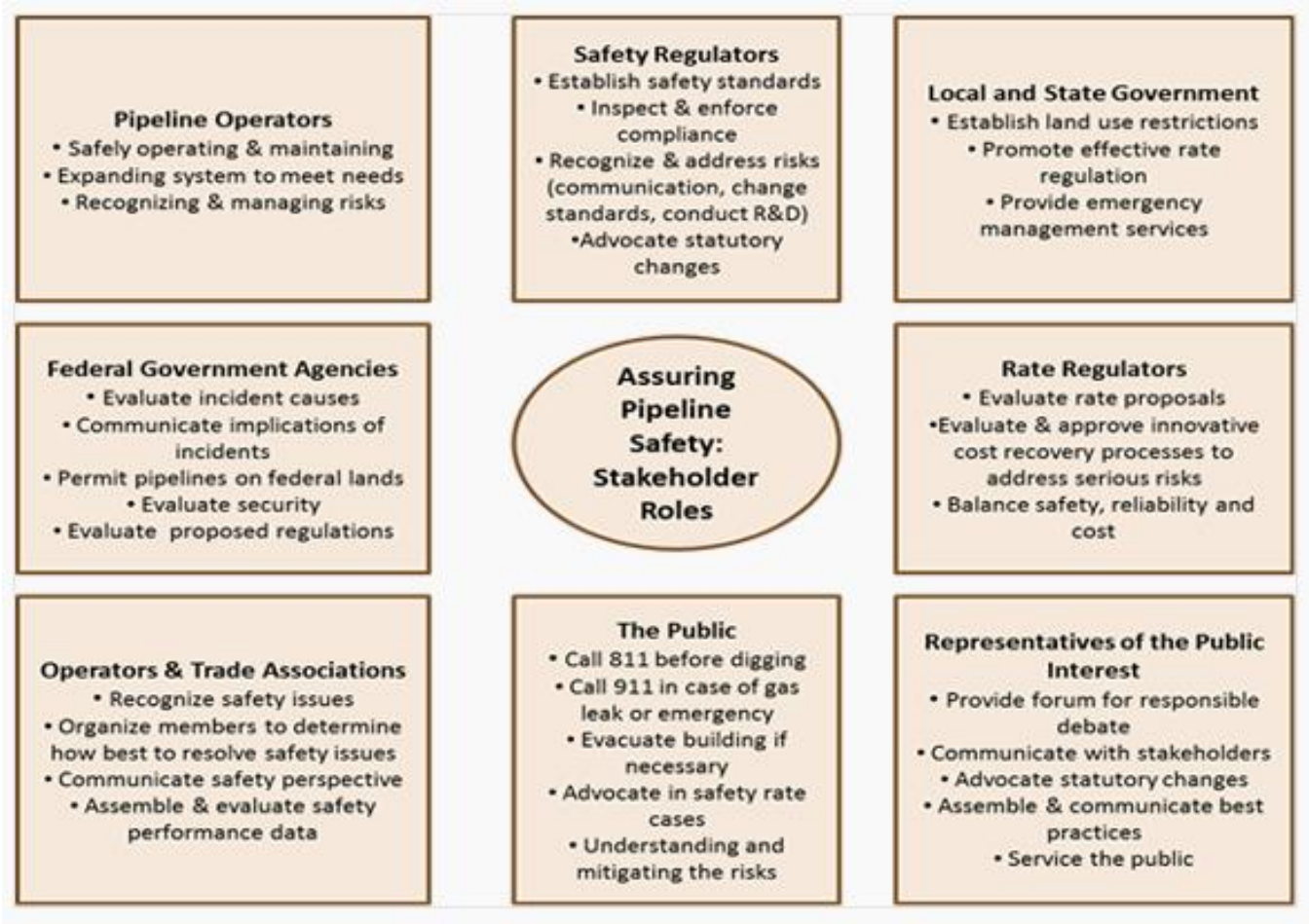
- Introduction: the US gas network
- Pipeline incidents: the context
- Data, methodology, first results
  - incidents, safety, gas regional prices: is there a link? What can we learn from that link?
- Ongoing work

The US Gas Network

- The U.S. natural gas pipeline network is a highly integrated transmission and distribution grid that can transport natural gas to and from nearly any location in the lower 48 States. The natural gas pipeline grid comprises more than 210 natural gas pipeline systems.
- 305,000 miles of interstate and intrastate transmission pipelines
- More than 1,400 compressor stations
- More than 11,000 delivery points, 5,000 receipt points, and 1,400 interconnection points
- 24 hubs or market centers
- 400 underground natural gas storage facilities
- 49 locations where natural gas can be imported/exported via pipelines
- 8 LNG (liquefied natural gas) import facilities and 100 LNG peaking facilities

IEA 2017

Pipeline incident: the context
Complex regulation



Pipelines are safe but incidents occur

The San Bruno pipeline explosion occurred at 6:11 pm PDT on September 9, 2010, in **San Bruno, California, a suburb of San Francisco,** when a 30-inch (76 cm) diameter steel natural gas pipeline owned by Pacific Gas & Electric exploded into flames in the Crestmoor residential neighborhood 2 mi (3.2 km) west of San Francisco International Airport near Skyline Boulevard and San Bruno Avenue.

The **United States Geological Survey registered the explosion** and resulting shock wave as a magnitude 1.1 earthquake

It took crews nearly an hour to determine it was a gas pipeline explosion.

Eyewitnesses reported the initial blast "had a wall of fire more than 1,000 feet high"

Breaking News, September 10, 2010

https://ft.maps.arcgis.com/apps/MapTools/index.html?appid=da822daa69a447bcaaece4d300f030b7

Research Question

Which is the impact of incidents regional gas prices?

Answer: from safety to security of supply

If in the aftermath of the incidents price are affected, then there is no immediate gas flow substitution from adjacent markets: gas vulnerability

The reverse would mean that security of supply by inter/intraregional gas flows is guaranteed

Novel study in the litterature

Literature Review (I)

- Based on the efficient market approach study the impact of incidents on equity value…
  - Capelle-Blancard & Laguna, 2010. JEEM
    - Stock market reaction to industrial disasters: 64 explosions in chemical plants and refineries worldwide in 1990-2005 belonging to 38 firms
      - Petrochemical: drop in their market value of 1.3% over 2 days immediately following the disaster.
  - Borenstein & Zimmerman, 1998. AER
    - Stock market reaction to airplane incidents.

