

Florence School of Regulation

# **Econometric Analysis of 3G Auction Spectrum Valuations**

**Presentation for:  
Spectrum Management in Europe  
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Erik Bohlin\*

Chalmers University of Technology, Göteborg, Sweden

\*) Co-author: Prof Gary Madden, Curtin Business School

# Initial Considerations

- Interference management was earlier the main objective
- The path toward economic efficiency for spectrum management is moving ahead but there are many constraints :
  - Earlier allocations
  - International agreements
  - Public use of spectrum
  - Technical considerations, etc.
- The mode of spectrum management will have differential impacts:
  - command and control
  - property rights regime (market based)
  - common used spectrum

In the following, the property rights regime will be analysed

In particular, the impact of "auction packages" by the NRAs

# Aims and Questions for Today

- What are the tools for NRAs to influence auction outcomes?
- In particular, how to influence successful auctions?  
(success → completed auctions, preferably with a premium over reserve price)
- Which of the tools are the most useful ones?
- What are some regulatory and policy implications, especially on investment? (cf. growing interest to stimulate investment as part of various growth uptake packages)

Answers to these questions will be based on a comprehensive econometric investigation

# Spectrum Management Variables Impacting Auction Outcomes

- Spectrum package attributes
  - Duration, number, revised, entrant reservations, reserve price
- License award process
  - Bidding mode, deposit size, competitiveness of the process
- Post-award financial and performance obligations
  - Upfront and annual fees, roll-out requirements, infrastructure sharing

Plus:

- National economic and mobile market conditions
  - Income, population density and mobile market competition

(These variables may partly be influenced by policy)

# Econometric Evaluation\*

- Sample (2000-2007) includes:
  - 23 Auctions
  - 83 license observations
  - Sourced from DotEcon Spectrum Awards Database
- Examine 3G award outcomes in terms of spectrum premiums paid
  - An econometric analysis using a sample of 3G spectrum allocations
- Spectrum premiums are modelled as depending on:
  - National and mobile market conditions
  - Spectrum package and licensing process attributes
  - Post-award operator obligations
- Analysis explicitly takes into account censored nature of these data

Paper: Madden, G., Morey, A., Bohlin, E. (2009), An Econometric Analysis of 3G Auction Spectrum Valuations, working paper

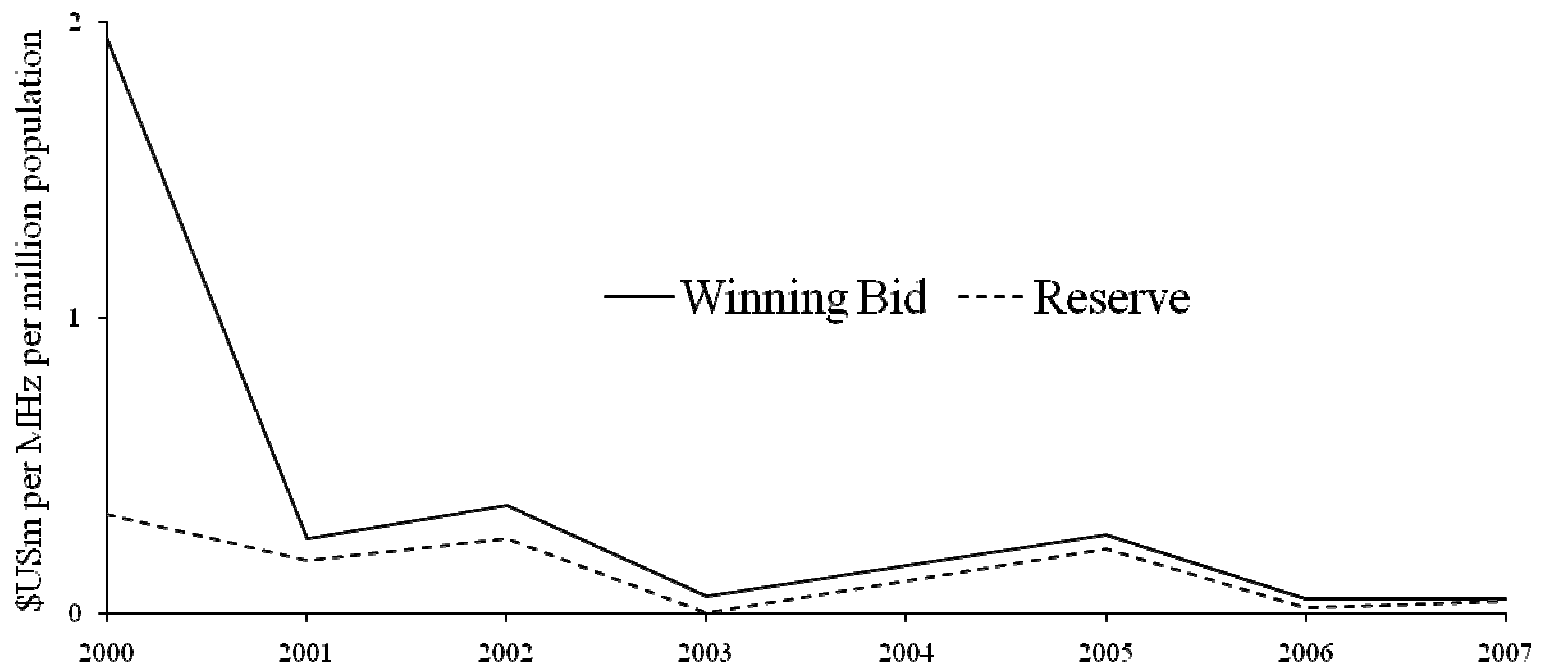
# Data for Results:

