Auction Design for Colombia's Forward Energy Market

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and Market Design Inc.
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Three steps to market design

- Product design ➢Last time
- Auction design ➢Today
- Transition ➢July-August

Responses to industry comments

Only the questions are shown here. Written answers are presented in the final version of the product design paper on CREG’s web site.

How will the aggregate demand curve be defined?

Are LSEs allowed to purchase energy in the auction that is not required for final customers?

Because 100% of the demand will be procured in the MOR auction, the LSE will not be required to purchase energy in the spot market for regulated customers. Is that correct?

We understand that the agents in the secondary market will be limited to suppliers, as long as the LSEs will not have to trade any energy in this market. Is that true?

The proposal is not favorable for the supply side, because all the risk is assigned to it. As a consequence, the implementation of a secondary market is suggested.

Is it correct that the regulated demand will be passive in the auction? Will there be competitive bidding only on the part of the generators (sellers)?

The secondary market that may appear as a consequence of the auction will include participation of LSEs or only of generators?

Is it possible that the LSEs, on behalf of the demand, to give up in an auction? Is it convenient to have a reserve price for the auction?

What will happen if there is not enough quantity offered in the auction? Is it possible to assign obligations, even if the auction does not have enough competition? In that case, will the residual demand be exposed to the spot prices? If the answer to the previous question is yes, can those prices be passed through to the customers. Is it possible to include the residual demand in the following auction?

Regarding the 2-year commitment period, it is suggested to include also a product with a 1-year commitment in order to improve risk management.

In relation to the auction for nonregulated customers, the participating agents should be who define the products according to their own needs.

Efficient price formation requires active participation of the buyers, so the price should not be defined completely by the sellers. For that reason a double auction should be analyzed.

Buying in a single mechanism (MOR) reduces the liquidity of the products and the participation in other alternative markets.

Given that supplier participation is voluntary, is it possible that in one of the eight auctions, some sellers will not participate, generating inefficiencies in the price formation.

What would happen with deviations in projected demand?

What would happen when a new LSE enters the market? How can it purchase its requirements?

There is a five month planning period in the last quarterly auction. This is considered too short and risky.

Bearing in mind the energy variability of hydropower plants, a couple of agents have proposed to analyze the possibility to allow offers with different percentages of the aggregate demand each month without changing the price and commitment period.

The agents who act as a suppliers should be limited to generators in order to avoid intermediation costs.

There has been a misunderstanding about the lot size. You have recommended a lot size in the following terms: “say 0.1% of regulated load (6 MW).” This expression has been interpreted as a fixed quantity (6 MW) instead of a percentage of the demand. It will be desirable to clarify this issue.

It will be necessary to establish a methodology to estimate the projected demand.

Product

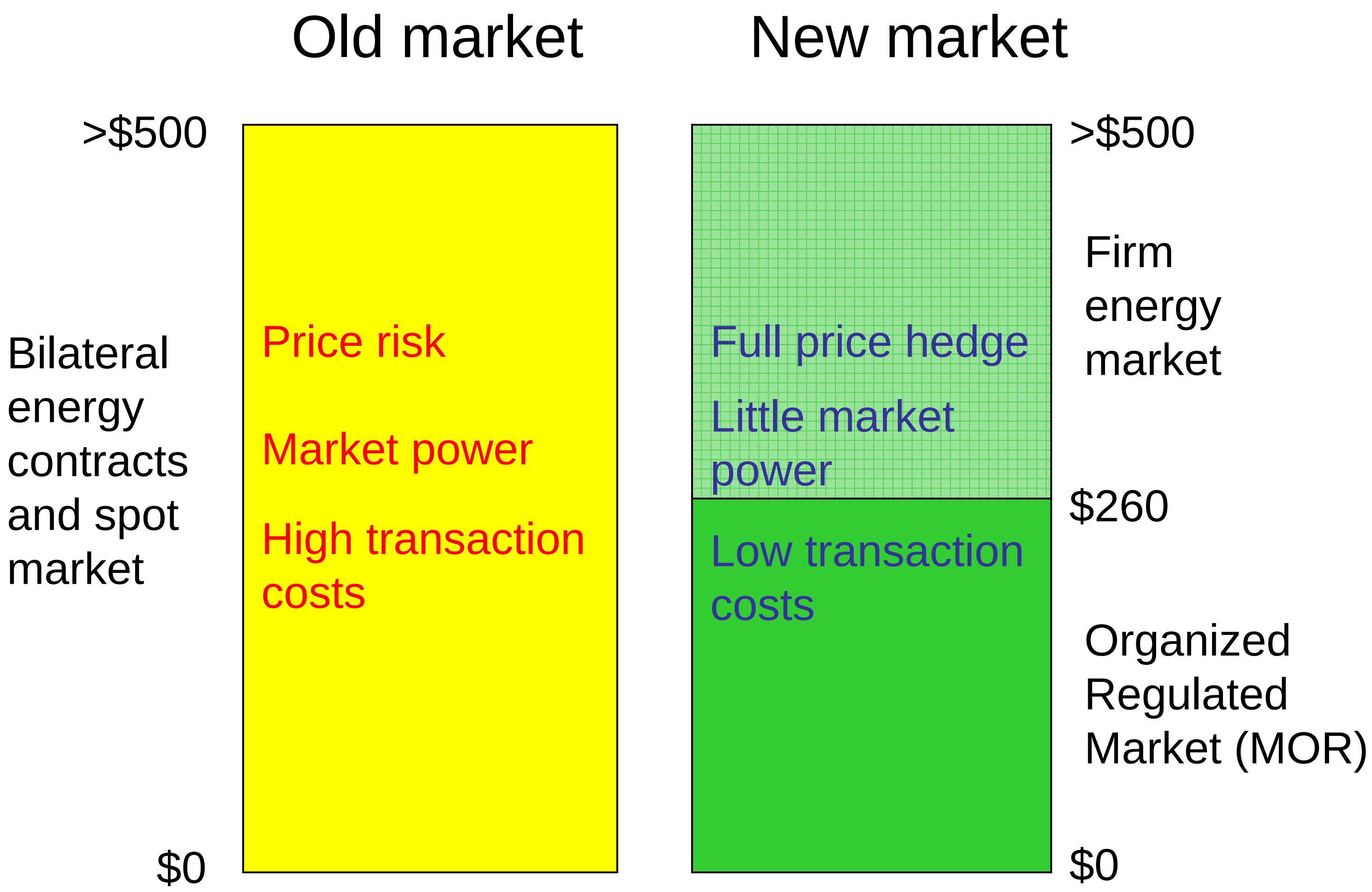
Two products, one auction

- Regulated customers (68% of load)
  - *Small* customers *without* hourly meters
  - *Passive* buyers in auction
- Nonregulated customers (32% of load)
  - *Large* customers *with* hourly meters
  - *Active* buyers in auction

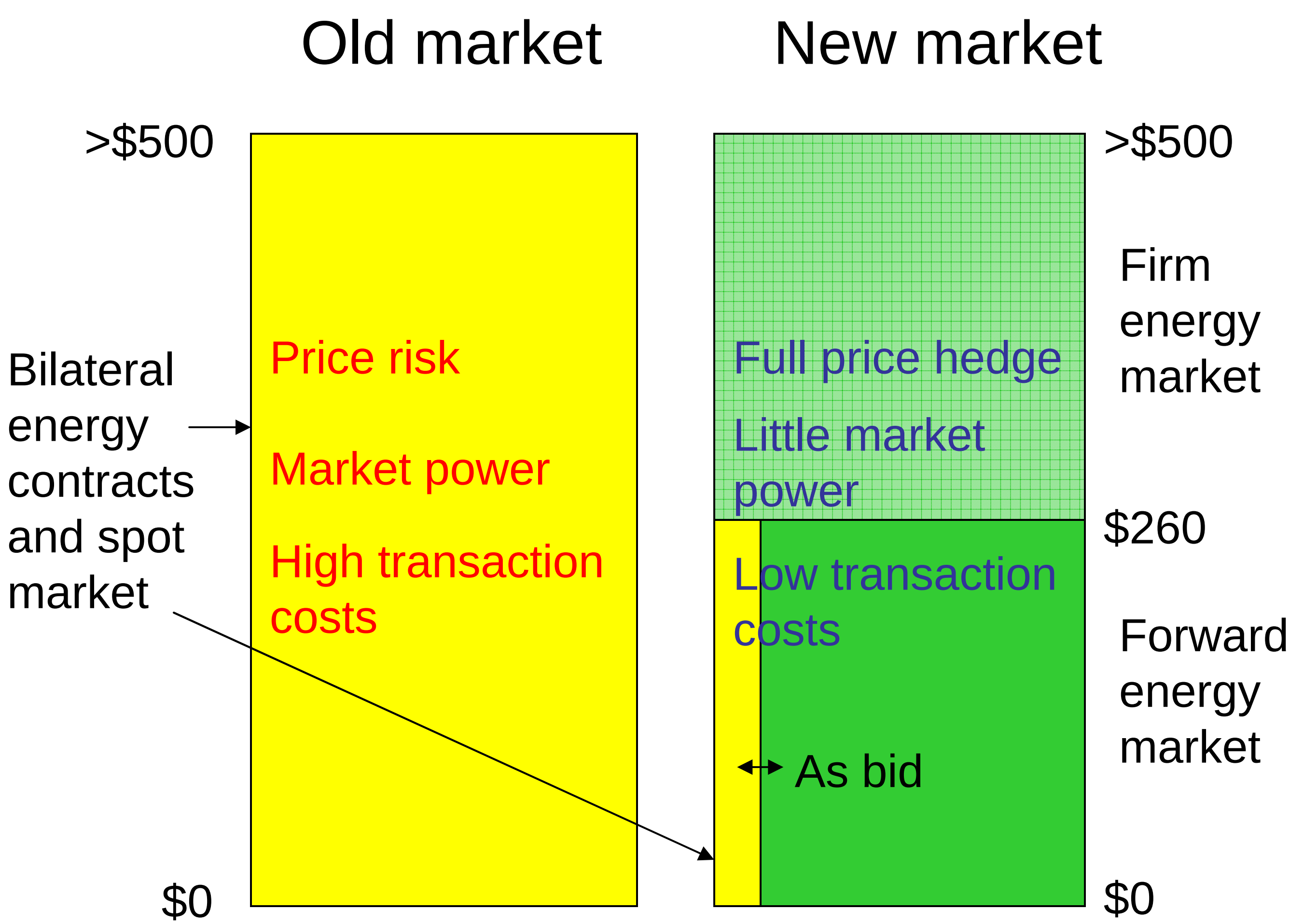
Regulated product: Energy share of regulated load

- Supplier bids for % of regulated load
- Supplier that wins 10% share has an obligation to serve 10% of regulated load in each hour
- Deviations between hourly obligation and supply settled at the spot energy price (or scarcity price if spot is higher)
- Pay as demand contract

Price coverage of regulated customer



Price coverage of nonregulated customer



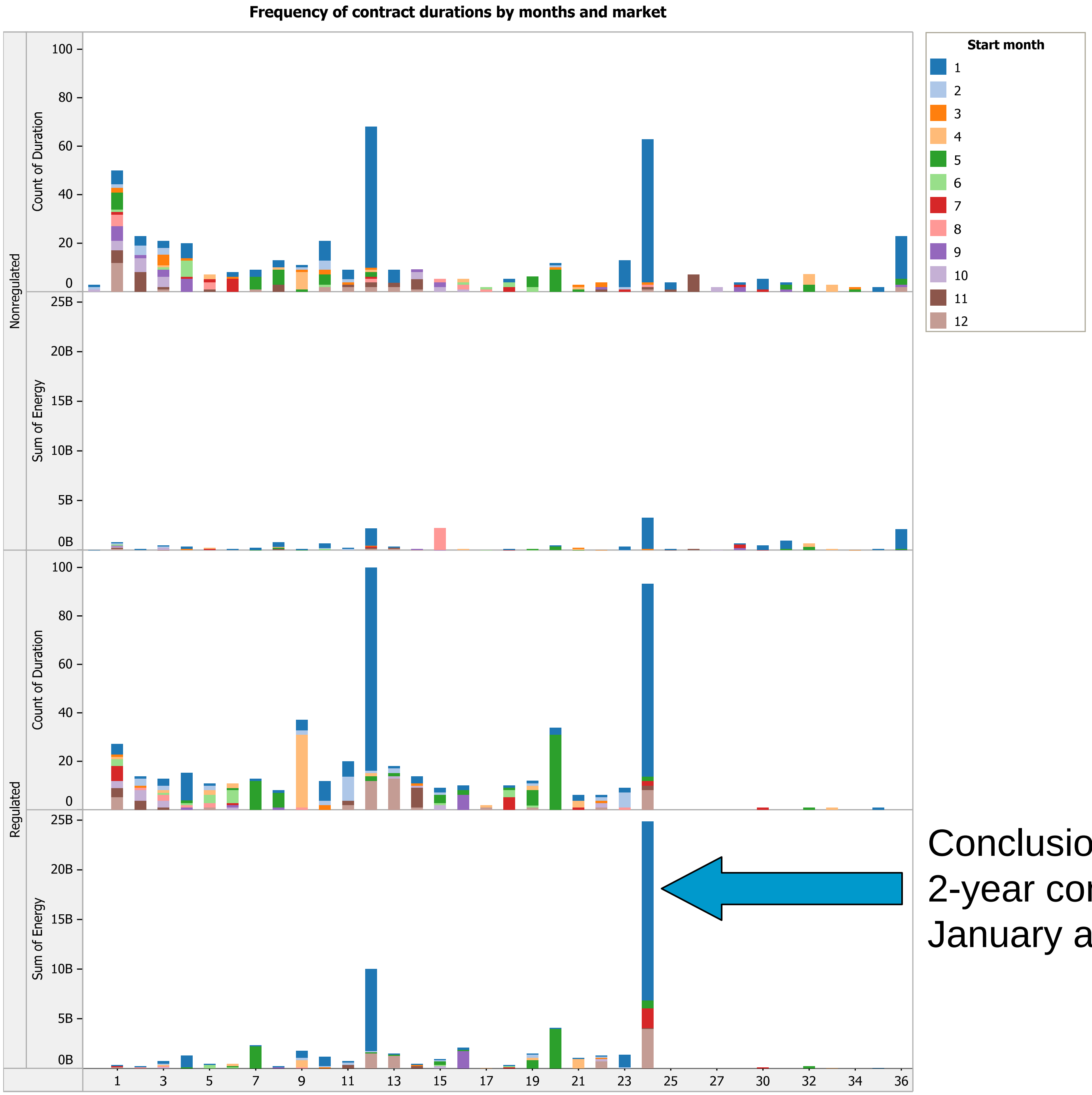
Regulated demand participation

- Participation by LSE is mandatory and passive (no active bidding of demand)
- Regulated customer may decide to become a nonregulated customer
  - Purchase hourly meter
  - Actively participate in auction
- But switch to nonregulated status is permanent (or occurs after sufficient delay)

Nonregulated demand participation

- Nonregulated demand participates in the same auction
  - Single nonregulated product
- Product: *expected* energy, not *actual* energy
  - Hourly, but based on expected energy demand
  - Hedges expected energy demand, but exposes customer to spot price *on the margin*
  - Requires hourly meter (and demand management)
- Participation benefits both regulated and nonregulated customers, as well as suppliers
  - Improved liquidity and price formation

Planning, commitment, and frequency



Count of Duration and sum of Energy for each Duration broken down by Market. Color shows details about Start month. The view is filtered on Duration of 3 years or less.

Conclusion:
2-year contracts, starting in January are most common.

Recommendation:
Quarterly 2-year contracts, annual rolling

<table>
<tr><td>Auction</td><td></td><td colspan="12">Energy commitment</td><td>Planning</td></tr>
<tr><td>date</td><td>Yr</td><td colspan="4">2009</td><td colspan="4">2010</td><td colspan="4">2011</td><td>Months</td></tr>
<tr><td>Year</td><td>Qtr</td><td>1</td><td>2</td><td>3</td><td>4</td><td>1</td><td>2</td><td>3</td><td>4</td><td>1</td><td>2</td><td>3</td><td>4</td><td>ahead</td></tr>
<tr><td rowspan="4">2008</td><td>1</td><td colspan="8">1/8</td><td colspan="4" rowspan="4">2 products,
8 prices
at any one time.</td><td>14</td></tr>
<tr><td>2</td><td colspan="8">1/8</td><td>11</td></tr>
<tr><td>3</td><td colspan="8">1/8</td><td>8</td></tr>
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<tr><td>2</td><td colspan="8">1/8</td><td>11</td></tr>
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<tr><td>4</td><td colspan="8">1/8</td><td>5</td></tr>
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Auction

Descending clock auction

- Same as in firm energy auction, but two substitutable products
- Bidders can be rationed at the clearing price
  - Typical case
    - A bidder drops from 2.0% to 1.5% at $70/kWh
    - Clearing occurs (S = D) at 1.7%.
    - Supplier wins 1.7%.