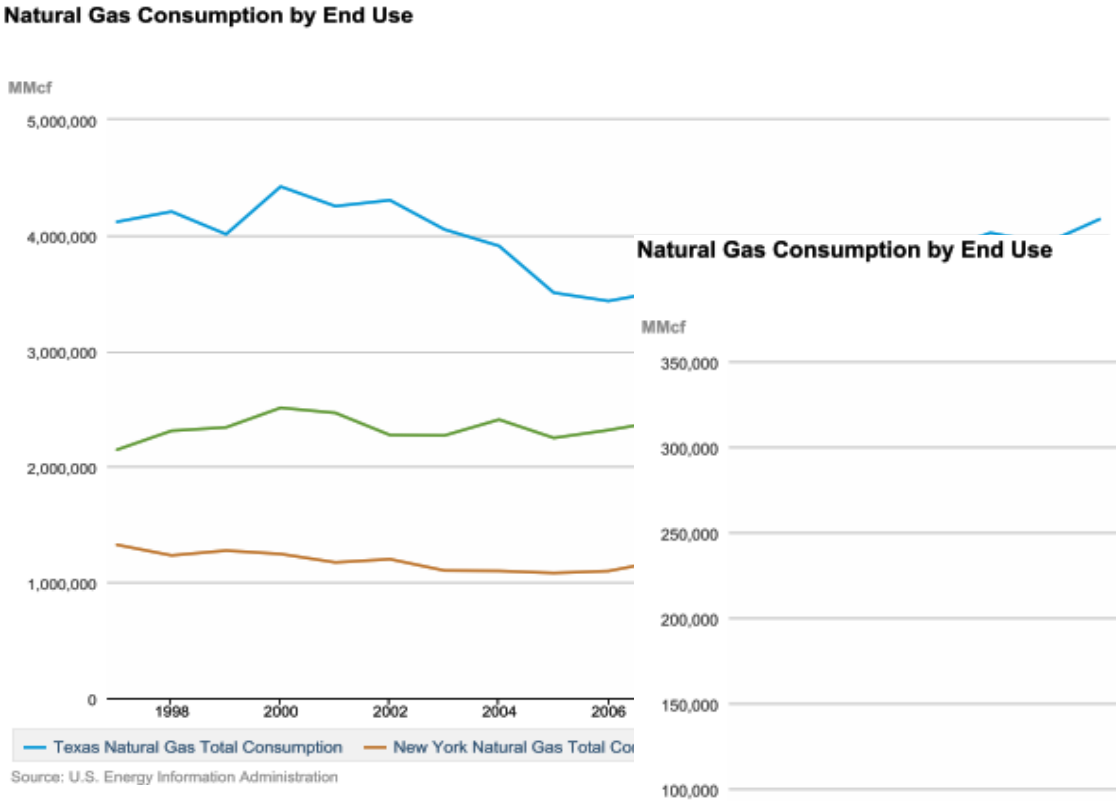
Literature Review (II)

- Technical literature
  - Restepo et al. 2009. *Int J Of Critical Infrastucture Protection*
    - Data on 1582 incidents related to hazardous liquid pipelines for the period 2002–2005 are analyzed.
    - Logistic regression to determine factors associated with nonzero product loss cost, property damage cost and cleanup and recovery costs.
      - Results used to construct illustrative scenarios for hazardous liquid pipeline incidents.
  - Furchtgott-Roth, 2013. *Stanford Working Paper*.
    - In addition to enjoying a substantial cost advantage, pipelines result in fewer spillage incidents and personal injuries than road and rail.

Illustration of the model: NY, CA and Texas

- Different profiles in terms of consumption, production, export and storage
  - Texas: big exporter
  - NY: big consumer
  - CA balanced profile between consumption and production, still with a moderate import volume

Illustration of the model: NY, CA and Texas, consumption



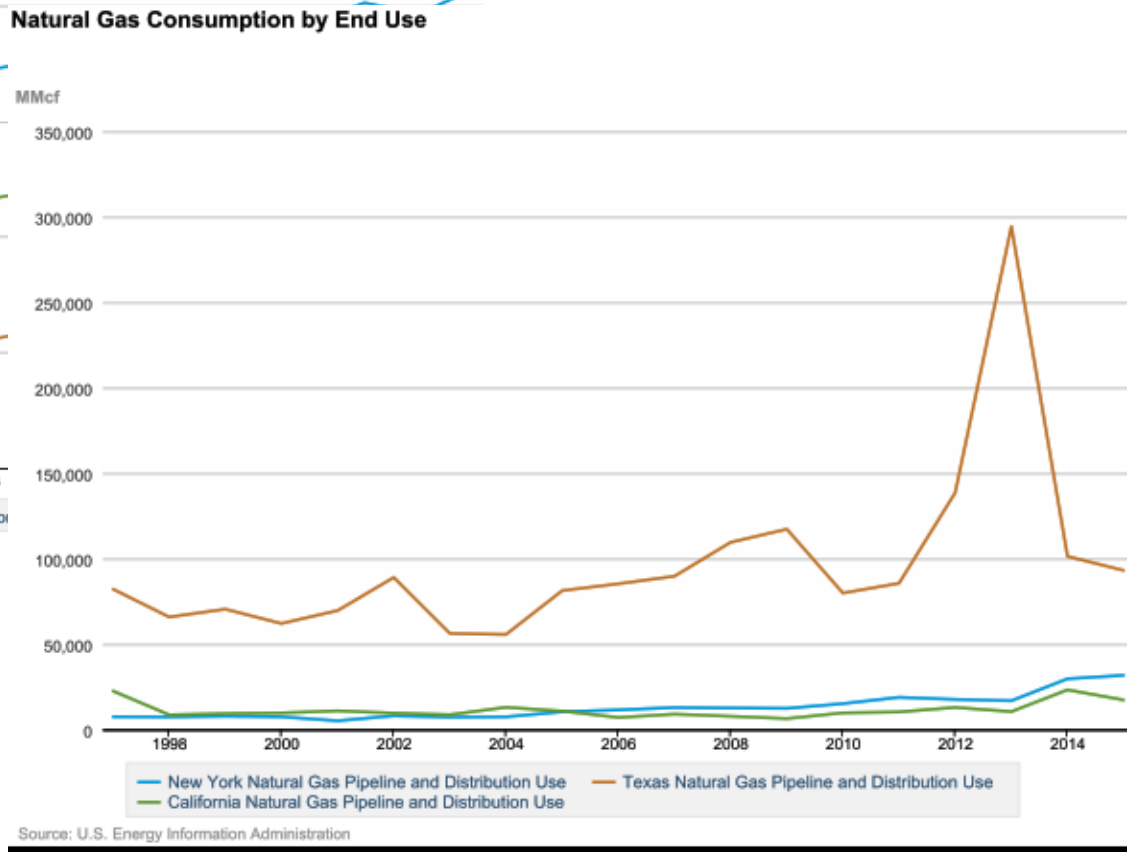
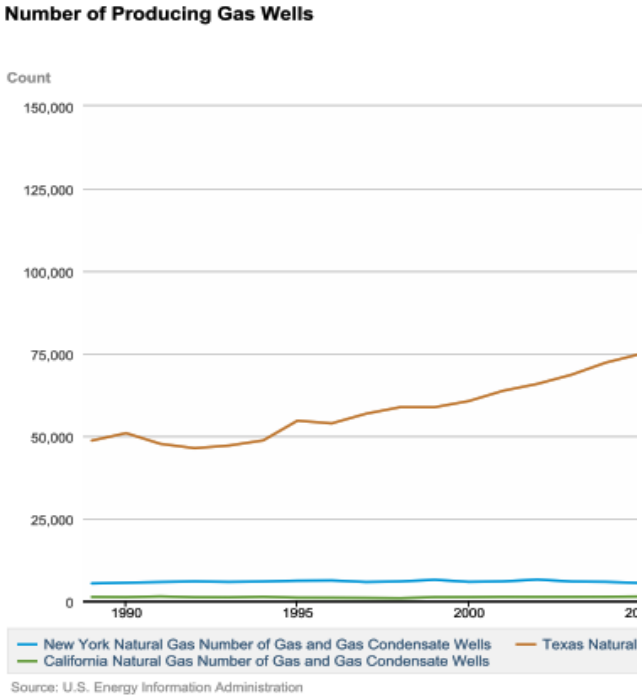
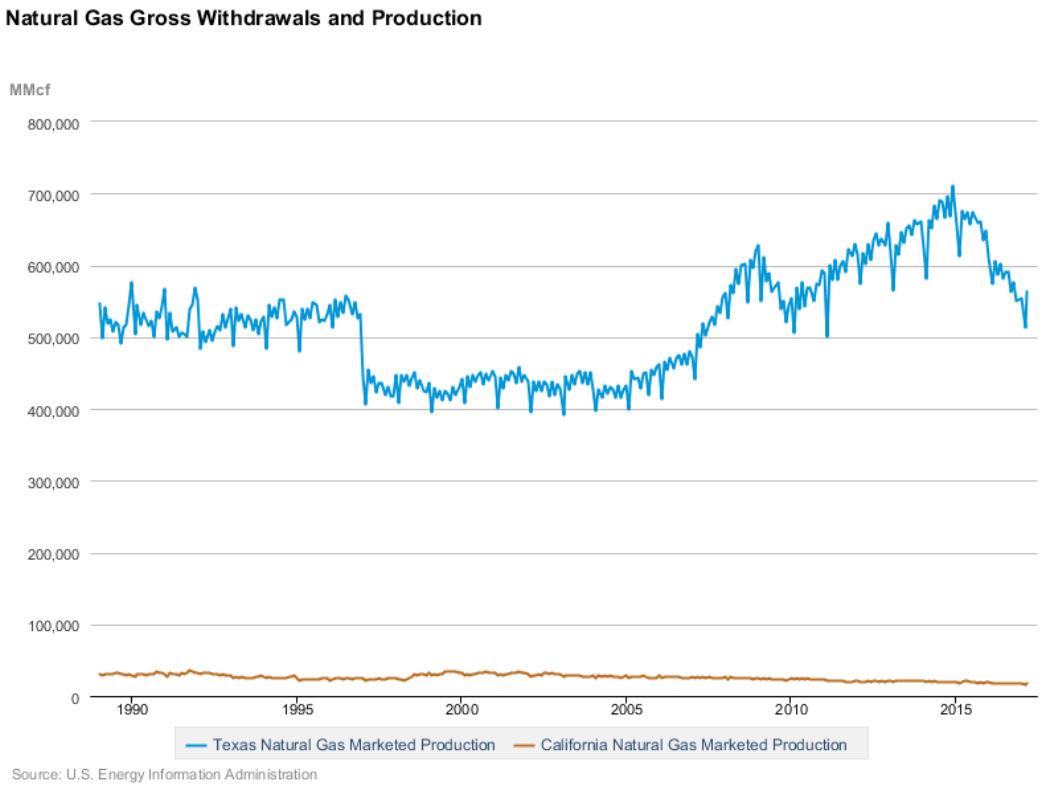