Country	Auction Commenced	Licences Offered	Licence Awarded
United Kingdom	April 2000	5	5
Germany	June 2000	6	6
Netherlands	July 2000	5	5
Italy	October 2000	5	5
Austria	November 2000	6	6
Switzerland	December 2000	4	4
New Zealand	January 2001	4	4
Belgium	March 2001	4	3
Singapore	April 2001	4	3
Greece	July 2001	4	3
Denmark	September 2001	4	4
Czech Republic	December 2001	4	2
Israel	December 2001	5	3
Taiwan	February 2002	5	5
Norway	September 2003	1	1
Bulgaria	March 2005	3	3
Latvia	April 2005	1	1
Denmark	December 2005	1	1
Georgia	May 2006	3	3
Indonesia	February 2006	3	3
Estonia	January 2007	1	1
Nigeria	March 2007	4	4
Norway	December 2007	1	1
<b>Total</b>		<b>83</b>	<b>76</b>

*Source:* DotEcon Spectrum Awards database coverage

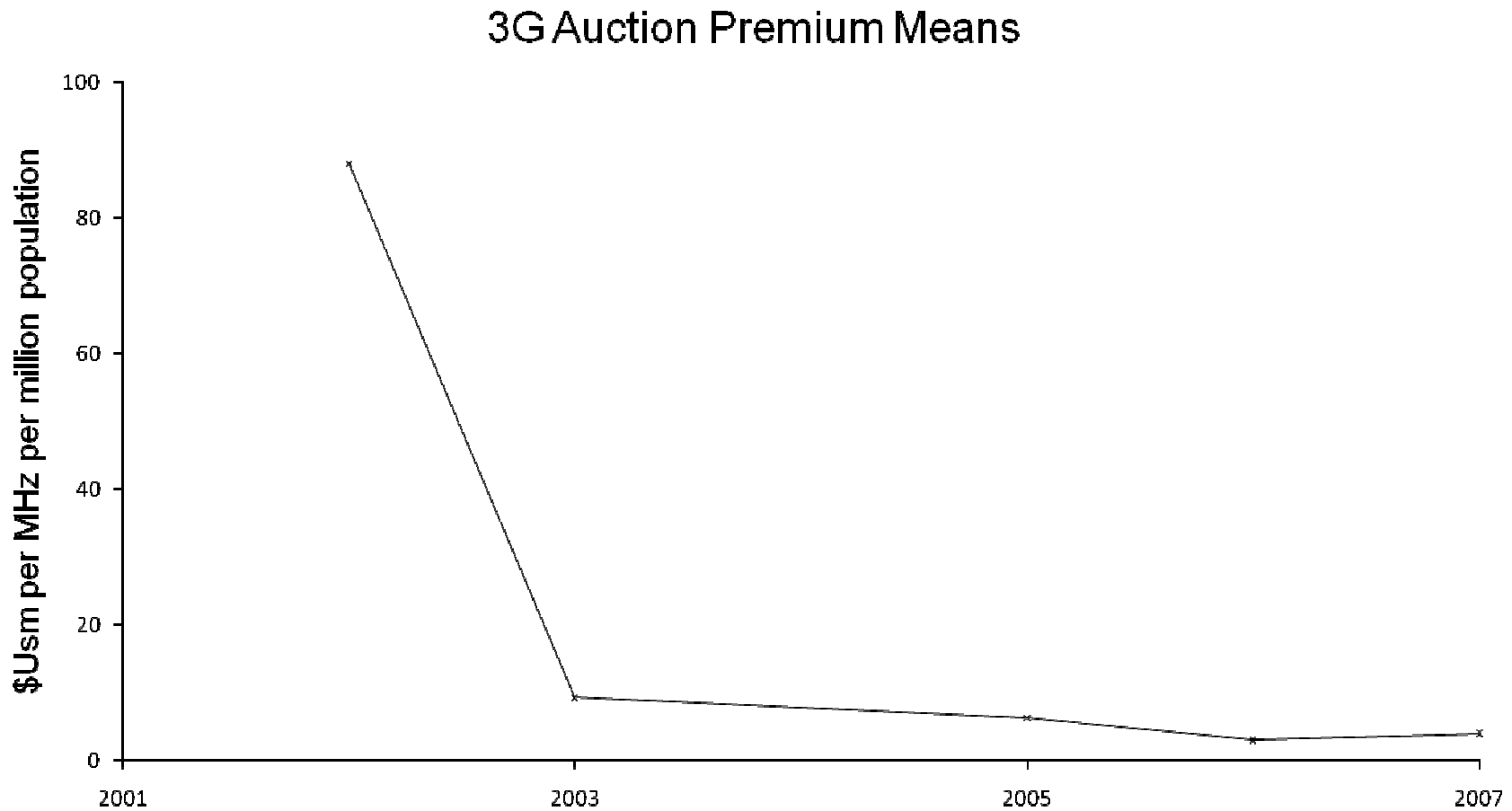
# The Reserve Price Sets the Stage for Auction Price and Value of License