Descending clock auction

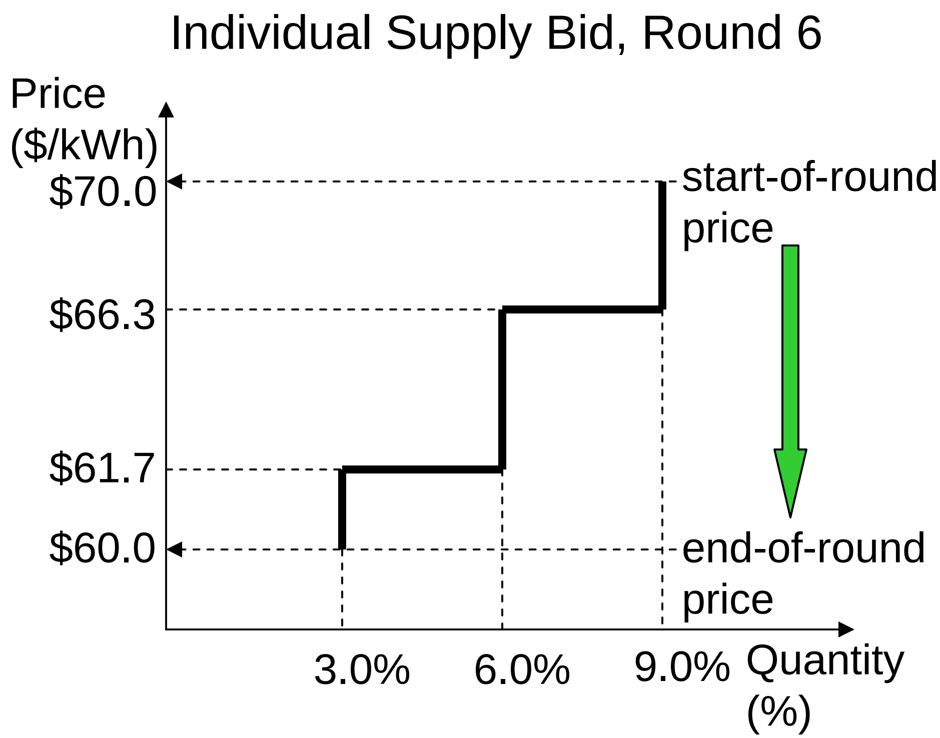
- Auctioneer announces high starting price
- Suppliers name quantities
- Excess supply is determined
- Auctioneer announces a lower price
- Process continues until supply equals demand

Starting price

- Starting price must be set sufficiently high to create significant excess supply
- Setting too high a starting price causes little harm
  - Competition among bidders determines clearing price; high start quickly bid down
- Setting too low a starting price destroys auction
  - Inadequate supply or insufficient competition
- Set starting price based on market fundamentals and indicative offers from suppliers at min and max starting prices
  - Min starting price roughly 20% above market
  - Max starting price roughly 50% above market

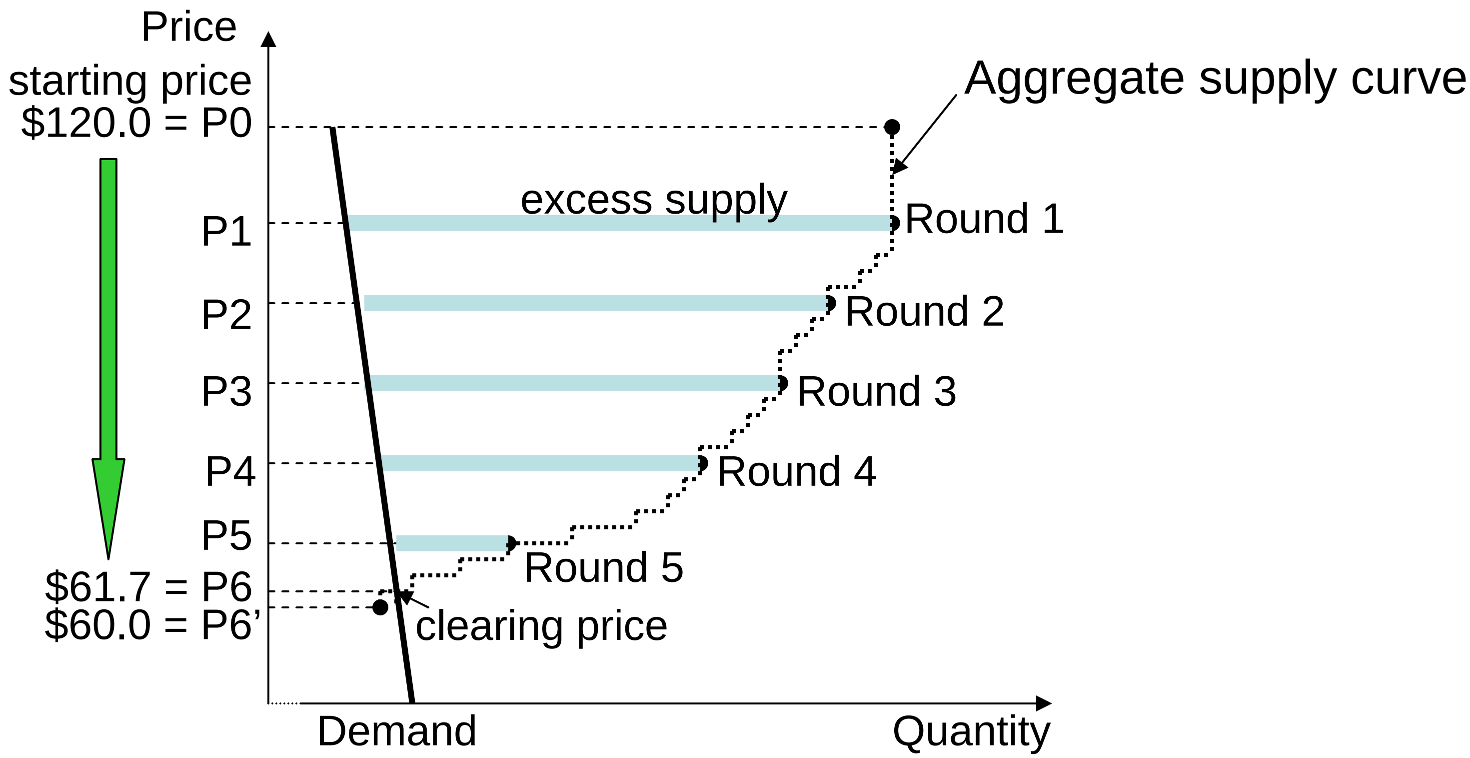
Mechanics

- Clock auction done in discrete rounds
- Two price “clocks,” one for each product
- In each round,
  - Auctioneer announces
    - Excess supply at end of prior round
    - Start of round prices (higher prices)
    - End of round prices (lower prices)
  - Each bidder submits a supply curve at all prices between start of round price and end of round price
  - Auctioneer determines excess supply at end of round price
    - For each product with excess supply, price increases
    - If no excess supply for either product, clearing prices are determined



- Activity rule
  - Bidders can only maintain or reduce quantity as price falls (upward sloping supply curve)
- “Intraround bids”
  - More accuracy without too many rounds
  - Better control of pace of auction
  - Ties are reduced

Descending clock auction



Sample bid illustrating switch and reduction

Carried forward from end of prior round						
Set by auctioneer at end of prior round				Product weights		
Bidder's bid in round				2	1	
		Price ($/kWh)		Quantity (%)		Aggregate
Bidder activity	Price point	Reg	Nonreg	Reg	Nonreg	supply
Start of round prices and quantities	0.0%	$70.00	$68.00	3.0%	2.0%	8.0%
Switches 1% Reg to Nonreg	37.0%	$66.30	$64.30	2.0%	4.0%	8.0%
Reduces Reg by 1%	83.0%	$61.70	$59.70	1.0%	4.0%	6.0%
End of round prices and quanties	100.0%	$60.00	$58.00	1.0%	4.0%	6.0%

- Activity rule
  - A bidder can only maintain or reduce its *aggregate* quantity as price falls (its aggregate supply curve must be upward sloping)
  - Allows full substitution between Reg and Nonreg products
  - Bidders can switch or reduce or both at any price point

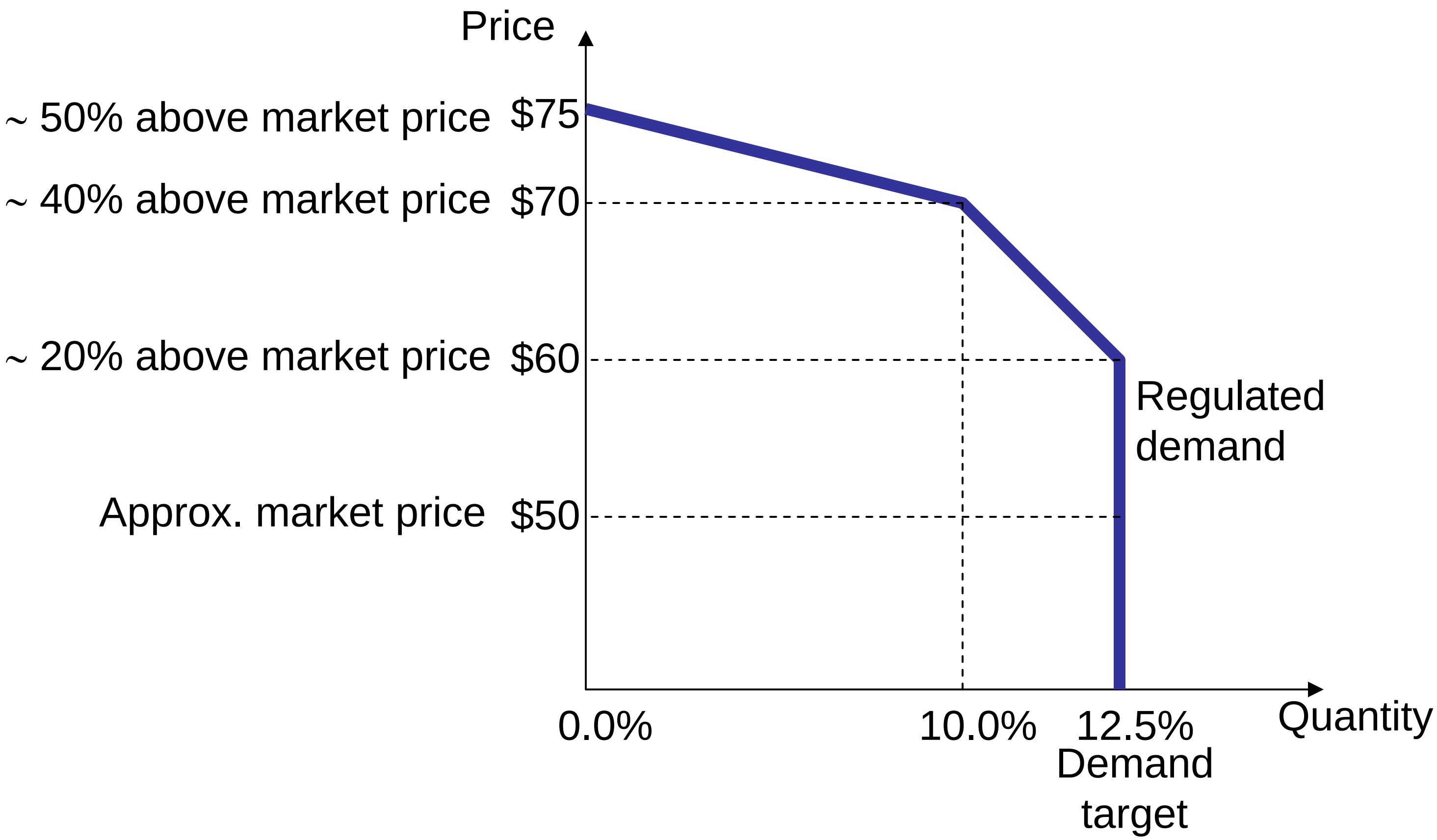
Information policy

- Demand curve and starting price announced before auction
- After every round, auctioneer reports
  - Aggregate supply
  - Excess supply at end of round price
  - End of round price for next round (determined from extent of excess supply)

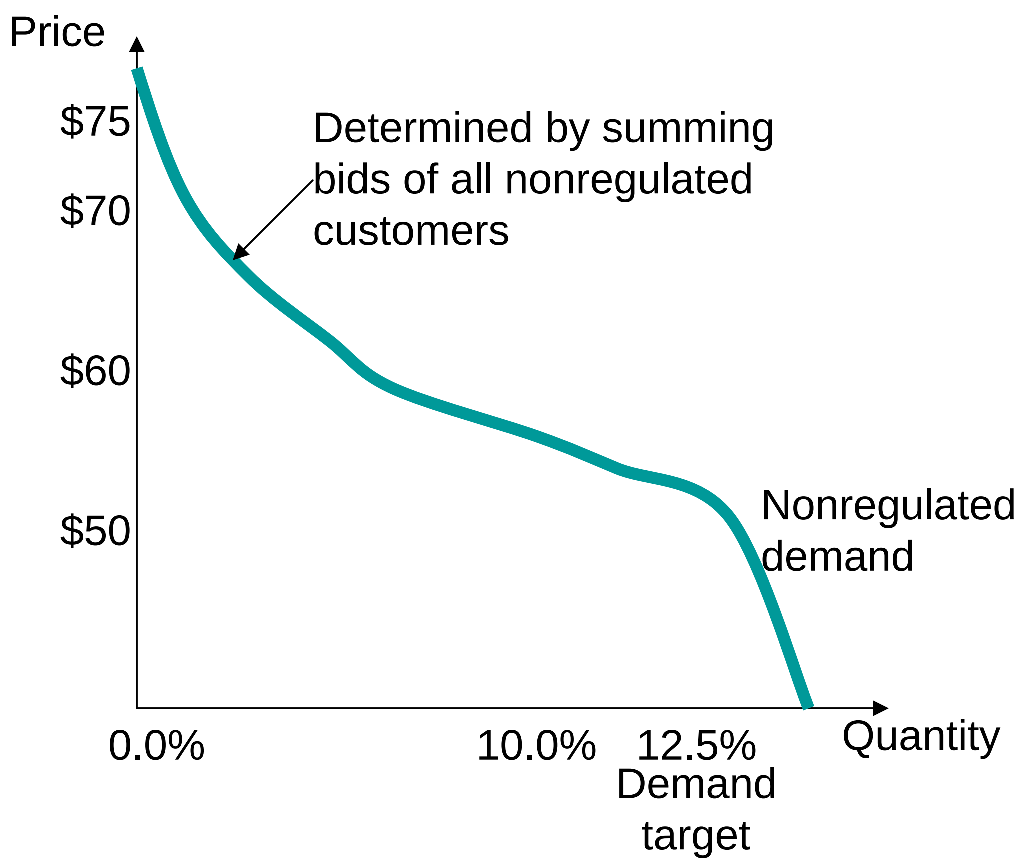
Forward energy auction

- Simultaneous descending clock auction
  - Two clocks; two prices
  - Regulated; nonregulated
- Supplier qualification and credit identical for both regulated and nonregulated product
- Regulated demand is mostly vertical (typically a fixed quantity purchased in each auction)
- Nonregulated demand is as-bid at qualification
- Suppliers can arbitrage freely across the two products throughout clock auction
- Auction ends when no excess supply for either product
  - Clock ticks down if and only if excess supply on product
- Any price separation reflects difference in serving regulated load and nonregulated load

Administrative demand curve for regulated product addresses insufficient competition



Demand curve for nonregulated product is submitted before auction by each nonregulated customer



Organized secondary auction

- Held monthly
- Simple uniform-price auction
  - Participants submit demand bids and supply asks for each product
  - Clearing-price determined from intersection of aggregate supply and demand curves
- Regulated and nonregulated products include
  - Monthly slice for next 12 months
  - Yearly slice for each year already auctioned in primary auction

Secondary market has 13 or 14 products each of Reg and Nonreg

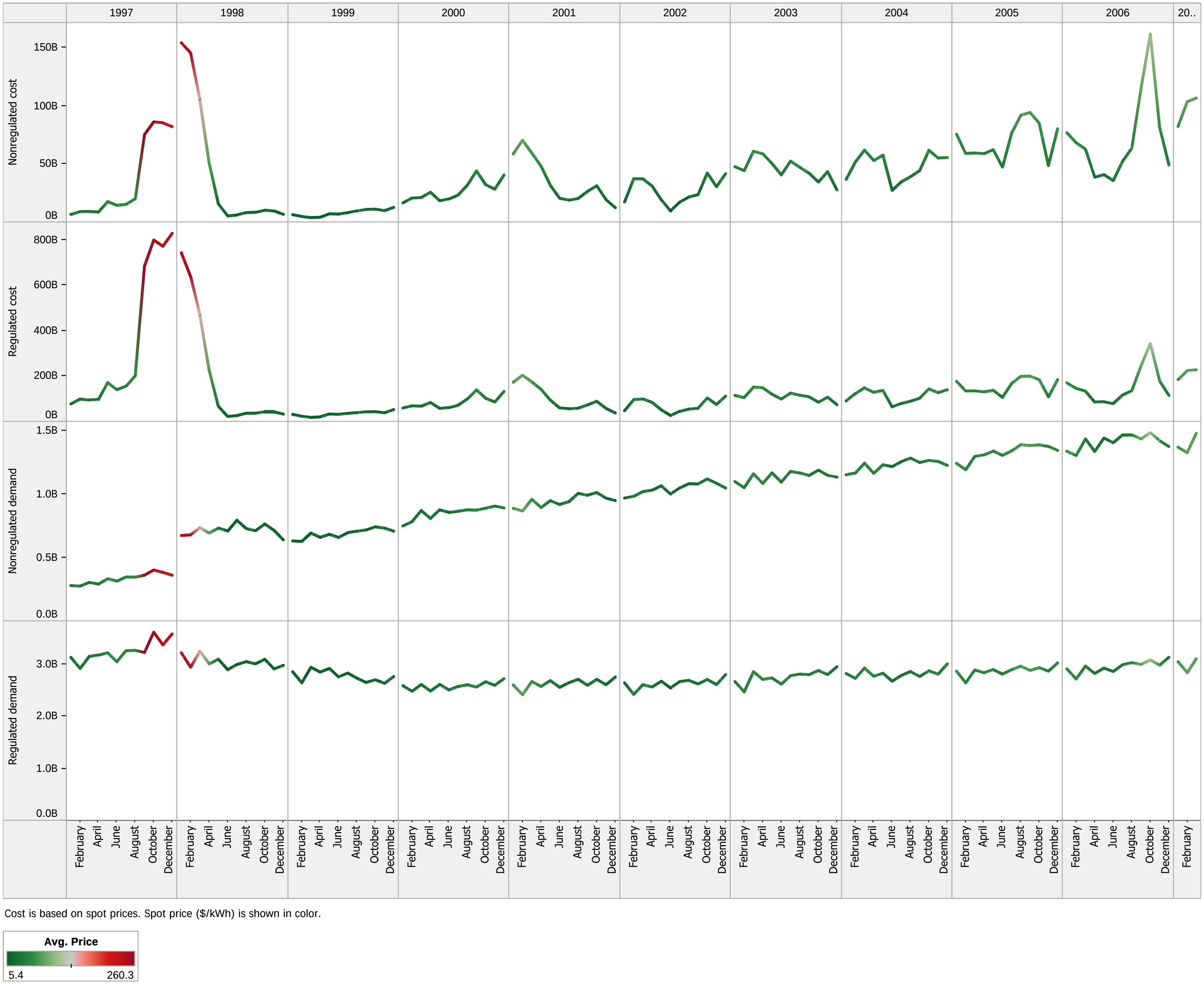
		Primary market products																												
		primary 2008-2009																												
			P2			P3			P4					primary 2009-2010																
		2009												2010												2011				
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5
Year	Month	**Organized secondary market products**																												
	1		2	3	4	5	6	7	8	9	10	11	12	1	+ year 2010															
	2			3	4	5	6	7	8	9	10	11	12	1	2	+ year 2010														
	3				4	5	6	7	8	9	10	11	12	1	2	3	+ year 2010													
	4					5	6	7	8	9	10	11	12	1	2	3	4	+ year 2010												
	5						6	7	8	9	10	11	12	1	2	3	4	5	+ year 2010											
2009	6							7	8	9	10	11	12	1	2	3	4	5	6	+ year 2010										
	7								8	9	10	11	12	1	2	3	4	5	6	7	+ year 2010									
	8									9	10	11	12	1	2	3	4	5	6	7	8	+ year 2010								
	9										10	11	12	1	2	3	4	5	6	7	8	9	+ years 2010 and 2011							
	10											11	12	1	2	3	4	5	6	7	8	9	10	+ years 2010 and 2011						
	11												12	1	2	3	4	5	6	7	8	9	10	11	+ years 2010 and 2011					
	12													1	2	3	4	5	6	7	8	9	10	11	12	+ years 2010 and 2011				