Illustration of the model: NY, CA and Texas production





Databases

- From January 1st., 1996 to August 31st 2012

1. All gas pipeline incidents (2421 observations) and their characteristics

2. Merged with a database of weekly price of gas in 18 Hubs in the U.S. (and Canada) over the same period:
   - For this presentation we consider Los Angeles City Gate, New York City Gate and Katy Hub, with the Henry Hub used as counterfactual

1. Incidents Data

Summary statistics: N, max, min, mean, sd
by categories of: state_id (state_id)

age<1960 age>1990

state_id	Damage	fatal	injuries	old	veryold	young
California	152	152	152	152	152	152
Max	3.77e+08	8	51	1	1	1
min	0	0	0	0	0	0
mean	2812854	.1052632	.6052632	.3223684	.2171053	.4605263
sd	3.06e+08	.6823983	4.159339	.4689282	.4136378	.5000871
New York	60	60	60	60	60	60
Max	1.30e+07	6	12	1	1	1
min	0	0	0	0	0	0
mean	610493.5	.25	.85	.2	.4333333	.3666667
sd	1723960	.8949008	1.830301	.4033756	.4997174	.4859611
Texas	300	300	300	300	300	300
Max	1.03e+08	3	7	1	1	1
min	0	0	0	0	0	0
mean	875856.7	.0866667	.3733333	.4233333	.1966667	.38
sd	6251384	.3258468	.8344318	.4949128	.3981423	.4861974
Total	2421	2421	2421	2421	2421	2421
Max	5.47e+08	33	51	1	1	1
min	0	0	0	0	0	0
mean	1002875	.1148286	.4365964	.354399	.2230483	.4225527
sd	1.39e+07	.829736	1.62057	.4784296	.4163765	.4940675

½ of Texas # of incidents but huge damage.

Fewer incidents

Only 38% of recent pipelines

Few human losses. Damage can be high but on average 1M US$

1. Hubs relevant market

HUB	US ZONE	STATE
AECO-C Hub	W	Alberta, Canada (Montana)
Kingsgate, BC	W	Idaho
Los Angeles City Gate	W	California
Malin, Oregon	W	Oregon
Sumas, Washington	W	British Columbia, Canada (Washington, Idaho & Montana)
Katy Hub	SW	Texas
San Juan Basin	SW	Utah, Arizona, Colorado & New Mexico
Topock, Arizona	SW	Arizona
Waha Hub	SW	Texas
Atlanta City Gate	SE	Georgia
Columbia Pool	SE	South Carolina
New York City Gate	NE	New York
Niagara Falls, Ontario	NE	Ontario, Canada (Minesota, New York, Ohio)
Chicago City Gate	MW	Illinois
Emerson, Manitoba	MW	North Dakota & Minesota
Ventura, Iowa	MW	Iowa
Opal, Wyoming	CENTRAL	Wyoming
Panhandle Field Zone	CENTRAL	Kansas, Oklahoma & Texas portions of PEPL