Annual Mean 3G Auction Winning Bid and Reserve Mean Values



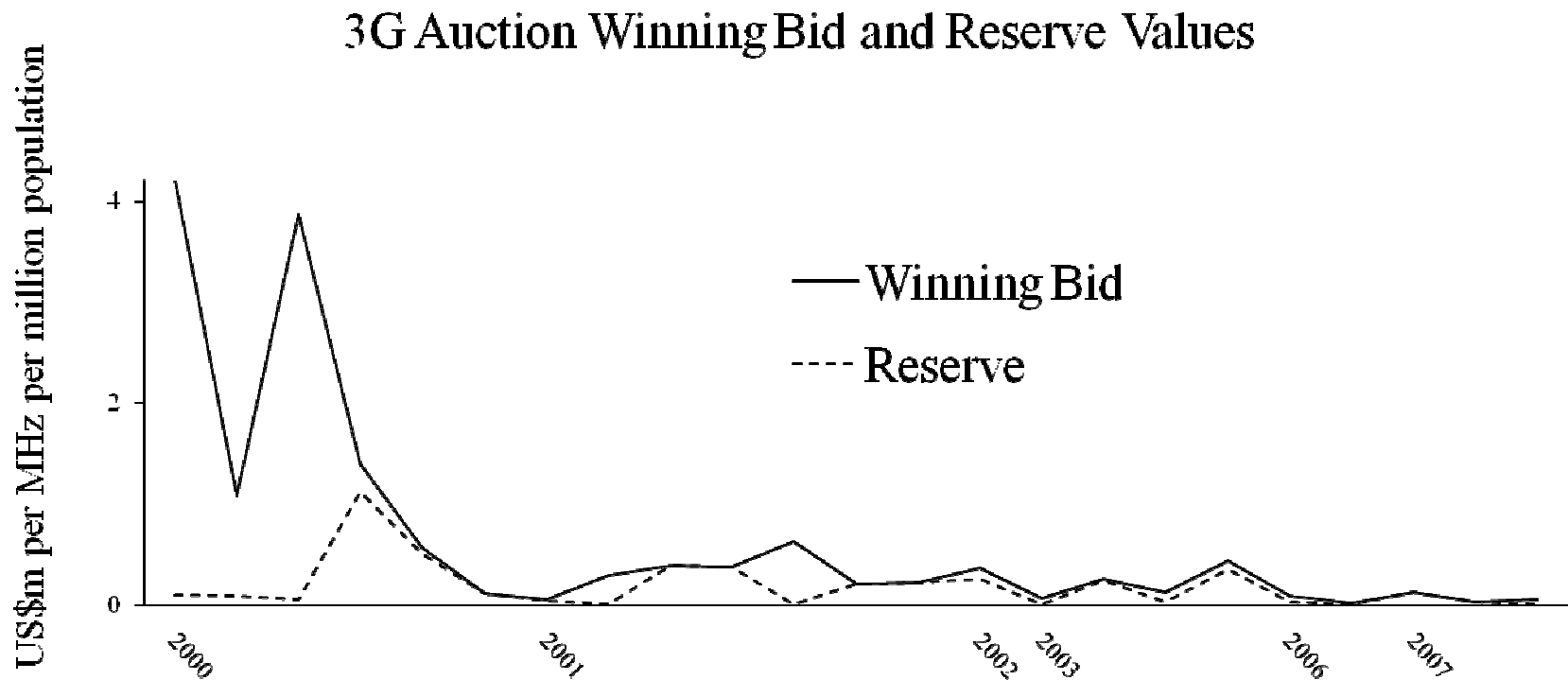
Declining trend for both reserve and winning bids, and narrowing margins