Handling differences among nonregulated customers

- Hourly demand is forecast for each nonregulated customer for every hour
- Single nonregulated product
- Rate is auction clearing price scaled by quality factor of each nonregulated customer
- Quality factor reflects expected cost difference (at spot price) for particular customer
- Each supplier receives its share of payments
- Supplier obligation is its share of aggregate nonregulated *expected* load

Forecasting hourly demand and cost

Monthly demand and cost for regulated and nonregulated load



Cost is based on spot prices. Spot price ($/kWh) is shown in color.

Simple hourly demand model

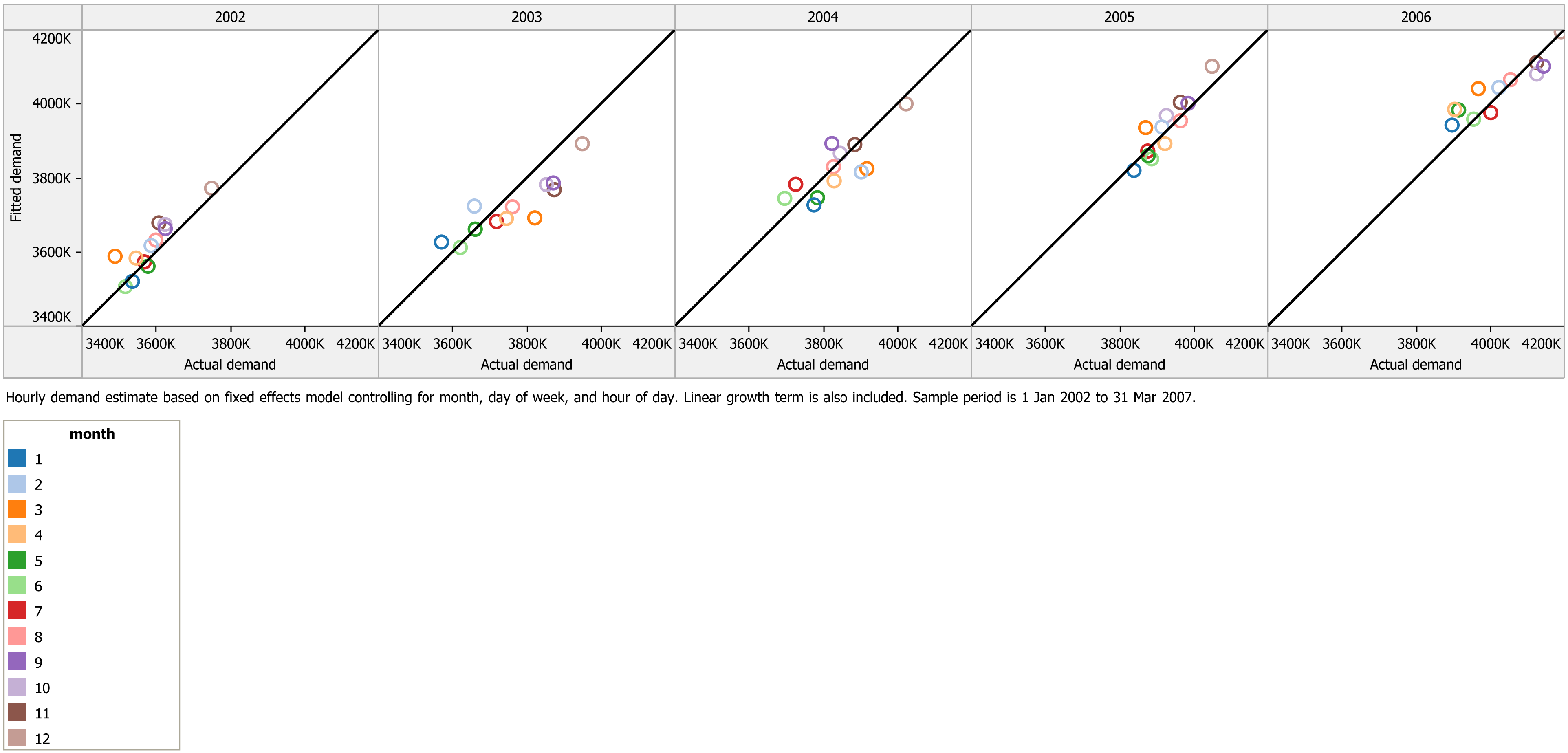
- Sample: 1 Jan 2002 to 31 Mar 2007
- Linear growth trend
- Fixed effects for
  - Month of year
  - Day of week
  - Hour of day

Hourly mean and *standard deviation* of demand and cost

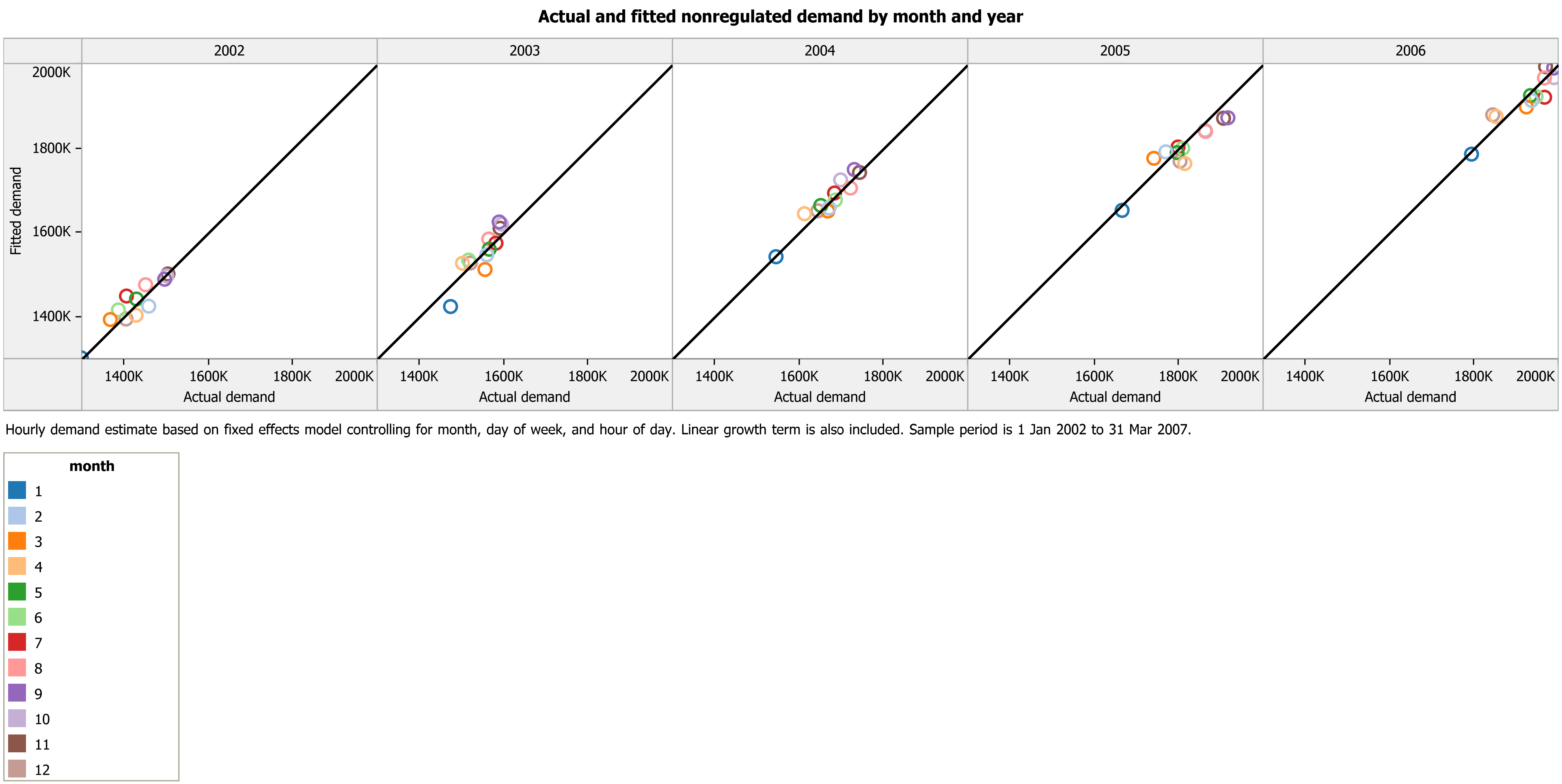
Load	Price ($/kWh)	Demand (MWh) Actual	Demand (MWh) Fitted	Error (%)	Cost ($M) Actual	Cost ($M) Fitted	Error ($/kWh)
Regulated	42.6	3,841	3,841	0.01	171	171	0.03
	21.5	*908*	*893*	*4.45*	*112*	*110*	*1.96*
Nonregulated	42.6	1,689	1,689	0.02	75	74	-0.09
	21.5	*275*	*251*	*6.89*	*46*	*45*	*3.42*
Total	42.6	5,530	5,530	0.01	246	245	0.03
	21.5	*1,062*	*1,033*	*4.39*	*155*	*153*	*2.00*

Note: Hourly mean and *standard deviation* for the period 1 Jan 2002 to 31 May 2007. Price and cost are in January 2007 Colombian pesos. Cost is based on spot price. Hourly demand estimate based on fixed effects model controlling for month, day of week, and hour of day. Linear growth term is also included.

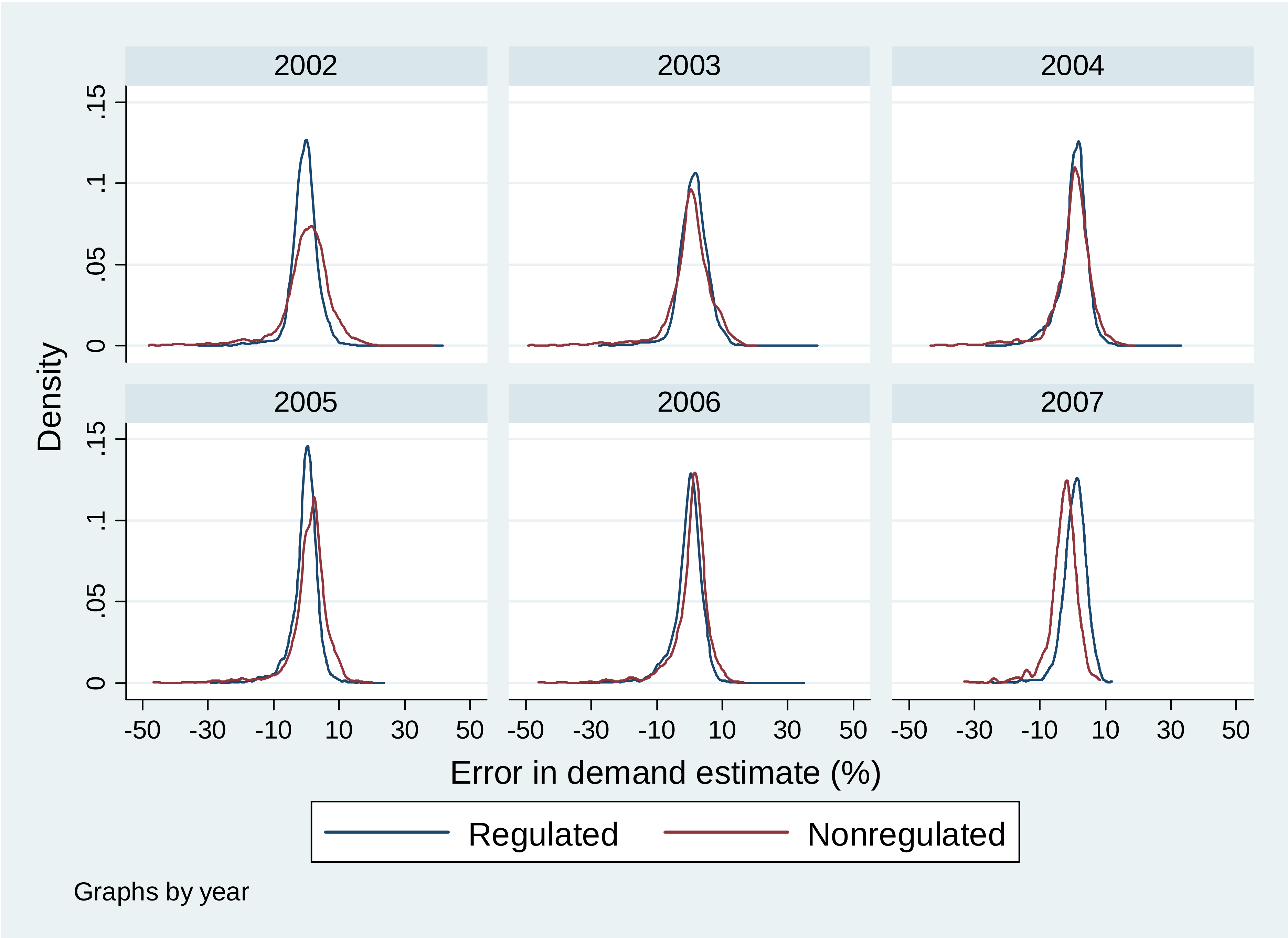
Actual and fitted regulated demand by month and year