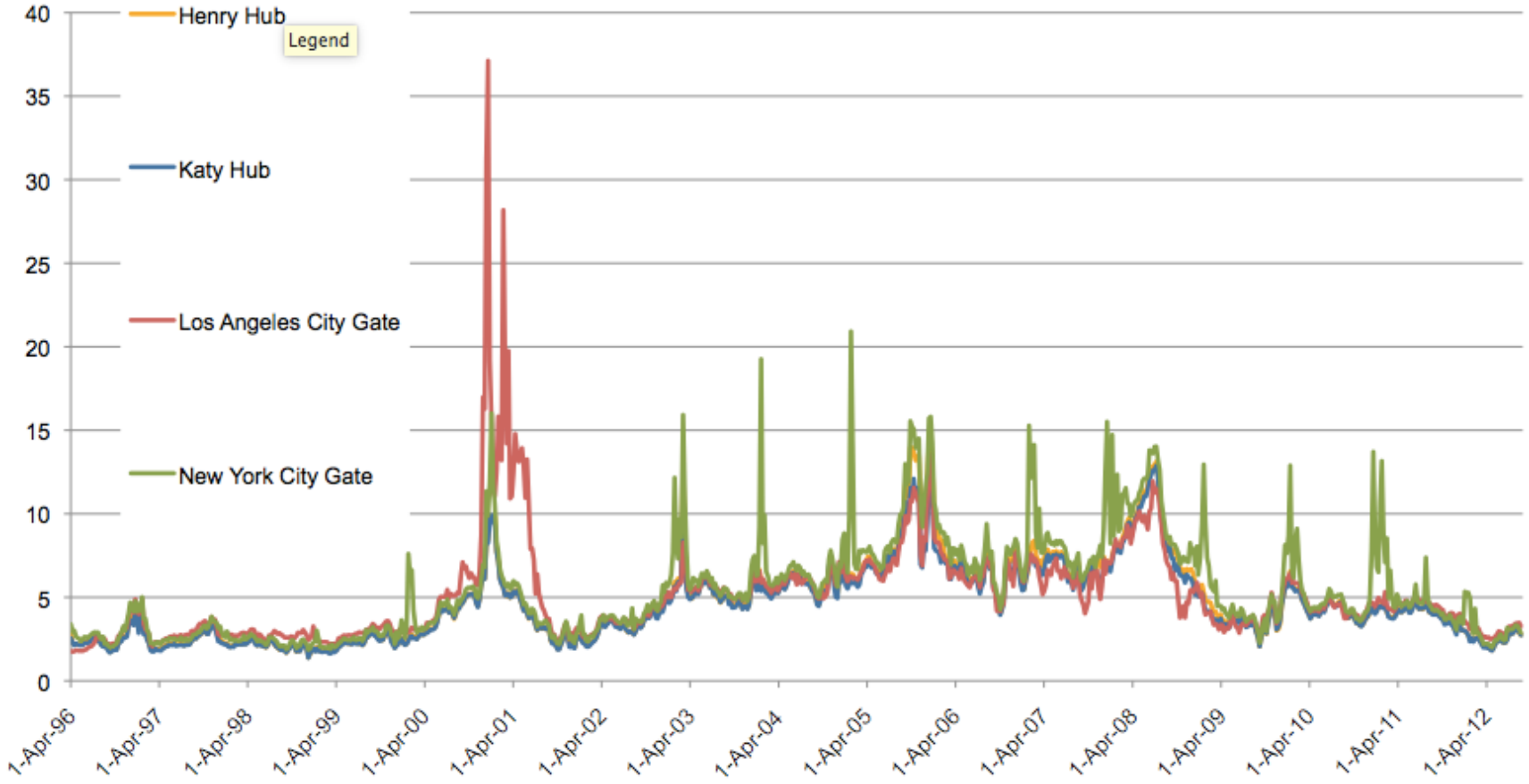
- An incident in Texas may impact three Hubs (same with all states in color).
- Canadian Hubs considered as affected by incidents in US neighboring state
- Neighboring states can also be considered: crucial to define relevant market

2. Incidents Data (II)

For each incident we also identify:

- the type of pipeline (transmission or distribution),
- the cause (miscellaneous, excavation, malfunctioning, etc) and
- the operator involved.

Prices



US$ per MMBtu

- Differences in movements among Hub prices

Methodology

- Event study under the market model approach:

1. Using a window of 3 weeks prior to each incident (precisely [-4,-1] we estimate the expected return at each hub as a constant plus a slope times Henry Hub return.

2. We calculate the abnormal returns (AR) as the difference between actual returns and the returns calculated in 1 for an estimation window of 2 weeks following the incident [0,+1].
   - To perform this exercise the data of the incident is placed in the Sunday following the incident to make it coincide with the weekly price data.

3. We calculate the cumulative abnormal returns (CAR).
   - **The abnormal returns can be interpreted as resulting gains or losses in the regional price due to the change in market conditions (e.g. scarcity)**
   - **They may underline security of supply problems.**

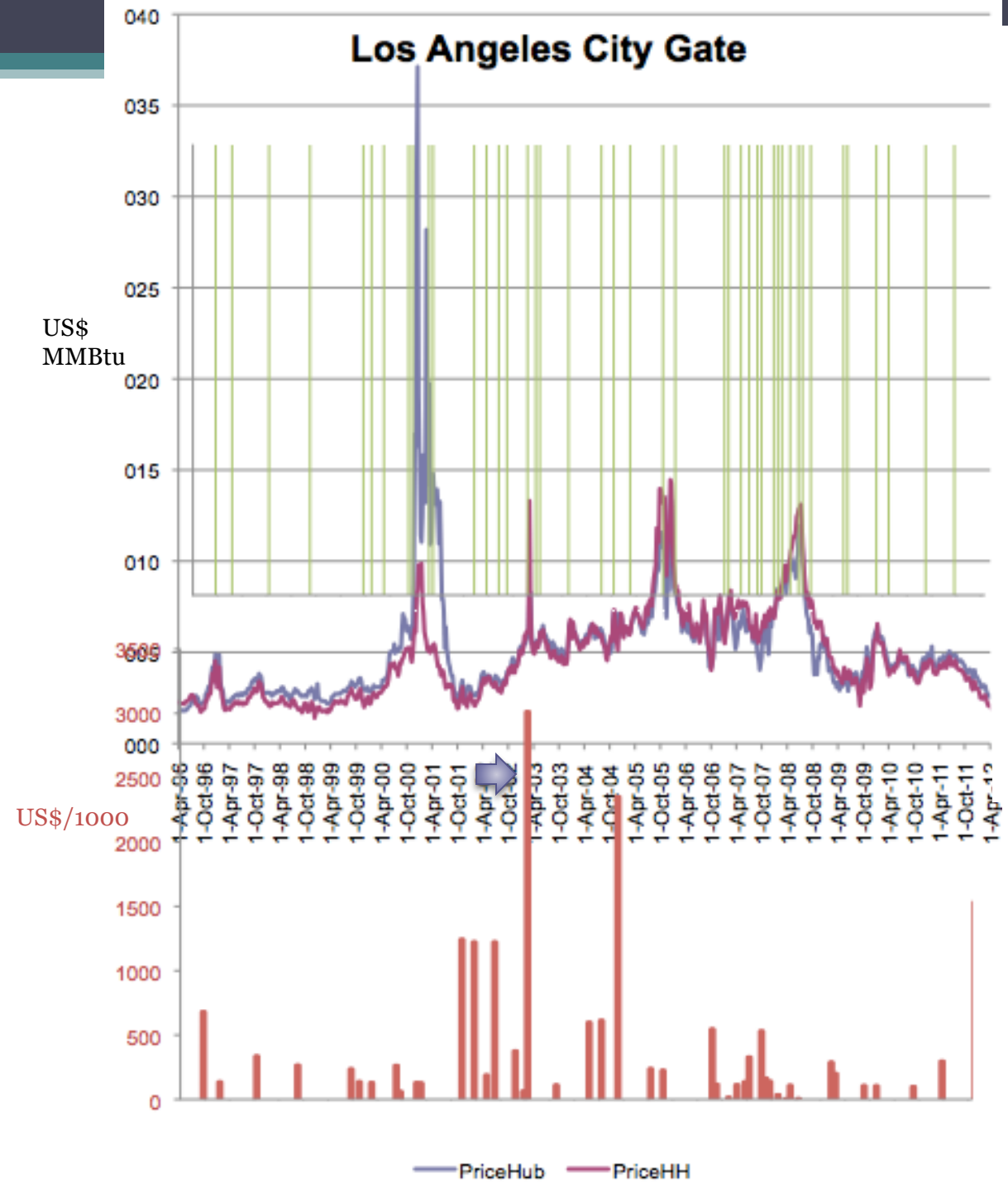
$$R_{it} = a_i + b_i R_{mt} + e_{it}$$

$$AR_{it} = Ri - \bar{a}i + \bar{b}iRmt$$

Main results

- 1/3 of incidents significantly explain divergences between Regional Hub's price and Henry Hub price.