# Winning Bid Premium Means



Note: Premium is the difference between reserve and winning bid

# More Variation in Individual Values



Individual country factors are important to explain variation

# What Impact on Investment?

- The higher auction fee, the higher value of the license
- Auction fee follows rather closely the reserve price
- Auction fee will have an impact on investment, although a complex one
  - high auction fee suggests high investment
  - but too high auction fee may drive out investment

# Questions Considered

- Which regulatory variables make the auction particularly valuable?
- In particular, what are the drivers to winning bid?
- Moreover, which of the regulatory variables are the most important?
- Finally, elaborate on investment impact

# Drivers tested:

<b>Variable</b>	<b>Definition</b>
<b>National economic and mobile market conditions</b>	
INCOME	= GDP per capita (US\$ thousands)
DENSITY	= National population per square kilometre (persons)
ASIA	= 1, if Indonesia, Singapore or Taiwan; = 0, otherwise
AINITIAL	= Average upfront license fee (US\$ millions) *)
<b>Spectrum package attributes</b>	
DURATION	= License term (years)
REVISED	= 1, if package is a re-offered license offering; = 0, otherwise
ENTRANT	= 1, if at least one license must awarded to an entrant; = 0, otherwise
RESERVE	= Minimum allowable spectrum bid price (US\$ millions)
<b>Licence award process</b>	
DEPOSIT	= Initial deposit required (US\$ millions)
AVAIL	= Available licenses to bidders (ratio)
<b>Post-award financial performance obligations</b>	
ANNUAL	= Annual license fee (US\$ millions)
<b>Post-award network performance obligations</b>	
SHARE	= 1, if infrastructure sharing is a licence requirement = 0, otherwise
COVER	= Population that must be covered by the network (percent)
TIME	= Time to achieve required network coverage (years)

\*) Note that average license fees are transformed into predicted values PAINITIAL in a two stage estimation process in order to adjust for endogeneity

## NRA Control Variables: Elasticity Estimates

Category	Variable	Elasticity
Spectrum package attributes	DURATION	-0.74
	REVISED	<b>0.05</b>
	ENTRANT	-0.03
	RESERVE	<b>0.26</b>
Licence award process	DEPOSIT	0.15
Financial obligations	ANNUAL	<b>-0.15</b>
Network obligations	SHARE	<b>0.41</b>
	COVER	<b>-0.86</b>
	TIME	<b>1.24</b>

*Notes:* Bold indicates coefficient is significant  
Elasticity with reference to winning bid