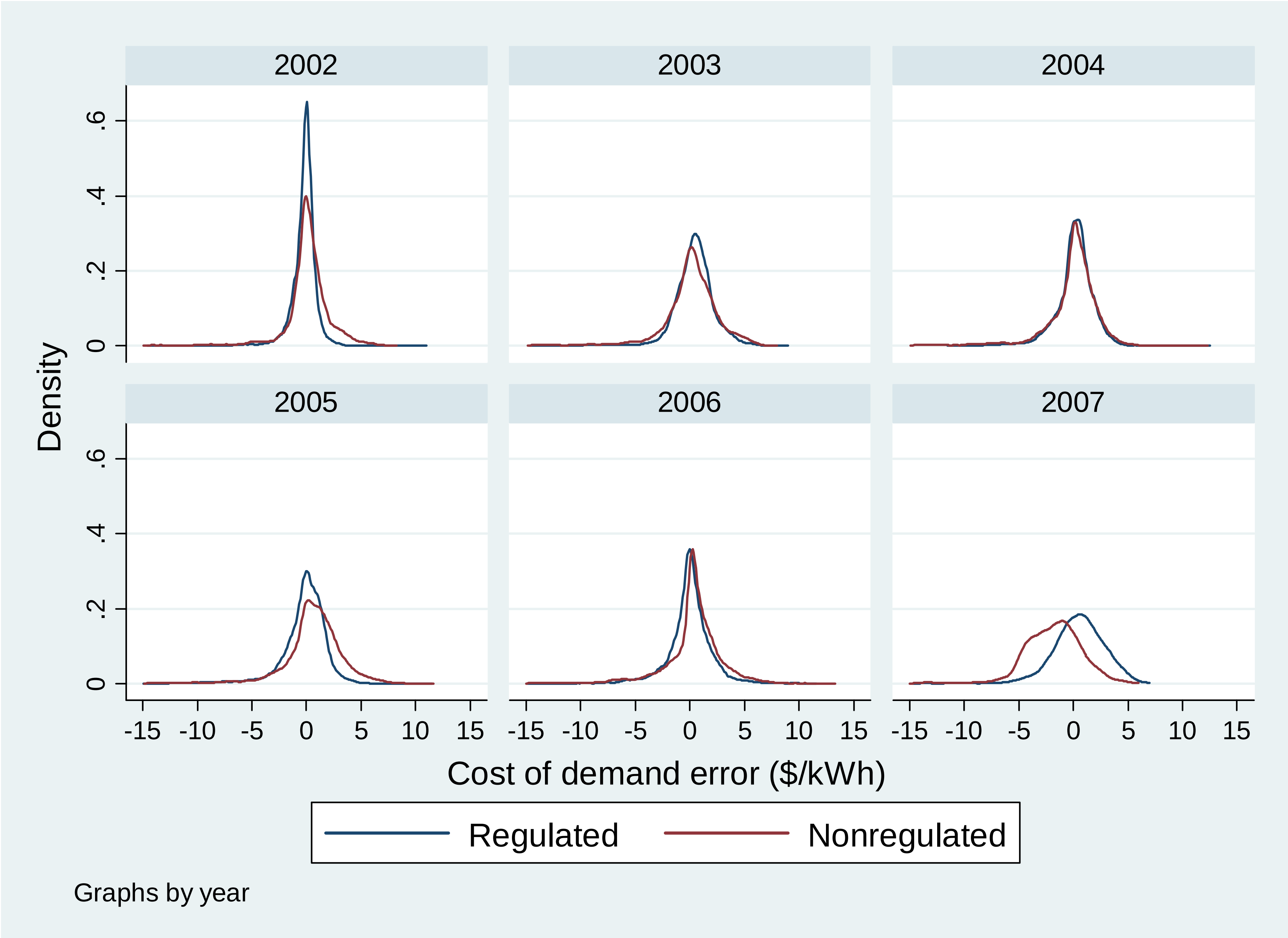


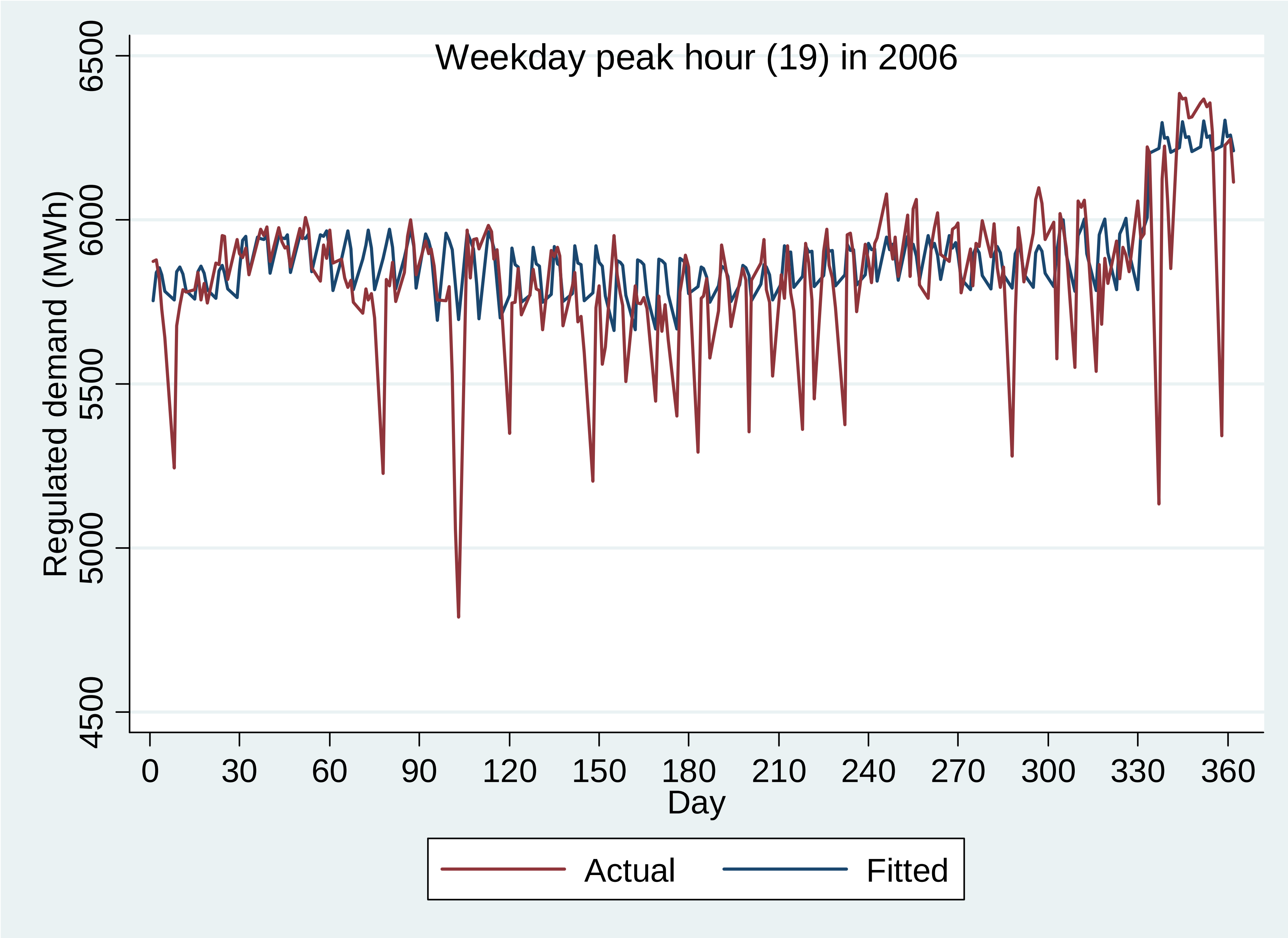
Hourly demand estimate based on fixed effects model controlling for month, day of week, and hour of day. Linear growth term is also included. Sample period is 1 Jan 2002 to 31 Mar 2007.



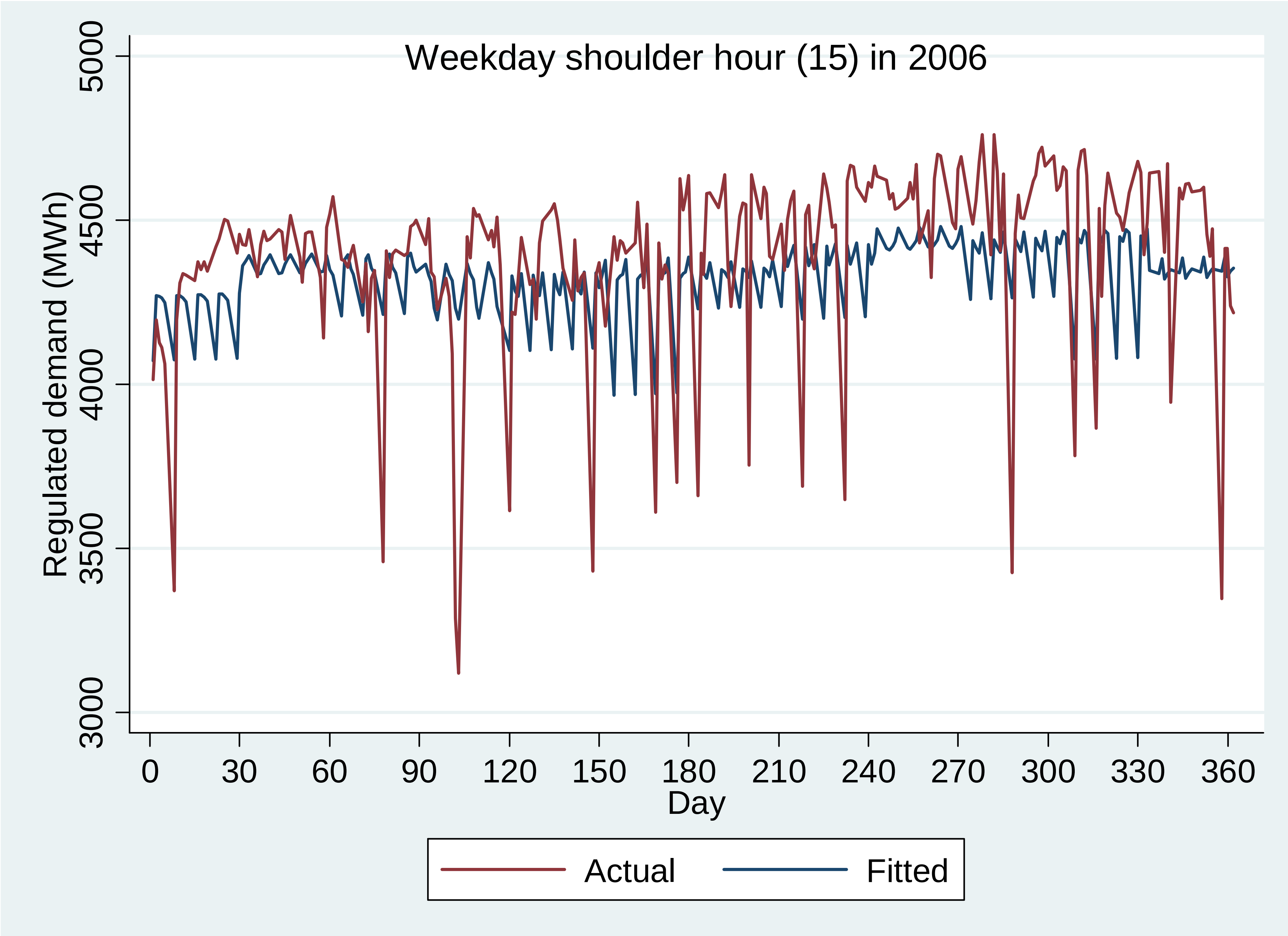
Hourly demand estimate based on fixed effects model controlling for month, day of week, and hour of day. Linear growth term is also included. Sample period is 1 Jan 2002 to 31 Mar 2007.


2002
2003
2004
2005
2006
2007
Density
0
.05
.1
.15
-50
-30
-10
10
30
50
Error in demand estimate (%)
Regulated
Nonregulated
Graphs by year

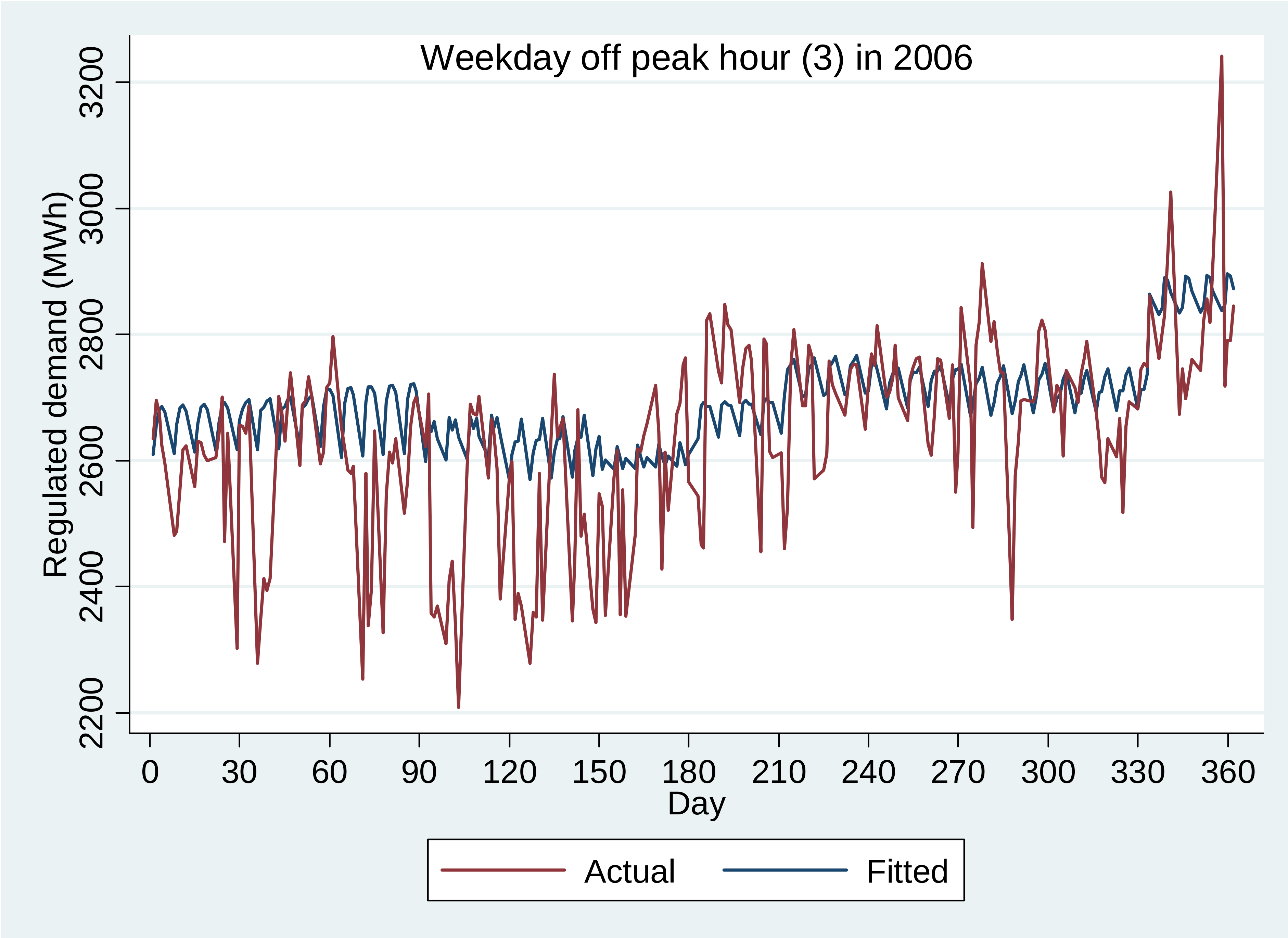

2002
2003
2004
2005
2006
2007
Density
0
.2
.4
.6
-15
-10
-5
0
5
10
15
Cost of demand error ($/kWh)
Regulated
Nonregulated
Graphs by year



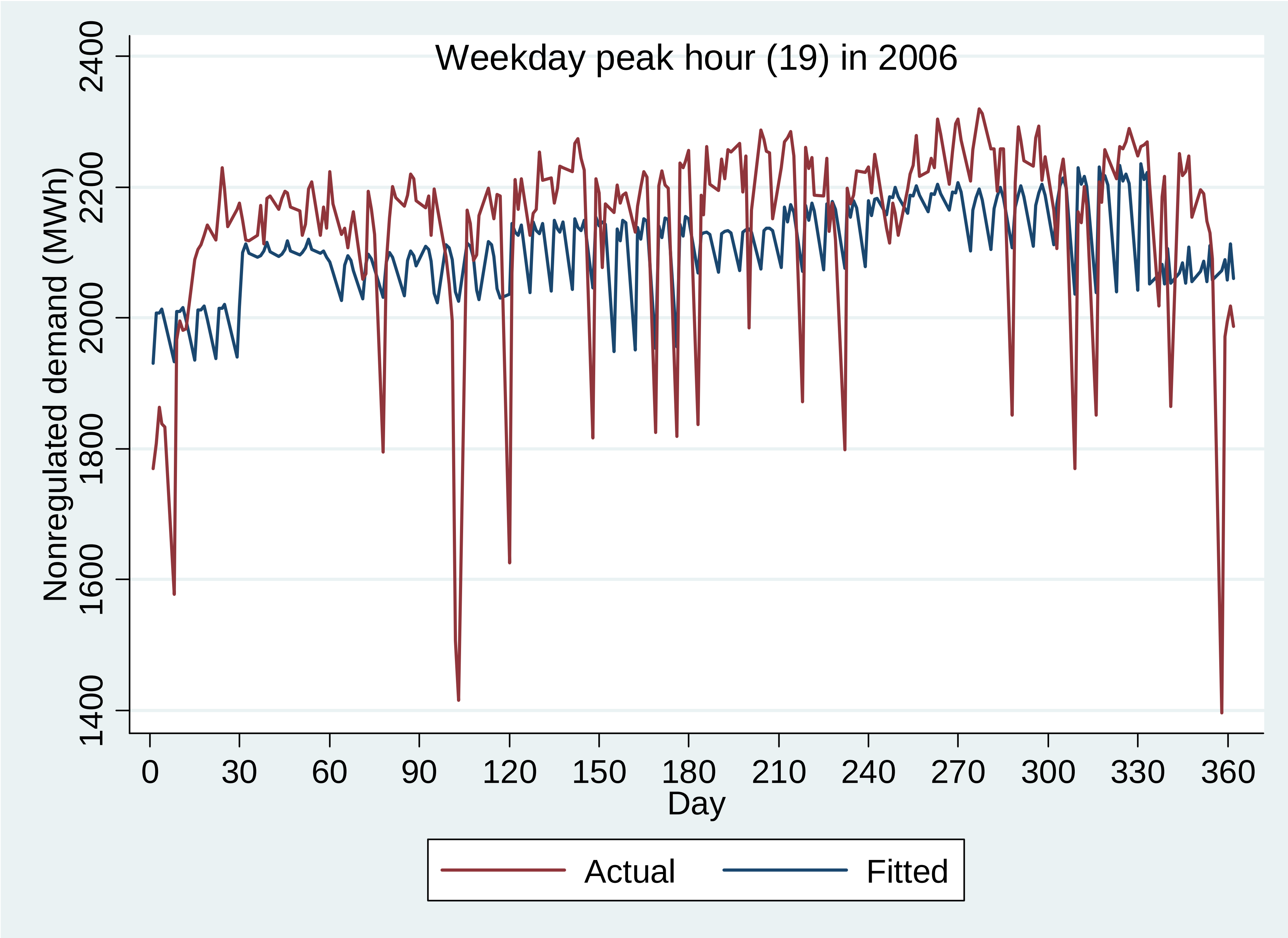
Weekday peak hour (19) in 2006
Regulated demand (MWh)
6500
6000
5500
5000
4500
0
30
60
90
120
150
180
210
240
270
300
330
360
Day
Actual
Fitted