- Incidents with high estimated damage in US$ or high number of fatalities do not always significantly explain abnormal returns.



Significative event dates in green
Damage for each event in US$/1000 in red

Zoom on the top 10 significative incidents

Date	operator_id	Damage	Fatalities	CAR
04/07/03	Southern California Gas Co	3010000	0	-0,15
03/07/05	Southern California Gas Co	2350000	0	0,34
05/07/12	El Paso Natural Gas Co	1530000	0	-0,23
12/24/01	Southern California Gas Co	1240000	0	-0,31
03/04/02	Southern California Gas Co	1220000	0	0,09
08/19/02	Southern California Gas Co	1220000	0	-0,14
09/30/96	Pacific Gas & Electric Co	678000	0	-0,16
11/01/04	Pacific Gas & Electric Co	610000	0	1,94
07/12/04	Southern California Gas Co	595000	0	0,22
01/22/07	Pacific Gas & Electric Co	543000	0	0,04

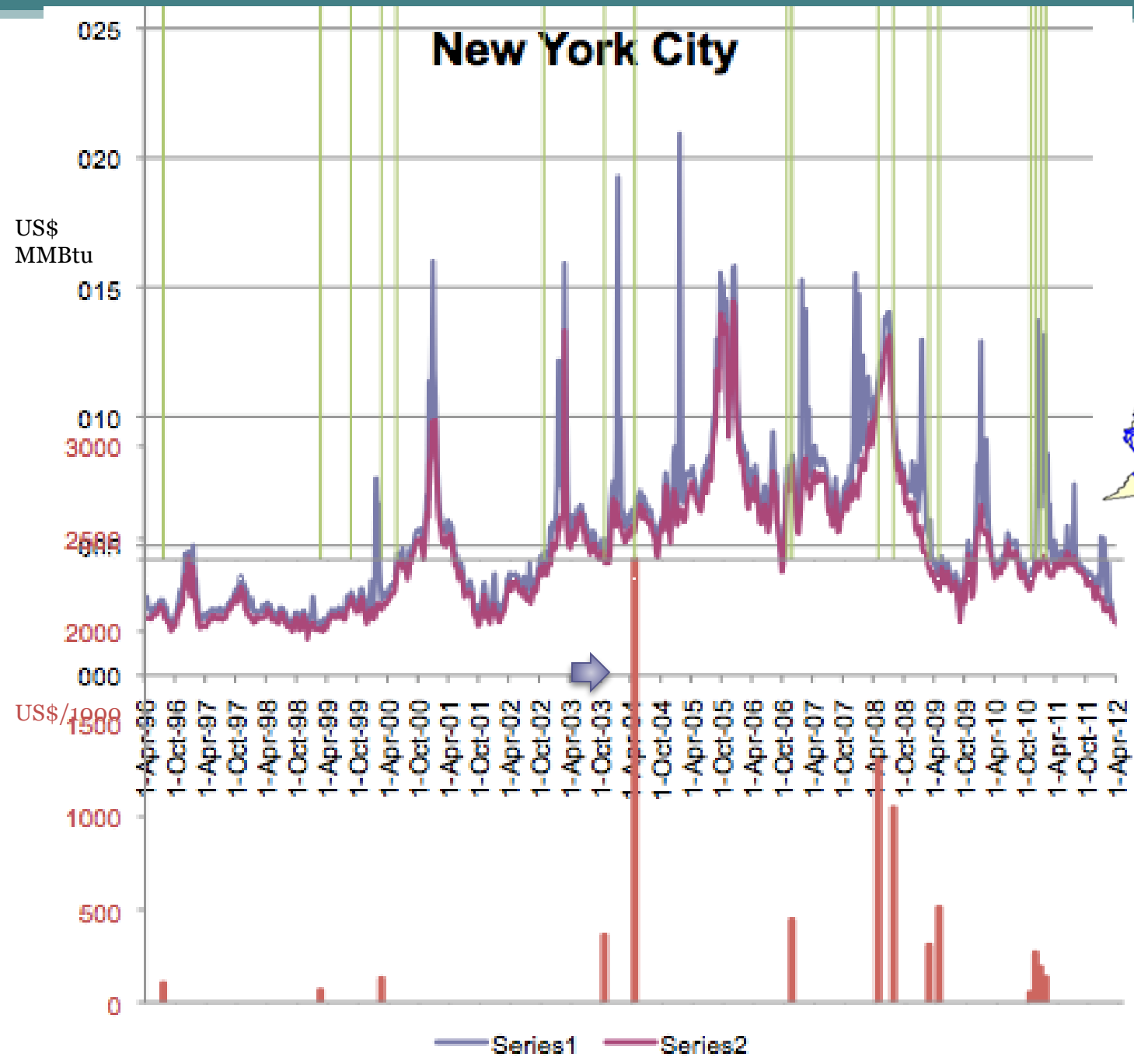
- Top 10 significative incidents classified with respect to damage (see tha arrow for the most important one)

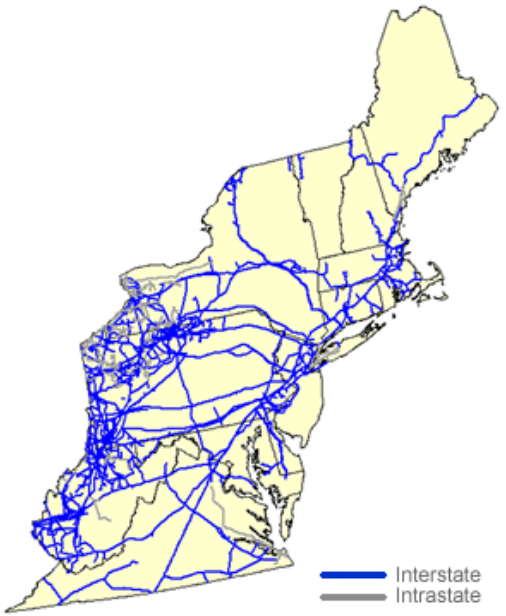
- Some incidents have occurred with a higher damage but are not significative