# Implications

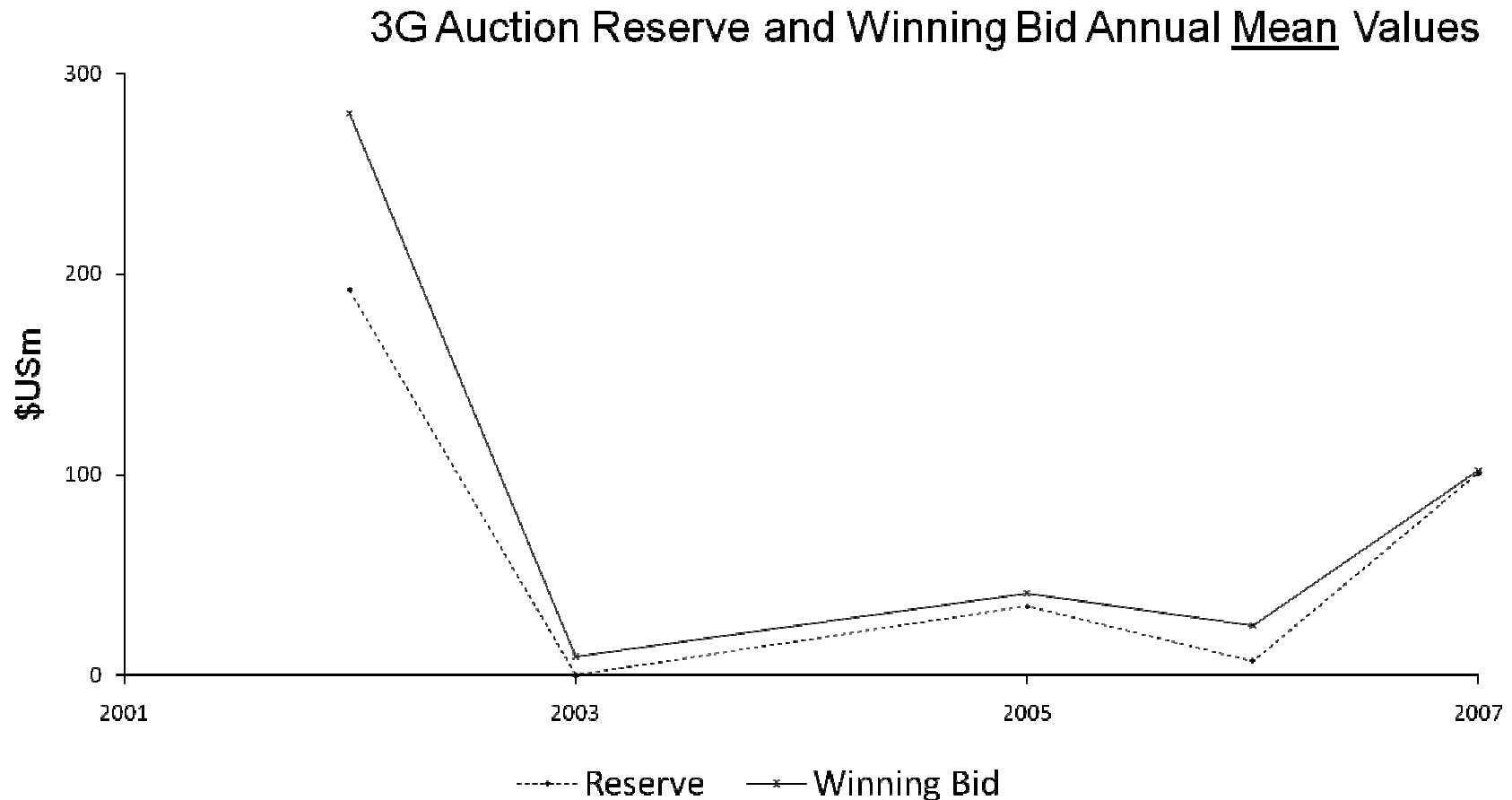
- Regulators have many variables to influence investment, via market based spectrum management
- Reserve price itself is an important variable
- Coverage obligations will adversely impact winning bid while potentially drive up investment
- The longer time to reach coverage will raise winning bid, but potentially reduce investment
- Long duration reduces winning bid, and may also reduce investment  
(note: duration significant when explanatory variable was winning bid premium)
- Negative impact of long duration may reflect increased regulatory uncertainty as perceived by bidders