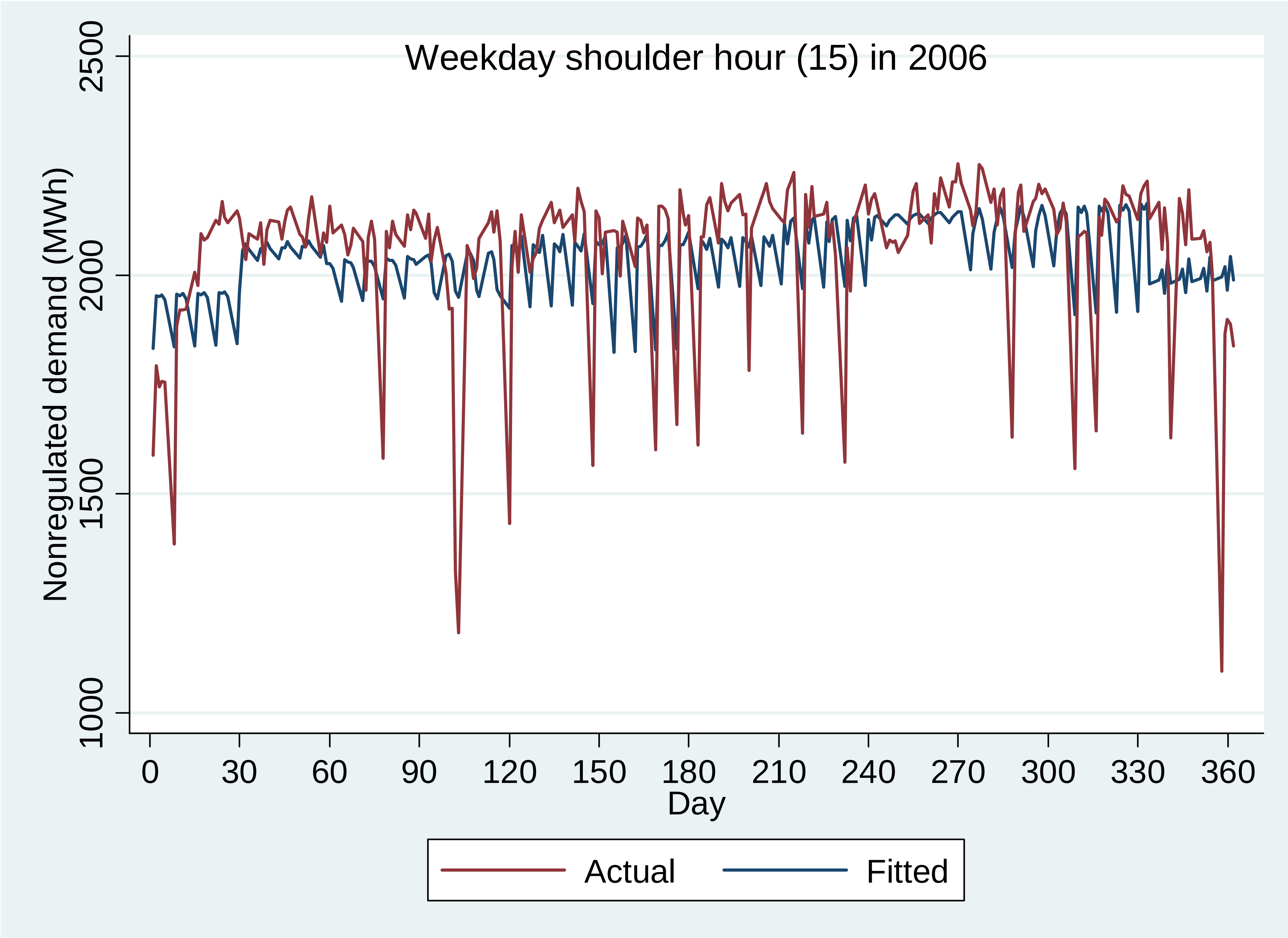
Weekday shoulder hour (15) in 2006
Regulated demand (MWh)
3000
3500
4000
4500
5000
0
30
60
90
120
150
180
210
240
270
300
330
360
Day
Actual
Fitted

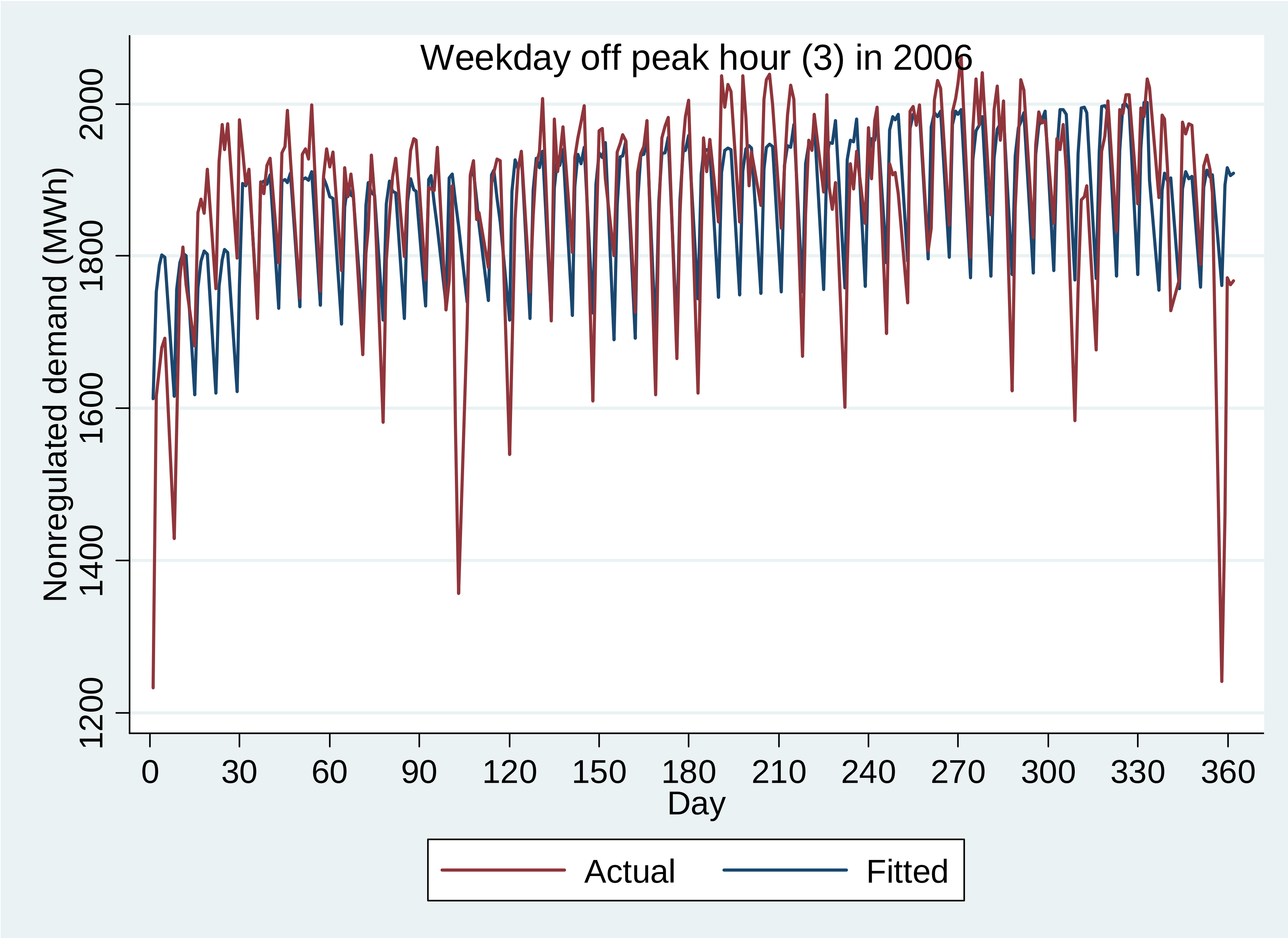


Weekday off peak hour (3) in 2006
Regulated demand (MWh)
2200
2400
2600
2800
3000
3200
0
30
60
90
120
150
180
210
240
270
300
330
360
Day
Actual
Fitted

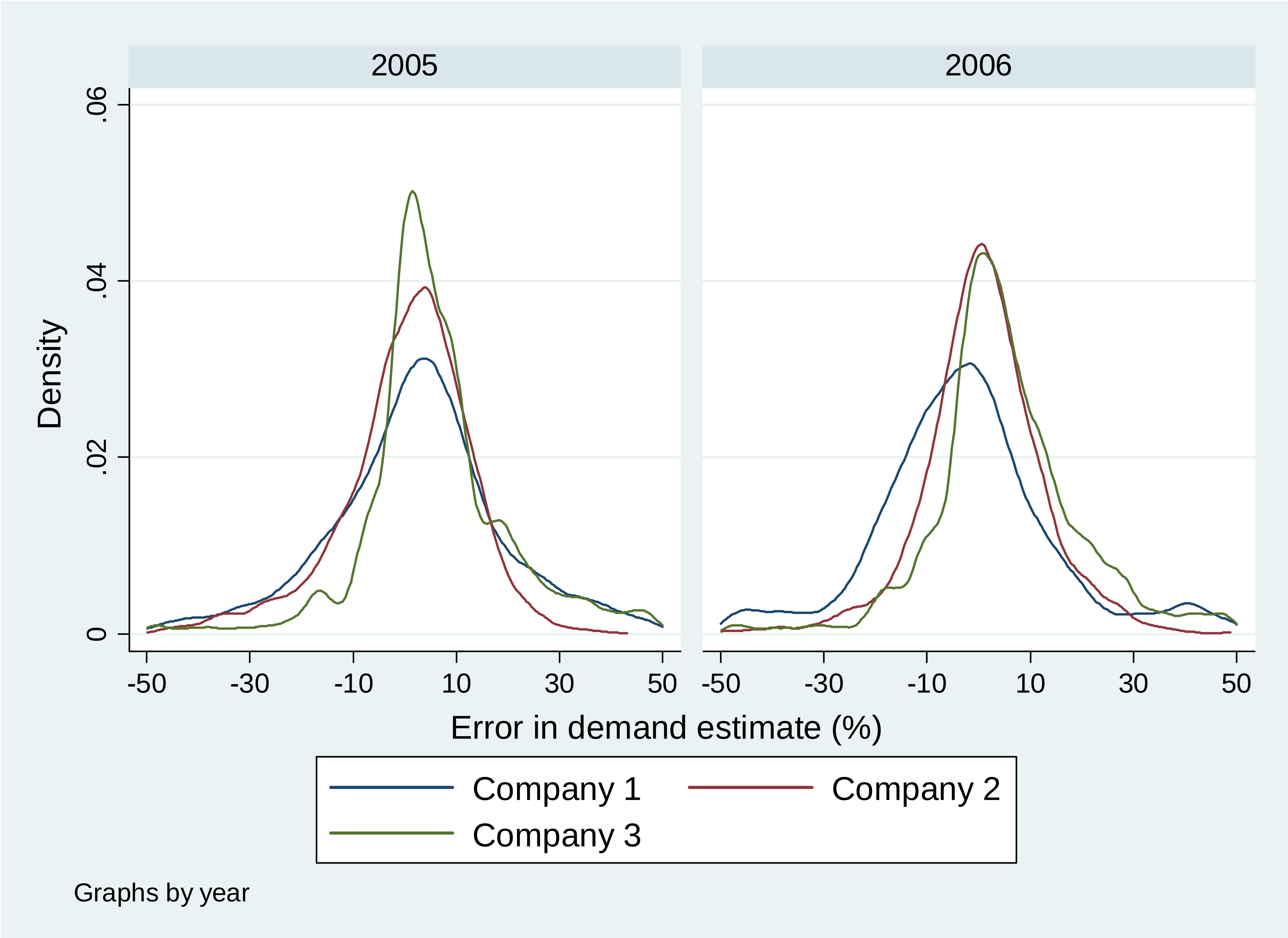


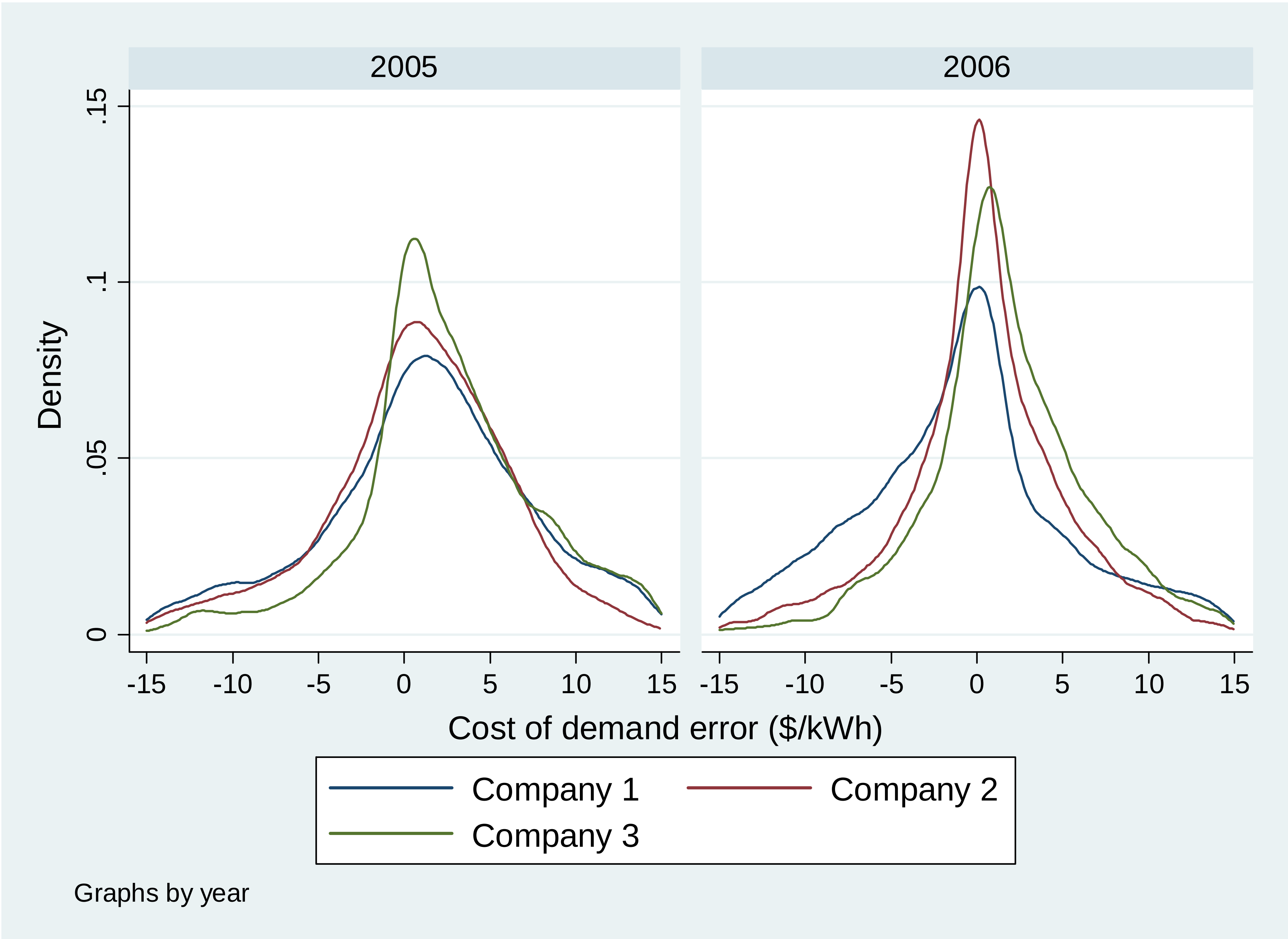
Weekday peak hour (19) in 2006
Nonregulated demand (MWh)
1400
1600
1800
2000
2200
2400
0
30
60
90
120
150
180
210
240
270
300
330
360
Day
Actual
Fitted