Another result that suggests a security of supply problem

Incidents with huge damage may not impact on prices

	state_id	Date	Hub	operator_id	Damage	fatalities	CAR	test	Test Result
	California	09/09/10	Los Angeles City Gate	Pacific Gas & Electric Co	377000000	8	0,35	1,53	non-sig





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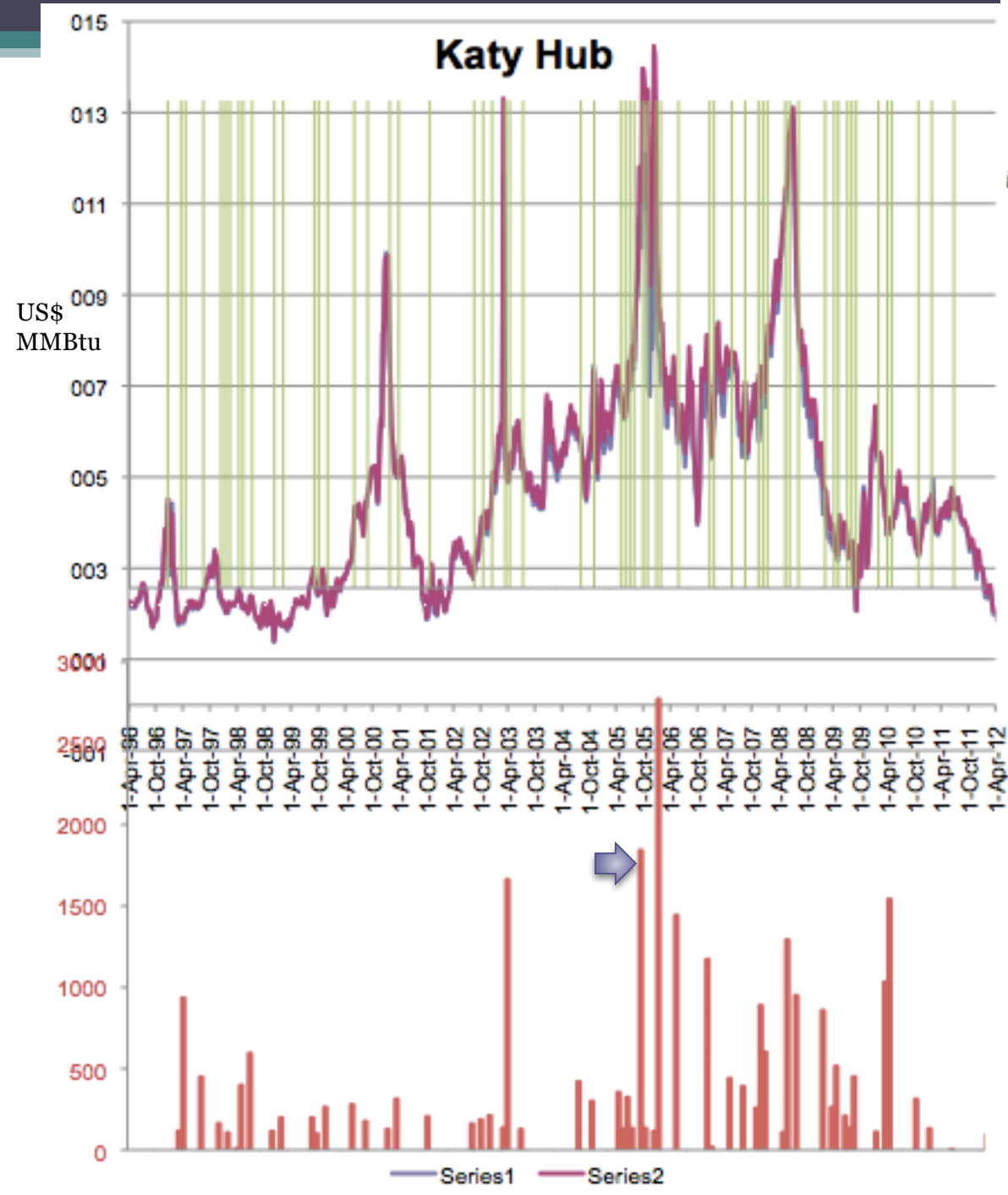

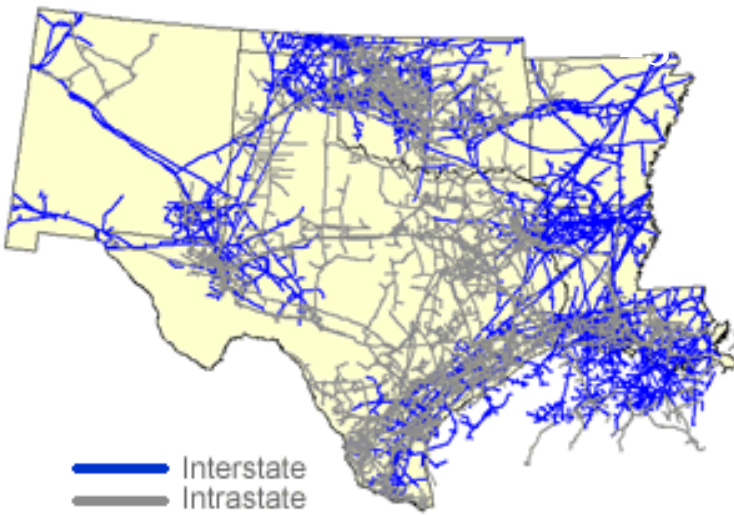

Significative event dates in green

Damage for each event in US$/1000 in red

Ongoing work

1) Proper definition of relevant market - a proper identification strategy : two unrelated state prices may become related due to an incident

2) Event study with rolling windows: incidents effect may overlap

3) Multivariate regressions to relate cross-sectional differences in the loss incurred to the incidents features such as:

- Local market conditions
- Regional and time (and seasonal) dummies that may explain why some incidents are non-significant
- Dummy equal to 1 if there is an explosion
- Total number of fatalities and injured (human damage)
- Dummy to account for security regulatory changes (so far year 2000 identified).

$$SL_{i,[0.+t]} = CAR_{i,[0,+t]} MV_{i,-1}$$

Concluding Remarks

- Pipelines are the safest way to transport gas but incidents occur in any case causing changes in regional prices.
  - The heterogeneity of such incidents implies that some may have no impact and the reasons for such a difference is explored in this paper for the first time: USA has a strong interconnection network but seems to be unable to smooth incidents effects on local markets.
  - Lessons can be learnt from exploring the reasons of this vulnerability behind safety regulation.