Additional slides

	Category	Variable	Coefficient	Marginal Effect
Censored		Constant	0.19474 (0.394)	0.12101 (0.258)
	National economic and mobile market conditions	PAINITIAL	0.00020*** (10.014)	0.00012*** (6.083)
		ASIA	0.65100*** (5.483)	0.40451*** (4.045)
Regression	Spectrum package attributes	DURATION	-0.08974*** (-3.576)	-0.05576*** (-2.050)
		REVISED	0.84186*** (2.882)	0.52310*** (4.974)
Results	Licence award process	ENTRANT	-0.24419 (-0.874)	-0.15173 (-1.514)
		RESERVE	0.00072*** (4.221)	0.00045** (2.204)
		DEPOSIT	0.01535 (1.260)	0.00954 (0.749)
	Financial obligations	ANNUAL	-0.00858*** (-6.734)	-0.00533*** (-9.499)
		SHARE	1.29610 (1.387)	0.80535 (1.284)
	Network obligations	COVER	-1.94486*** (-8.334)	-1.20846*** (-4.460)
		TIME	0.42235*** (6.927)	0.26243*** (6.540)
	n	83		
	ANOVA	0.204119		
	DECOMP	0.353814		
	Log likelihood	-101.9131		

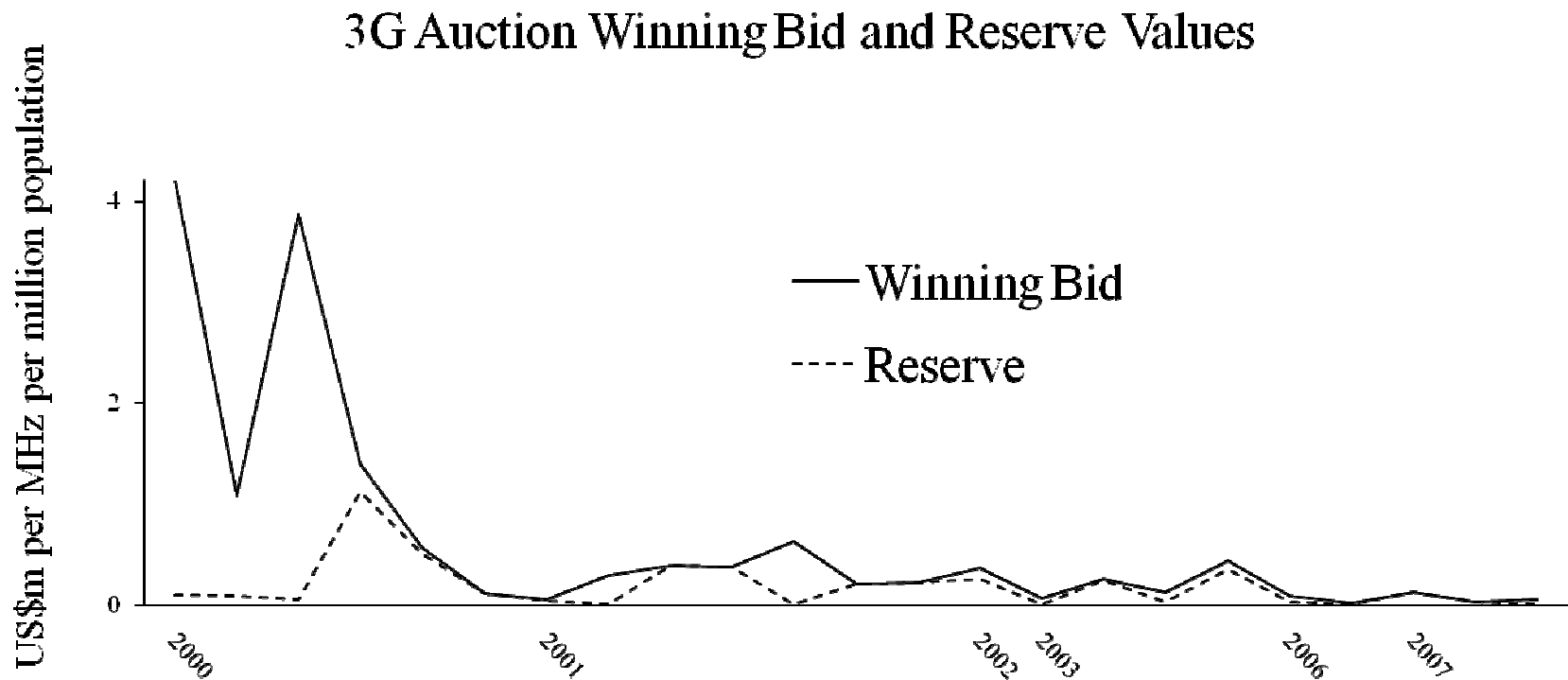
Notes: *t* statistics in parentheses. \* significant at 10%; \*\* significant at 5%; \*\*\* significant at 1%. Standard errors are adjusted for heteroskedasticity