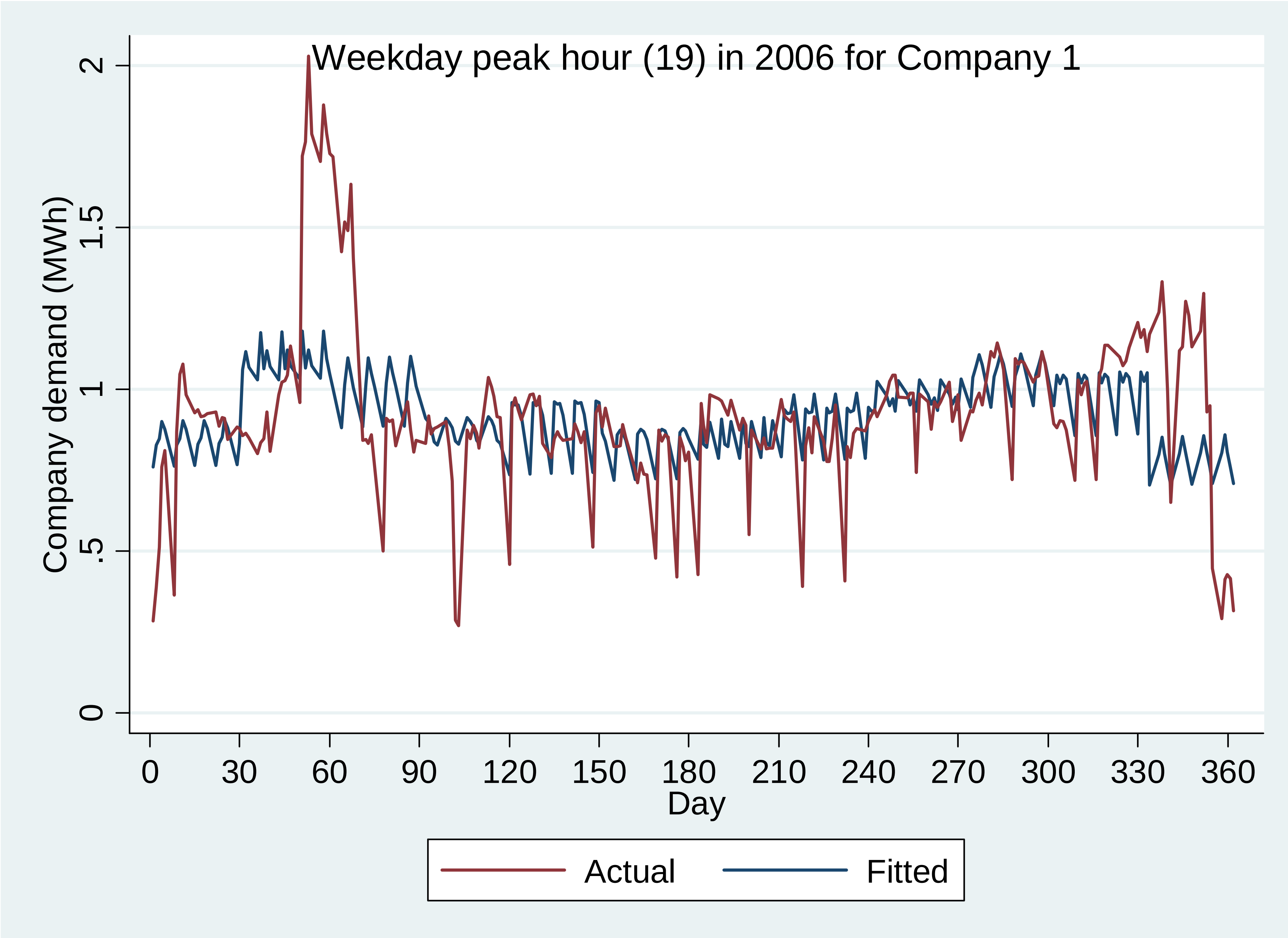

Weekday shoulder hour (15) in 2006
Nonregulated demand (MWh)
1000
1500
2000
2500
0
30
60
90
120
150
180
210
240
270
300
330
360
Day
Actual
Fitted



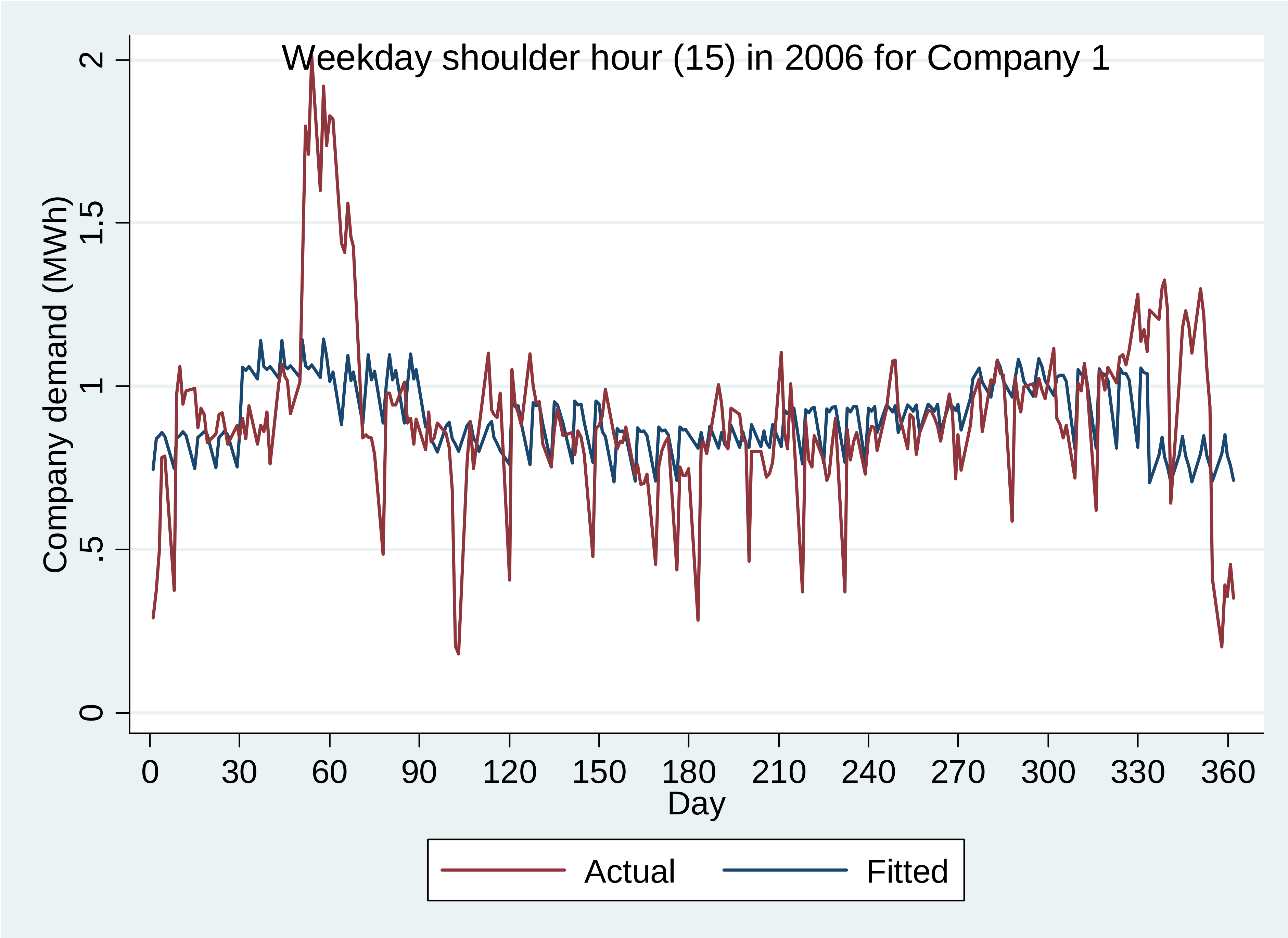
Weekday off peak hour (3) in 2006
Nonregulated demand (MWh)
2000
1800
1600
1400
1200
0
30
60
90
120
150
180
210
240
270
300
330
360
Day
Actual
Fitted

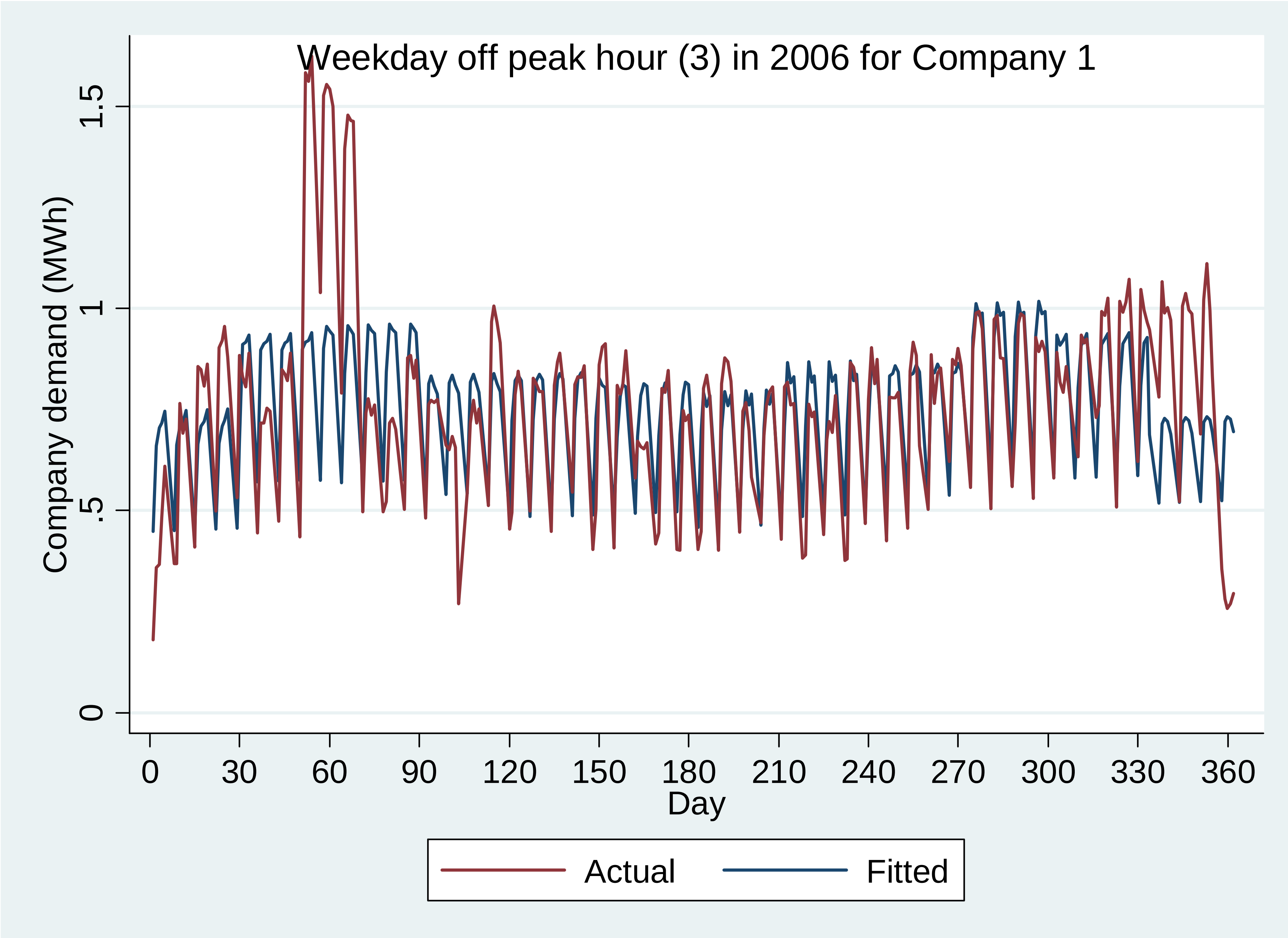

2005
2006
Density
0
.02
.04
.06
-50
-30
-10
10
30
50
Error in demand estimate (%)
Company 1
Company 2
Company 3
Graphs by year

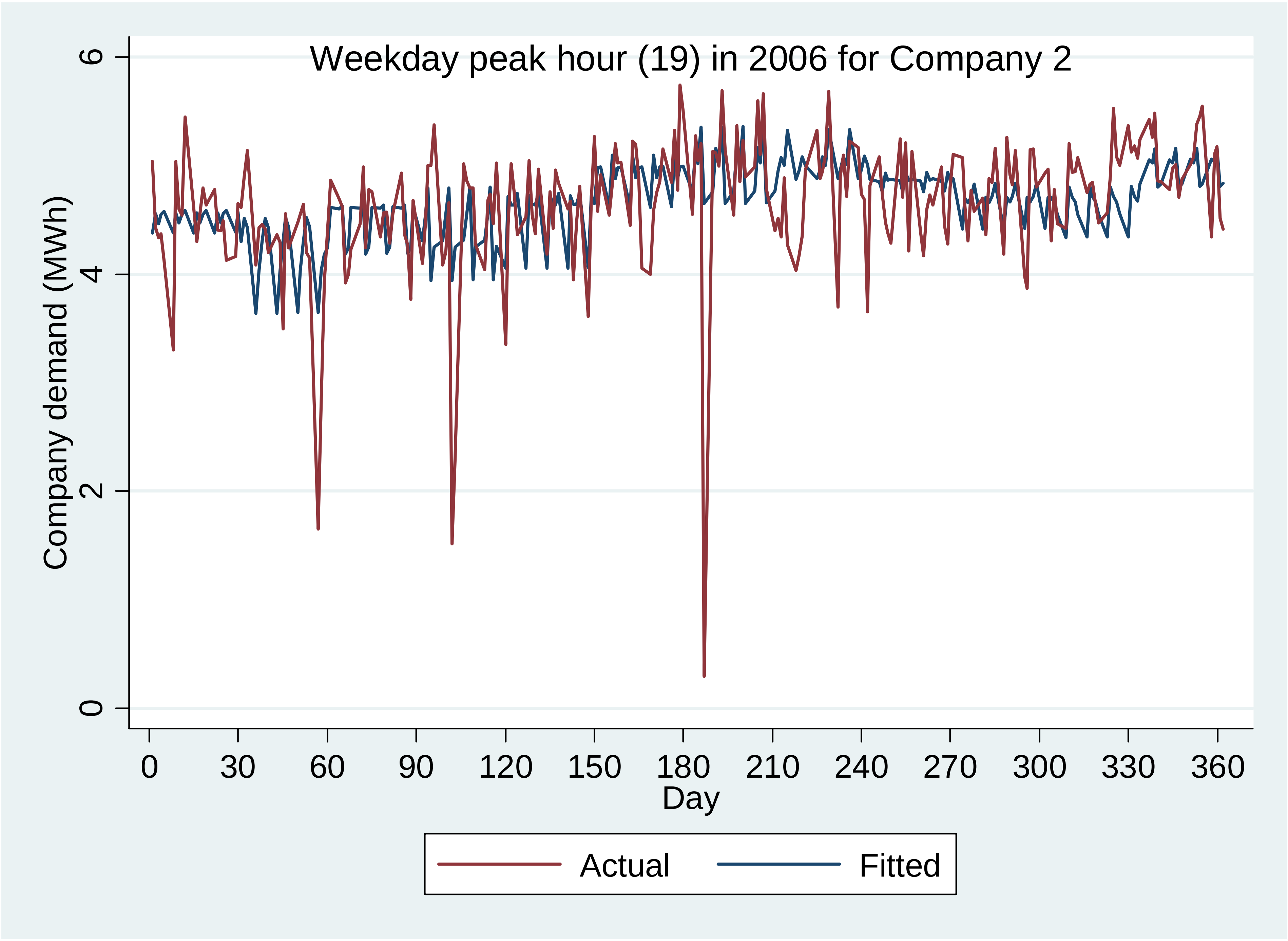

2005
2006
Density
0
.05
.1
.15
-15
-10
-5
0
5
10
15
Cost of demand error ($/kWh)
Company 1
Company 2
Company 3
Graphs by year

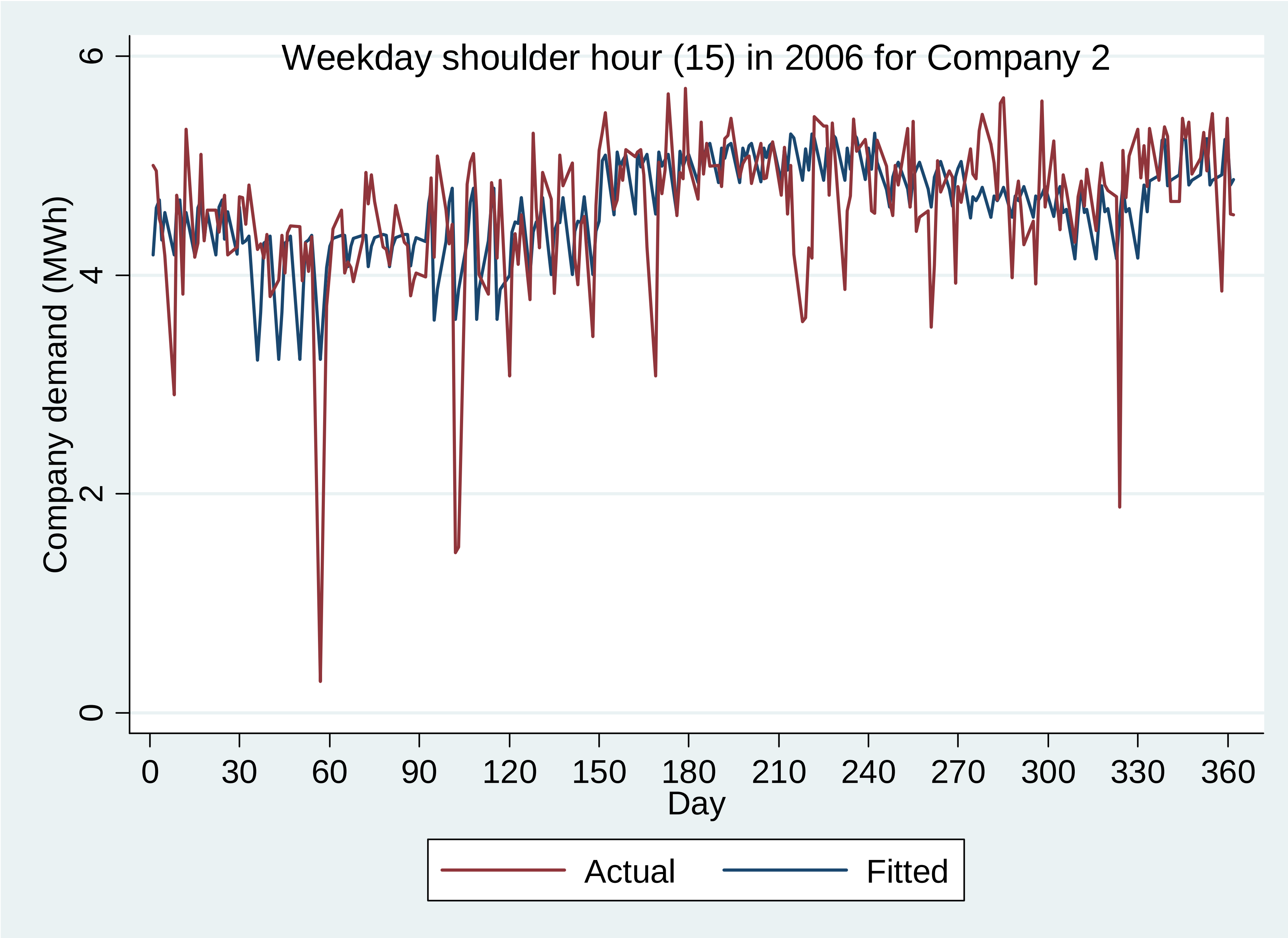


Weekday peak hour (19) in 2006 for Company 1
Company demand (MWh)
0
.5
1
1.5
2
0
30
60
90
120
150
180
210
240
270
300
330
360
Day
Actual
Fitted