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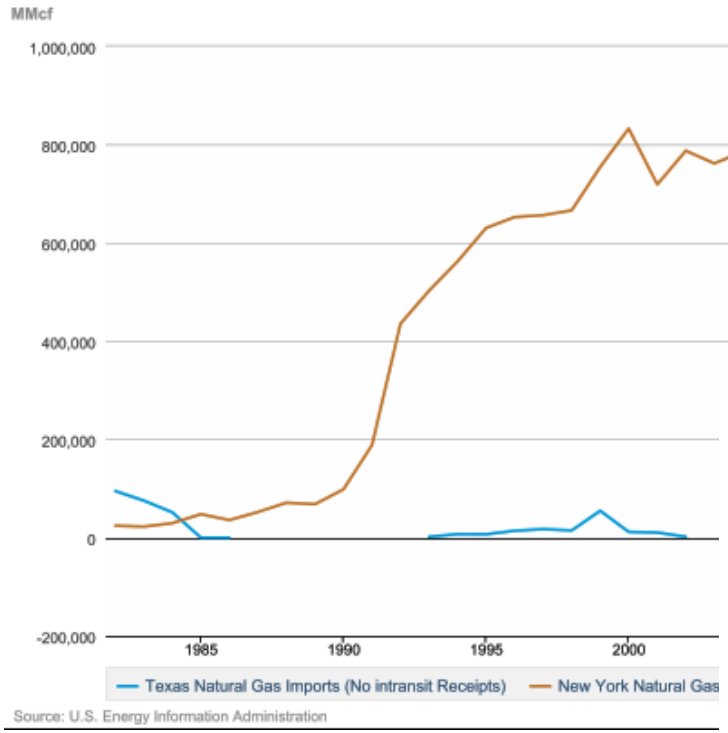
THANK YOU!

The Economics of Natural Gas: New Research Perspectives for a Rapidly-Changing World

Chaire d’Economie du Gaz Naturel

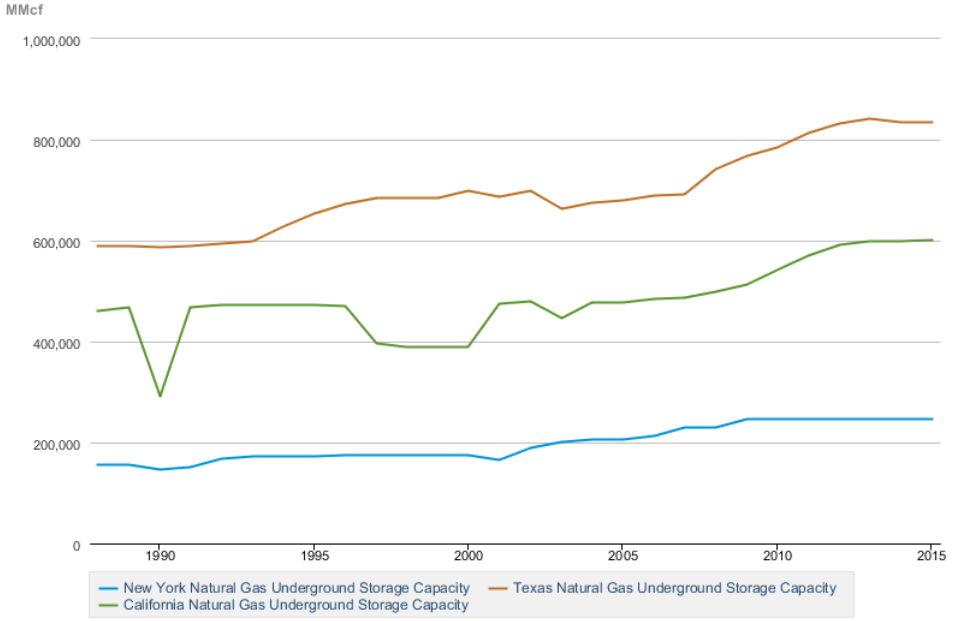
DAUPHINE UNIVERSITÉ PARIS

U.S. Natural Gas Imports & Exports by State



Source: U.S. Energy Information Administration

Underground Natural Gas Storage Capacity



Source: U.S. Energy Information Administration

Safety Regulation: In Practice

PHMSA (The U.S. Department of Transportation's Pipelines and Hazardous Materials Safety Administration):

- issues pipeline safety regulations addressing construction, operation and maintenance
- inspects pipeline operators, and enforces against violations of pipeline safety laws and regulations.
- regulates interstate and intrastate hazardous liquids transmission pipelines, except that approves some state agencies to exercise interstate inspection authority and/or intrastate inspection and enforcement authority.
- regulates gathering pipelines greater than 6 5/8" diameter in all "non-rural" areas and rural areas within a quarter-mile of an "unusually sensitive area" and operating above a certain pressure.
  - Unusually sensitive areas are determined and include drinking water sources and ecological resources unusually sensitive to environmental damage from a liquids release.
  - Other gathering lines can be regulated by states or the Interior Department.

States may issue regulations over intrastate pipelines if they are consistent with federal regulations. These state pipeline safety agencies are usually members of the National Association of Pipeline Safety Representatives (**NAPSR**).

The National Transportation Safety Board (**NTSB**) investigates some pipeline incidents and issues reports and recommendations to regulators, companies, and industry groups.

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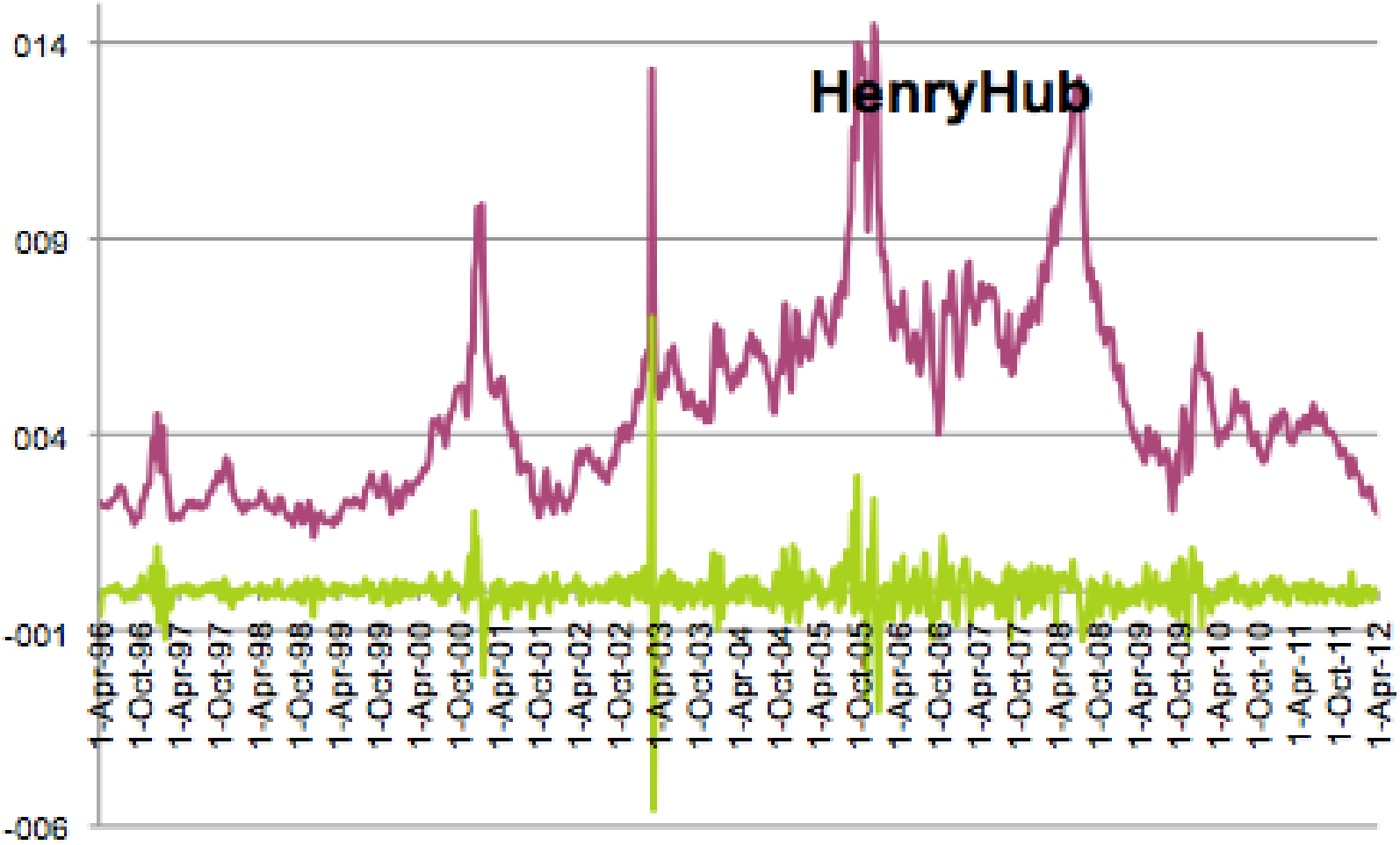
Quick overview HH price