# The Reserve Price Sets the Stage for Auction Price and Value of License



Note: Y axis is measured in price per megahertz per million population in US\$

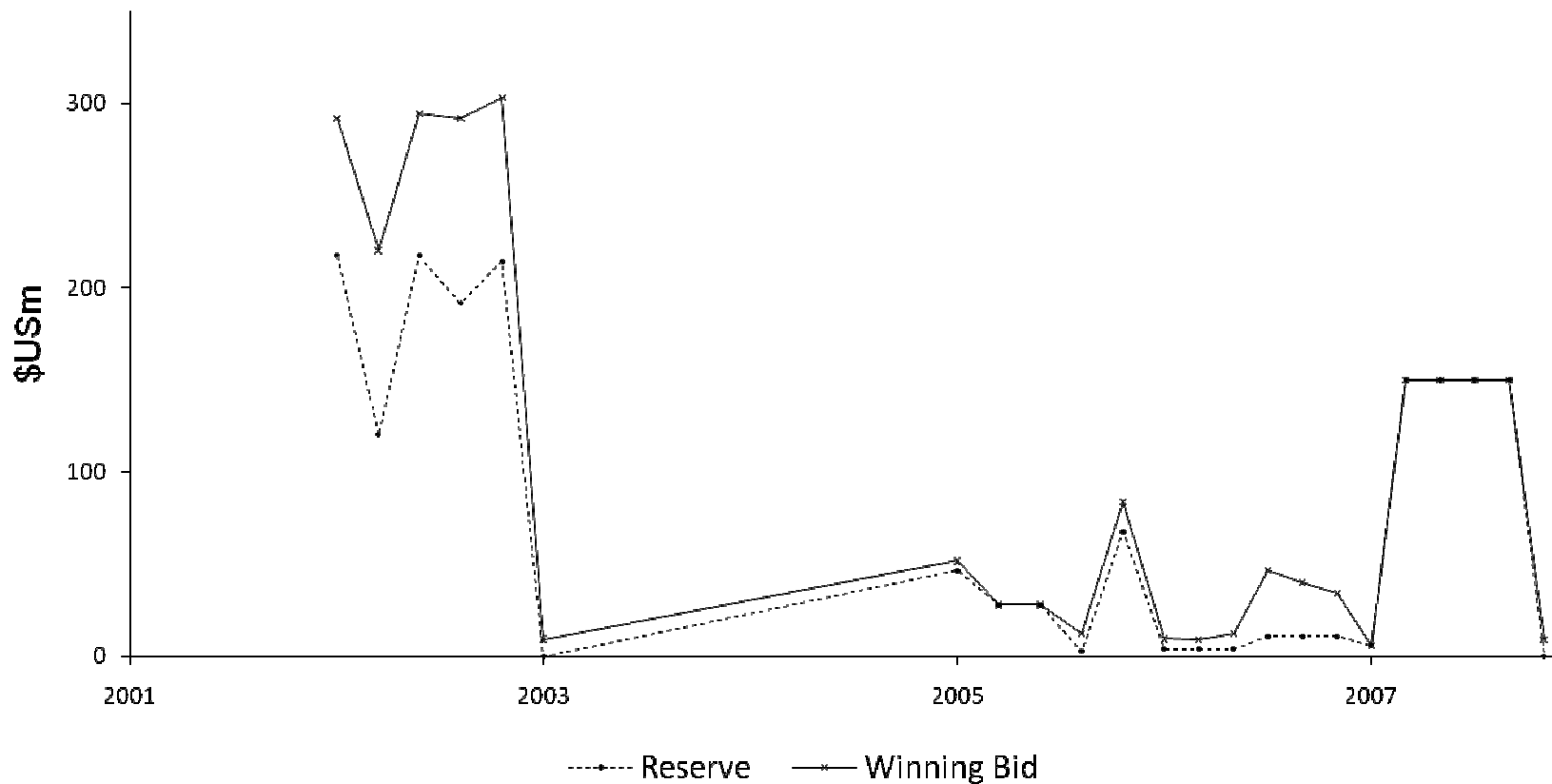
# More Variation in Individual Values



Individual country factors are important to explain variation

# More Variation in Individual Values

## 3G Auction Reserve and Winning Bid Values



Note: Y axis is measured in price per megahertz per million population in US\$