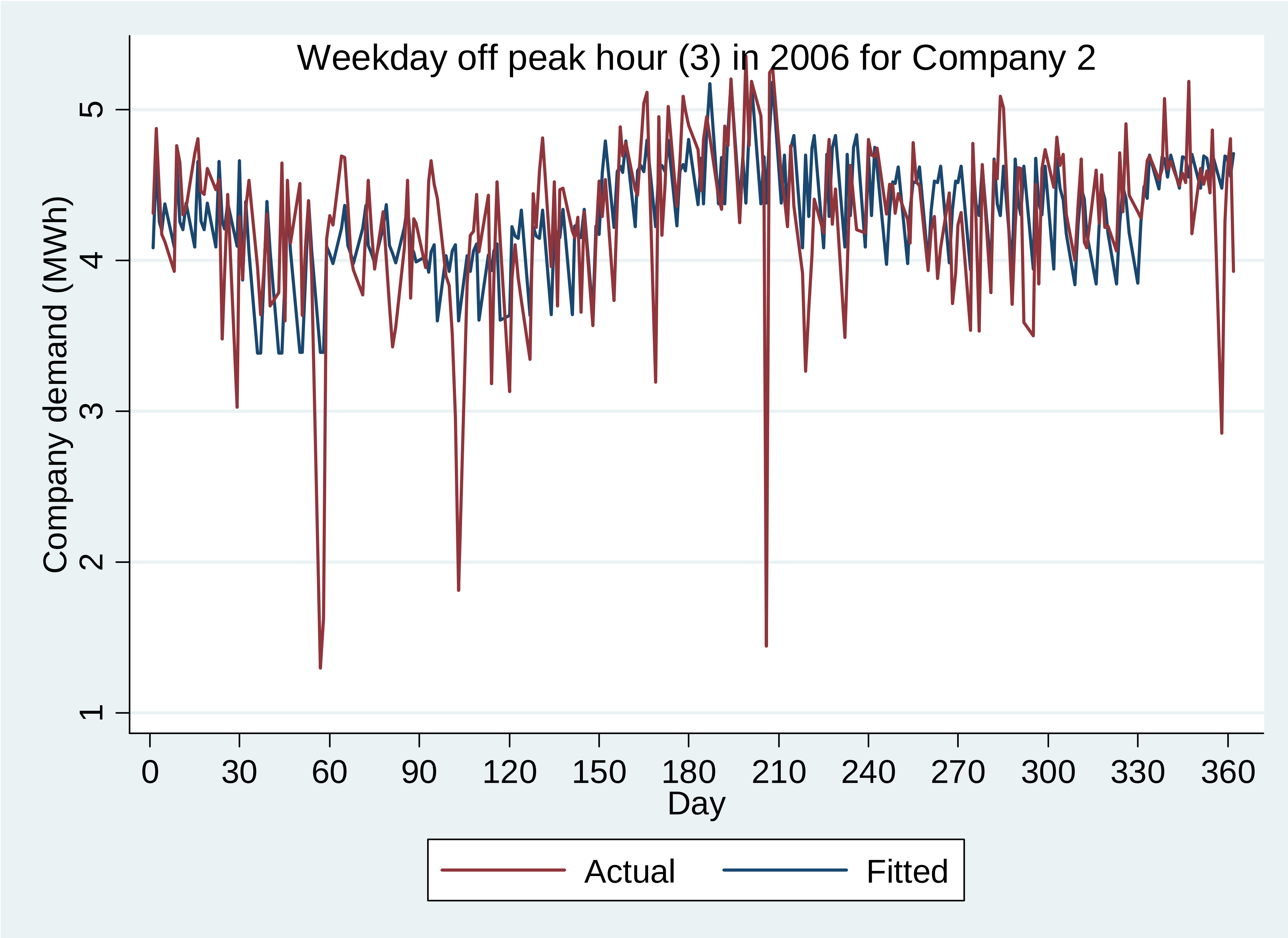

Weekday shoulder hour (15) in 2006 for Company 1
Company demand (MWh)
0
.5
1
1.5
2
0
30
60
90
120
150
180
210
240
270
300
330
360
Day
Actual
Fitted

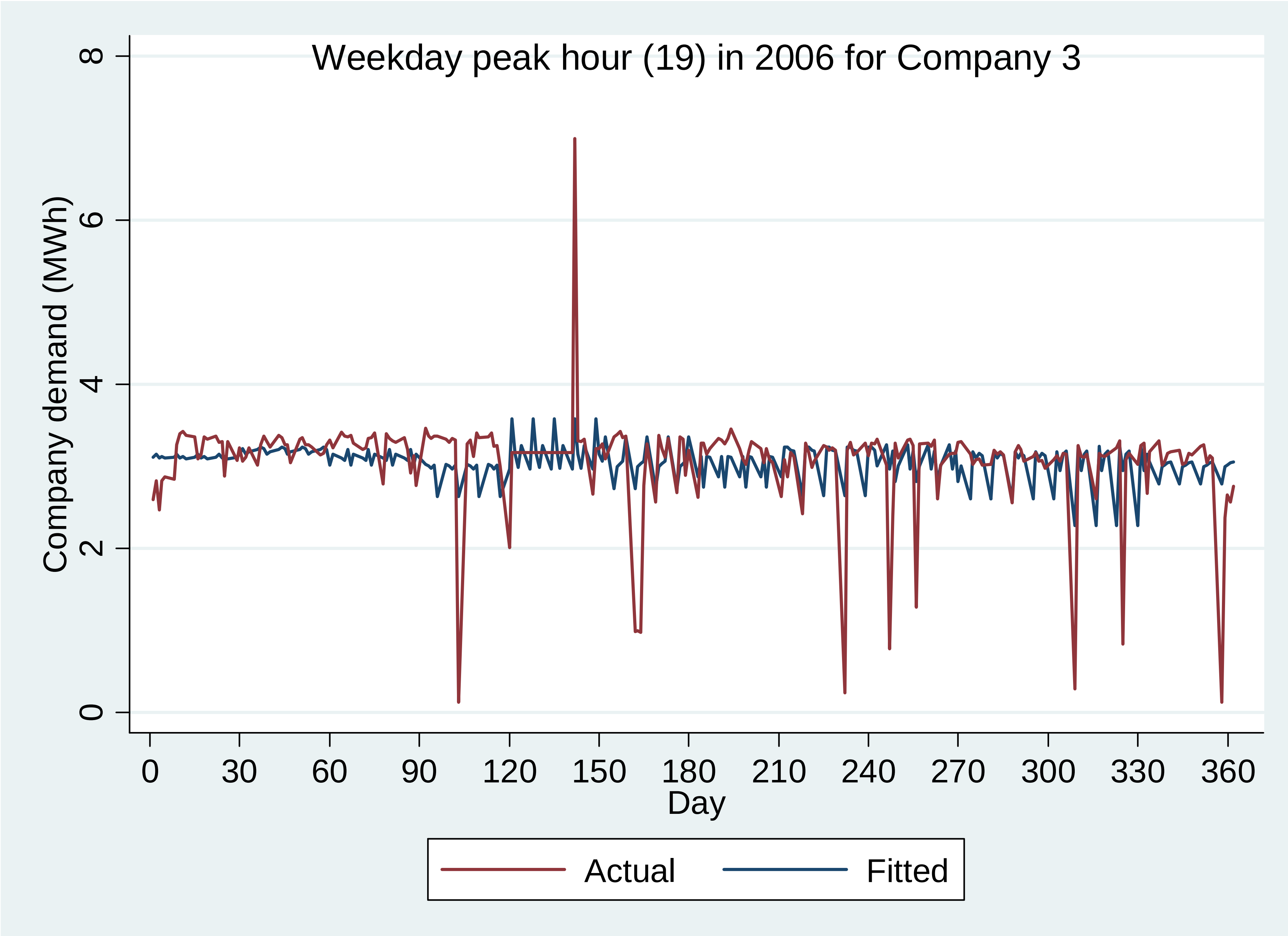

Weekday off peak hour (3) in 2006 for Company 1
Company demand (MWh)
0
.5
1
1.5
0
30
60
90
120
150
180
210
240
270
300
330
360
Day
Actual
Fitted


Weekday peak hour (19) in 2006 for Company 2
Company demand (MWh)
0
2
4
6
0
30
60
90
120
150
180
210
240
270
300
330
360
Day
Actual
Fitted

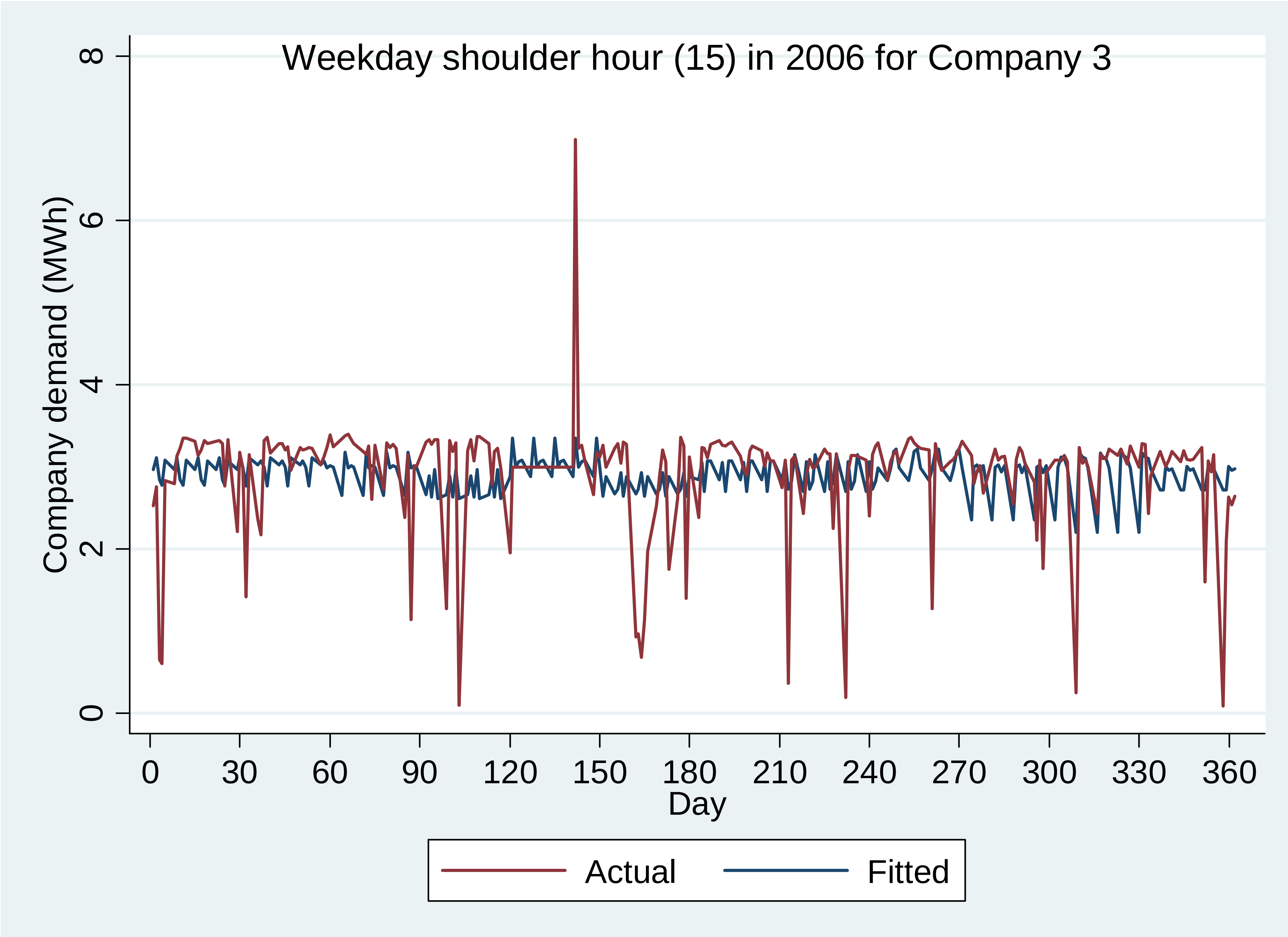


Weekday shoulder hour (15) in 2006 for Company 2
Company demand (MWh)
0
2
4
6
0
30
60
90
120
150
180
210
240
270
300
330
360
Day
Actual
Fitted

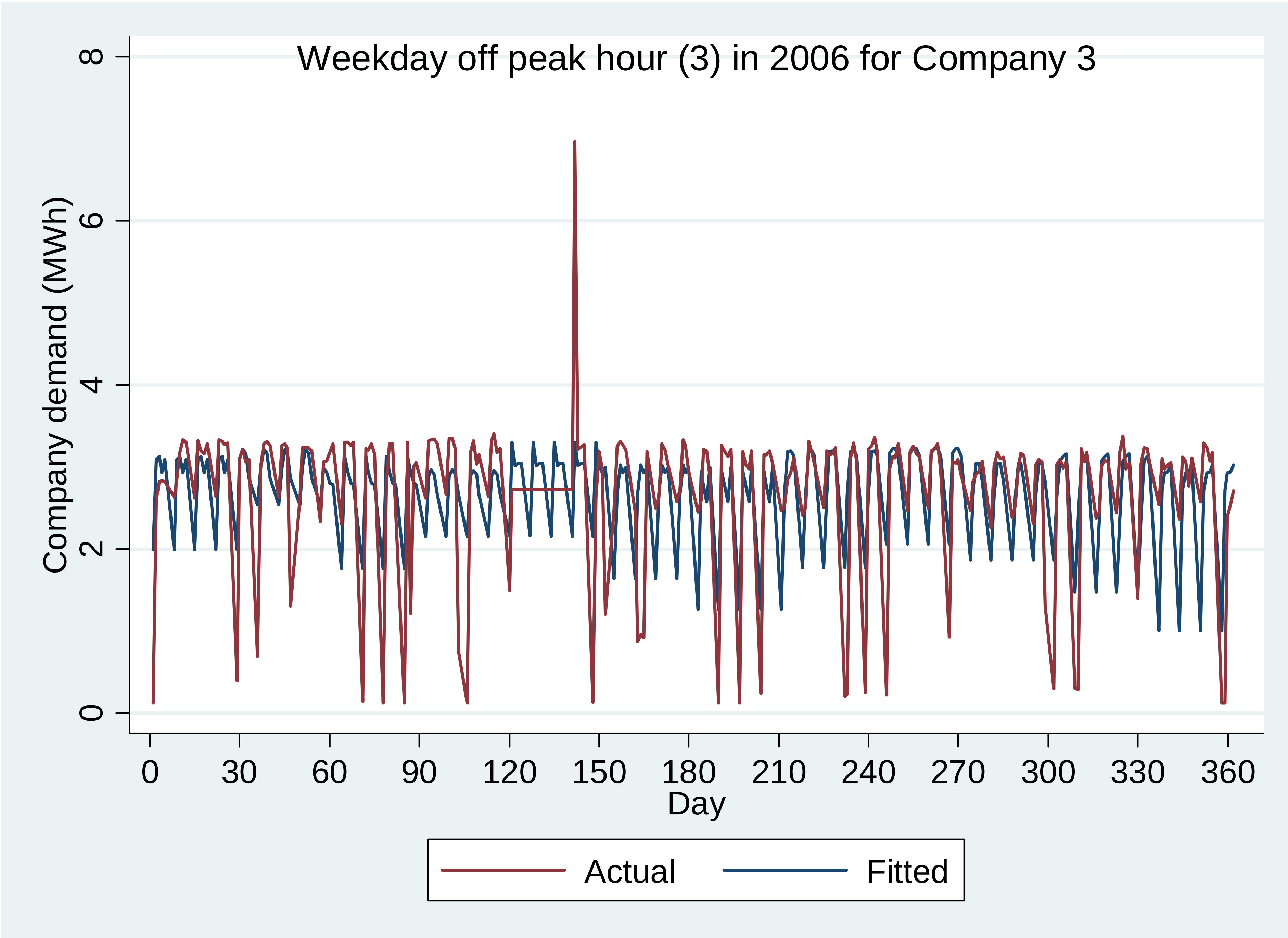

Weekday off peak hour (3) in 2006 for Company 2
Company demand (MWh)
1
2
3
4
5
0
30
60
90
120
150
180
210
240
270
300
330
360
Day
Actual
Fitted



Weekday peak hour (19) in 2006 for Company 3
Company demand (MWh)
0
2
4
6
8
0
30
60
90
120
150
180
210
240
270
300
330
360
Day
Actual
Fitted



Weekday shoulder hour (15) in 2006 for Company 3
Company demand (MWh)
0
2
4
6
8
0
30
60
90
120
150
180
210
240
270
300
330
360
Day
Actual
Fitted



Weekday off peak hour (3) in 2006 for Company 3
Company demand (MWh)
0
2
4
6
8
0
30
60
90
120
150
180
210
240
270
300
330
360
Day
Actual
Fitted

International experience and grades

- Maryland: F
  - Single RFP to procure many years of energy (all eggs in one basket)
  - Poor auction design
- New Jersey: A-
  - Annual auction for one-third of load
  - Very good auction design
- Illinois: A-
  - Nearly identical to New Jersey
- France (Virtual Power Plant auction): A
  - Quarterly auctions with flexibility on duration
  - Excellent auction design
- Spain: C?
  - Process appears too rushed at end

Conclusion

Background

Mostly presented in May meeting on product design.