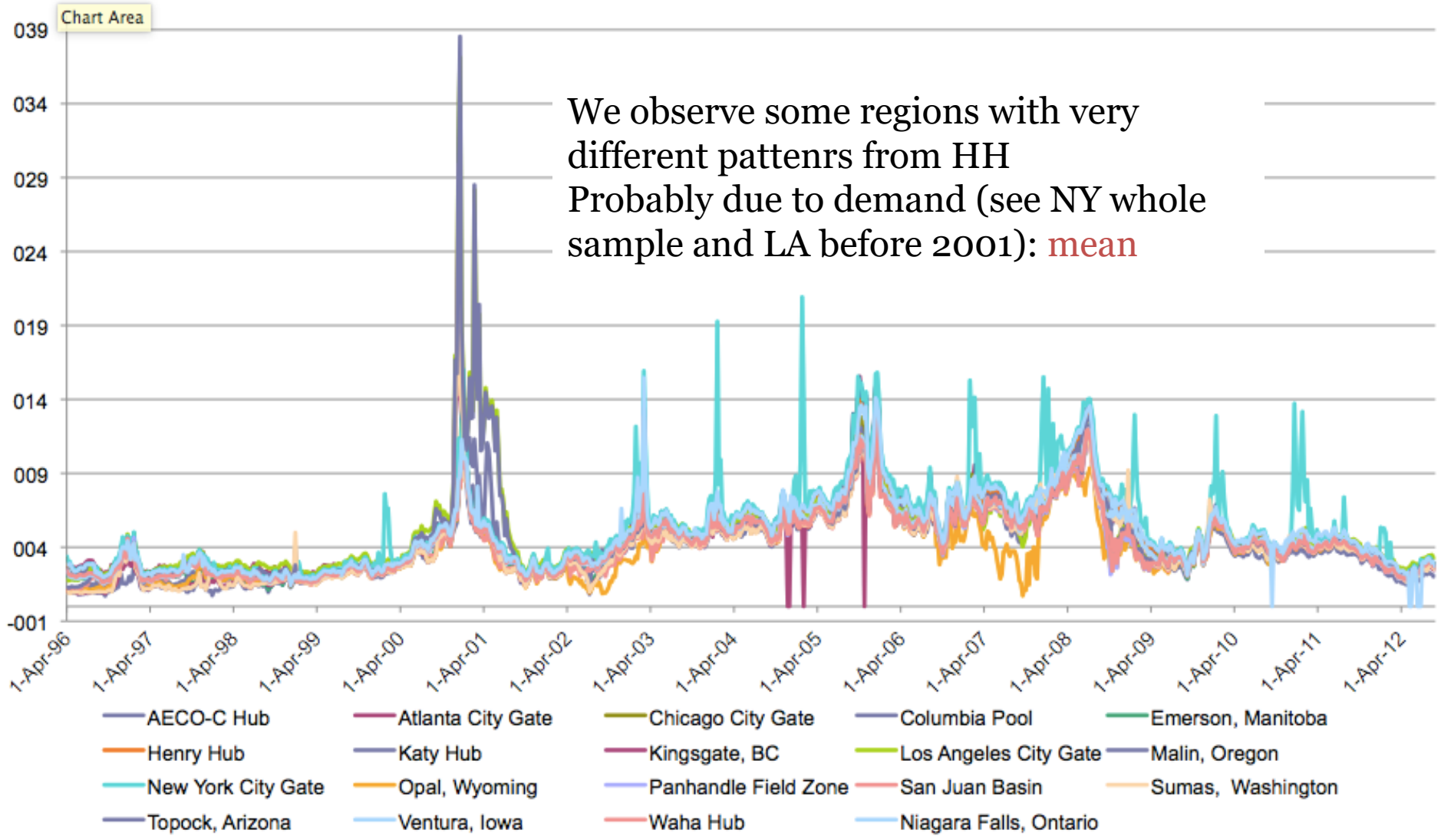


Many Ups and downs in our reference price (and returns)

Price in US$ per MMBtu

Return

Description: Regional Price Data



We observe some regions with very different pattenrs from HH
Probably due to demand (see NY whole sample and LA before 2001): mean

Prices in US$ per MMBtu

Date	operator_id	Damage	fatalities	CAR
04/12/04	Central Hudson Gas & Electric Corp	2390000	0	23,91
04/07/08	Consolidated Edison Co Of New York	1310000	0	1,49
07/28/08	Consolidated Edison Co Of New York	1050000	1	3,38
04/27/09	Consolidated Edison Co Of New York	512000	1	0,73
11/13/06	Keyspan Energy Delivery Long Island	444000	0	-0,36
10/27/03	Central Hudson Gas & Electric Corp	361000	0	0,18
02/09/09	Keyspan Energy Delivery Long Island	307000	0	-3,32
11/08/10	Consolidated Edison Co Of New York	266000	0	0,19
01/03/11	Central Hudson Gas & Electric Corp	189000	0	-6,83
01/24/11	Consolidated Edison Co Of New York	133000	0	6,48

Date	operator_id	Damage	fatalities	CAR
03/06/06	Northern Natural Gas Co	2770000	0	-0,85
11/21/05	Sea Robin Pipeline Co	1840000	0	1,75
06/02/03	Devon Gas Services, Lp	1660000	0	0,17
08/02/10	Energy Transfer Company	1540000	0	0,02
07/24/06	Northern Natural Gas Co	1440000	0	0,46
09/01/08	Energy Transfer Company	1290000	0	-0,12
02/19/07	Tennessee Gas Pipeline Co (El Paso)	1170000	0	-0,80
09/01/08	Natural Gas Pipeline Co Of America (Kmi)	1120000	0	-0,12
06/14/10	Enterprise Products Operating Llc	1030000	1	0,05