Objective

Purpose of market

- Efficient price formation
- Transparency
- Neutrality
- Risk management
- Liquidity
- Simplicity
- Consistency

Efficient price formation

- Reliable price signals based on market fundamentals
- Competitive
- Mitigate market power

Transparency

- Offers are comparable
- Clear why winners won
- Prompt regulatory review and approval
- Regulatory certainty

Neutrality

- All suppliers treated equally
- All demanders treated equally

Risk management

- Reduces risk for both sides of market
- Rate stability, yet responsive to long-term market fundamentals
- Shields from transient events
- Addresses counterparty risk

Liquidity

- Promotes secondary market
- Liquid market for primary product
- Liquid market for derivative products
  - Long-term strips
  - Short-term slices

Simplicity

- For participants
- For system operator
- For regulator

Consistency

- Consistent with other key elements
  - Spot energy market
  - Firm energy market
- Consistent with best practice in world

Setting

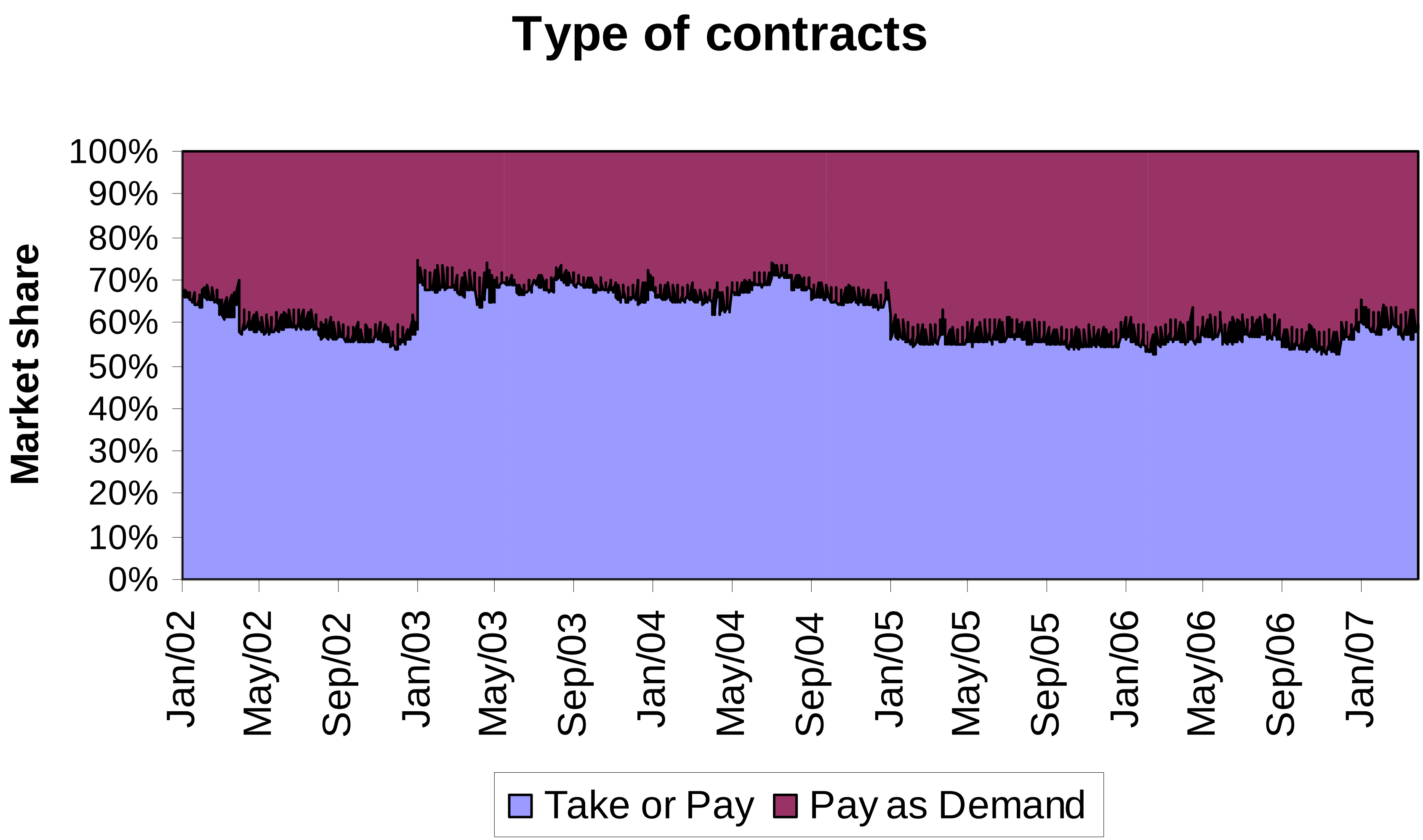
Colombia setting

- Hydro-dominated electricity market
  - 80% of energy
  - 67% of capacity
  - 50% of firm energy (exceptional dry period)
- Hourly bid-based spot energy
  - Single zone
- Firm energy market
  - Assures sufficient firm energy
  - Hedges prices above scarcity price (about $260/kWh)
    Note: All $ amounts in January 2007 Colombia Pesos

Market structure of firm energy (moderate concentration)

Company	ENFICC Declared (GWh)			Market share	HHI
	Hydro	Thermal	Total		
Emgesa	10,419	2,373	12,792	21%	455
Epm	8,523	3,295	11,818	20%	388
Corelca		9,873	9,873	16%	271
Isagen	5,099	2,327	7,426	12%	153
Epsa	1,487	1,655	3,142	5%	27
AES Chivor	2,925		2,925	5%	24
Gensa	57	2,594	2,651	4%	20
Termoflores		2,189	2,189	4%	13
Termoemcali		1,533	1,533	3%	7
Merielectrica		1,404	1,404	2%	5
Termotasajero		1,349	1,349	2%	5
Termocandelaria		1,062	1,062	2%	3
Proelectrica		708	708	1%	1
Menores	689		689	1%	1
Urra S.A	438		438	1%	1
Total	29,637	30,363	60,000	100%	1,374

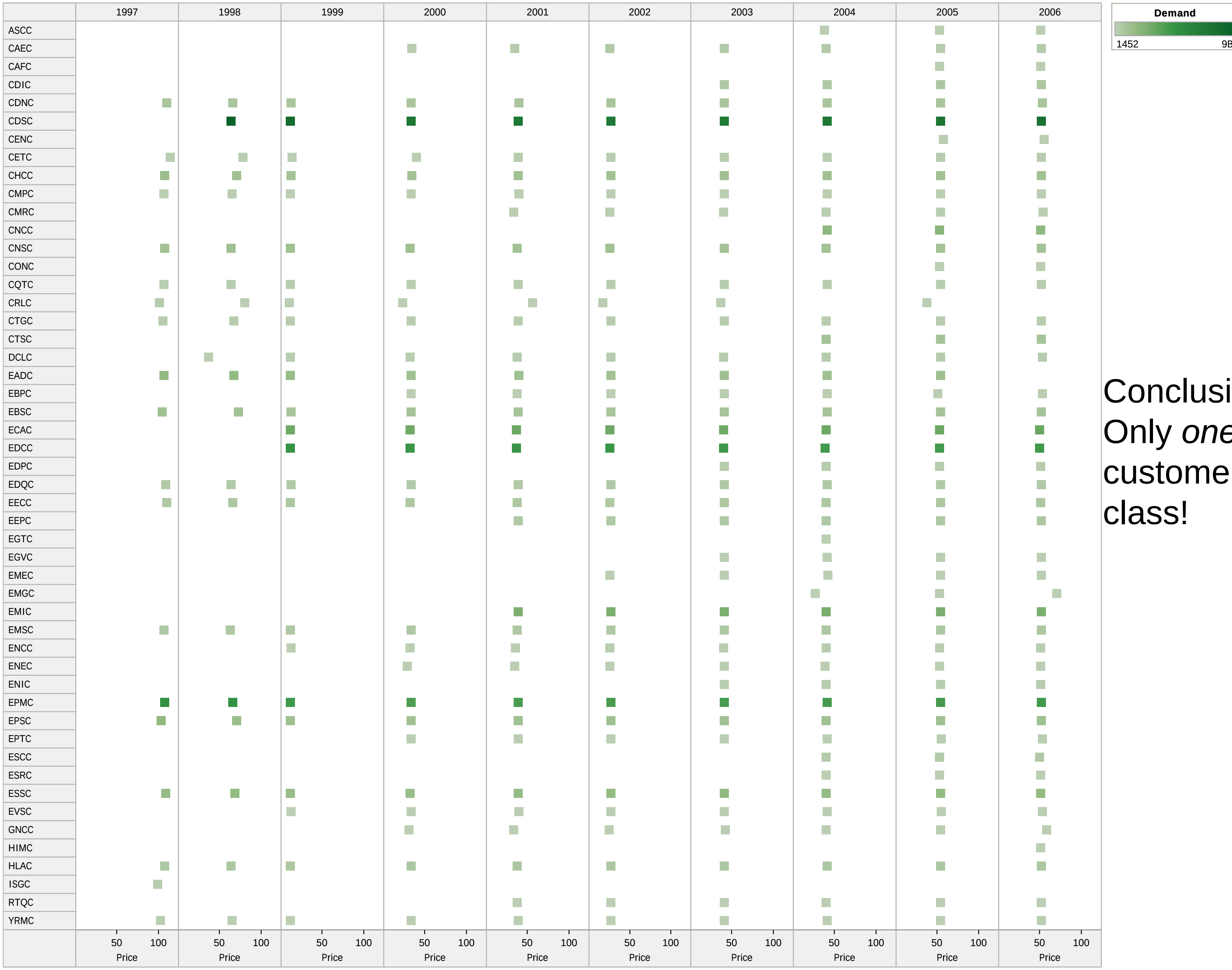
Pay-as-demand is common



Regulated product

- Regulated load is aggregate of all LSEs
- 100% of regulated load is purchased in auctions
- Mandatory for LSEs
- Voluntary for suppliers
- Accommodates multiple customer classes if required
  - For example, undesirable load shape of LSE

Average cost ($/kWh) by LSE and Year



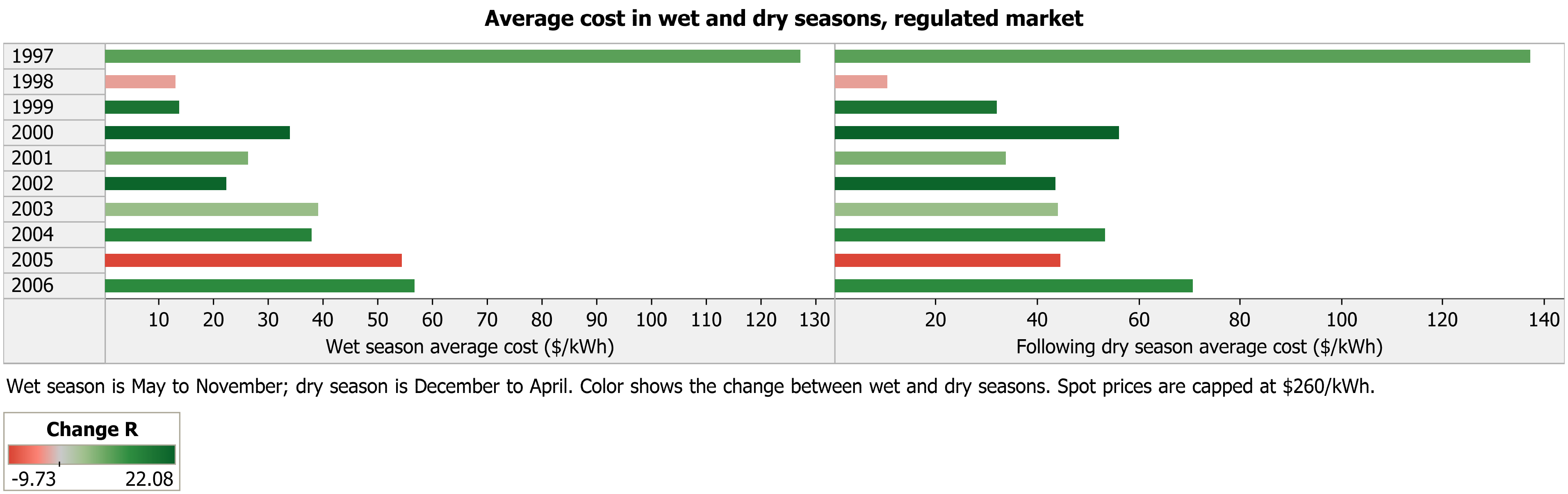
Price for each LSE broken down by Year. Color shows details about Demand. The data is filtered on Days, which ranges from 350 to 366.

Conclusion: Only *one* customer class!

Further issues

Seasonal factor?

- Costs are about 19% higher in dry season
- Wet season .92; dry season 1.11
- Conclusion: seasonal factor *not* needed

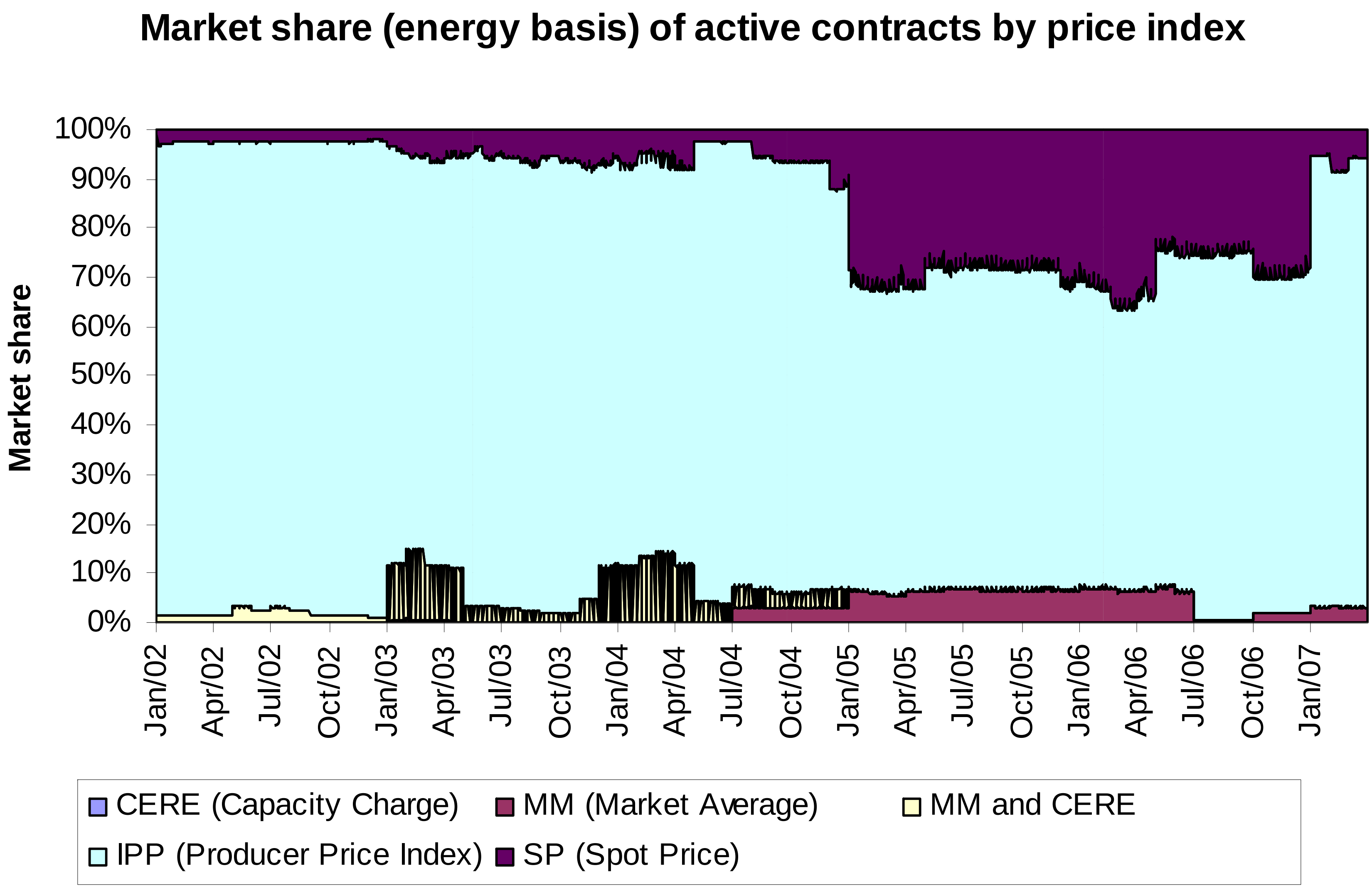


Wet season is May to November; dry season is December to April. Color shows the change between wet and dry seasons. Spot prices are capped at $260/kWh.

Load-following not ideal for all

- Different resource types have different ideal dispatch
  - Baseload, peaker, limited-water hydro, etc.
- Difference in dispatch and obligation introduces risk and market power issues
- Problem mitigated by
  - Balanced portfolio of resources
  - Balanced portfolio of contracts (Reg. and NR)
- Conclusion: benefits of pay-as-demand greatly exceed costs

Index multi-year contracts with IPP



Small lot size

- 0.1% of load category (reg. and nonreg.)
  - About 6 MW average load for regulated
  - About 3 MW average load for nonregulated
  - Varies with each hour, since load following
- Great flexibility in expressing quantity
- Accommodates small bidders
- Improves secondary market

Planning period

- Time between auction and start of commitment
- Opportunity to make adjustments
- Impacts how much uncertainty has been resolved
- Longer implies price stability
- Longer implies more costly guarantees

Commitment period

- Time between start and end of commitment; contract duration
- Longer implies price stability
- Longer implies better financing
- Longer implies greater guarantees

Frequency

- Number of auctions per year

Alternative to improve liquidity of 1-year product: Quarterly 1- and 2-year contracts, semi-rolling