SPECTRUM AUCTIONS IN EUROPE

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WHAT'S IT ALL ABOUT?

- **The right to use radio spectrum**

Country	Revenue (∈/pop)	Country	Revenue (∈/pop)
Finland	0	Austria	82
Spain	15	Switserland	18
UK	648	France	337
Netherlands	171	Sweden	0
Germany	613	Norway	5
Italy	240	Belgium	?

- **The game is about ∈1000 billion**

WHAT EXPLAINS THE DIFFERENCES?

- **Allocation method**
  - **auction, or**
  - **beauty contest**

- **Country characteristics**
  - **GDP/pop**
  - **........**

- **Market characteristics**
  - **# incumbents**

- **Auction Details**
  - **supply**
  - **rules**
  - **competitive oversight**

HOW TO SELL?

- **Auction or Fixed Price?**
- **What Price?**
- **What auction?**

HOW TO PLAY IN AUCTION?

ENGLISH (ASCENDING) AUCTION

1. Independent Private Values:

$$b_i(v_i) = v_i$$

2. Affiliated Values:

Avoid the winner's curve by quitting at

$$E(v_i \mid X_i \,;\, X_i = X^1 = X^2 \,;\, \text{lower bids})$$

What is the value given that you win?

AUCTION THEORY

- **Auction is modelled as game with incomplete information (Harsanyi)**

- **Auction strategies are found by solving game for Bayesain Nash Equilibria; involves solving differential equations (Vickrey)**

- **Optimal auction for seller is found by using mechanism design theory and relevation principle (Myerson, M.O.R.)**

- **Translation into actual auction design, engineering aspects (Wilson, Milgrom)**

EUROPEAN SPECTRUM AUCTIONS

- **WHAT:**

  60 MHz (paired) + 35 MHz (unpaired) (+ rights)

4 $\times$ 15	**B, F**
2 $\times$ 15 + 3 $\times$ 10	**UK, NL**
6 $\times$ 10	
5 $\times$ 10 (+ option)	**I**
12 $\times$ 5 (+ bundling)	**G, A**

- **HOW:**

  Variations of multiround, simultaneous ascending auction

SIMULTANEOUS MULTIROUND AUCTION

Round ***t*** **:**

Install Equation Editor and double-click here to view equation. **: highest bid from previous round**

Install Equation Editor and double-click here to view equation. **: bidder currently standing high**

Install Equation Editor and double-click here to view equation. **: lots on which *i* is active**

Install Equation Editor and double-click here to view equation. **: minimum price for this round**

Increment rule: Install Equation Editor and double-click here to view equation.

Install Equation Editor and double-click here to view equation. **: lots on which *i* can bid**

Activity rule: Install Equation Editor and double-click here to view equation.

Install Equation Editor and double-click here to view equation. **: bid of *i* on *k***

End:

round *T* in which there is no new bid

Install Equation Editor and double-click here to view equation. **wins *k* and pays** Install Equation Editor and double-click here to view equation.

BACK OF ENVELOPE VALUE CALCULATION:

ARPU : ƒ 100 / month

discount: 1% / month

Mkt size: 6 million

Value determined by : mkt share, take-up rate, cost of rolling out network

Incumbent:	**1/3 , 3 bln**	**:**	**12 bln**
Entrant:	**1/10 , 4 bln**	**:**	**0.5 bln**

OTHER AUCTIONS

- **Smaller Stakes, but more interesting problems:**

  - **Dutch DCS-1800 auction**
  - **UK WLL-auction**
  - **Dutch auction commercial broadcasting**
  - **Dutch auction gasoline stations**

- **How to design a quick auction that includes combinatorial elements?**

THE DCS-1800 AUCTION

F	Winner	Price
75	Duchtone	600
75	Telfort	545
13	Libertel	40,4
12	KPN	40,2
13	Orange	38,0
12	Telfort	40,5
13	KPN	43,0
12	TeleDanmark	41,1
13	KPN	40,4
12	KPN	39,1
13	Orange	46,5
12	TeleDanmark	41,25
13	KPN	42,98
12	TeleDanmark	39,9
13	KPN	39,9
12	KPN	40,5
13	Libertel	45,5
22	TeleDanmark	71,5

Ben paid less than half of Dutchtone, Telfort.

WLL-AUCTION UK

	1	2	3	Mln
A	4,54	4,62	4,54	4,0
B	3,0	3,0	3,0	3,0
C	3,0	3,0	3,0	3,0
D	---	---	---	2,0
E	---	---	---	2,0
F	---	---	---	2,0
G	---	---	---	2,0
H	---	---	---	2,0
I	2,0	2,0	---	2,0
J	---	1,0	---	1,0
K	---	---	---	1,0
L	---	1,0	---	1,0
M	---	---	---	1,0
N	0,16	0,15	0,15	0,1

- **16 of 42 sold**
- **Revenue £38 mln**
- **Could have taken long**

SPECTRUM FOR COMMERCIAL RADIO

National FM:

1 block news radio

6 blocks unrestricted with 70% coverage

1 block unrestricted with 60% coverage

Regional FM:

73 frequencies

National AM:

11 blocks

RIGHTS TO OPERATE GASOLINE STATIONS

- ± **250 licences in period of 22 years**
- **10-15 per year**
- **network effects?**
- **discrimination?**
- **combinatorial elements?**

COMPLEMENTARITIES AND COMBINATORIAL AUCTIONS

	A	B	AB
1	4	4	16
2	6	6	14
3	11	4	15

Combo-auction: 1 wins *AB*, pays 15

Ordinary Ascending Auction: Either inefficient or winner makes a loss.

Phase 1: Install Equation Editor and double-click here to view equation.

Phase 2: **Risk taking of *A*?**

No → inefficient; Assume: yes

Phase 3: Install Equation Editor and double-click here to view equation.

2 quits

Phase 4: **1 and 3 bid on *A* until $p_A = 11$**

1 wins, pays at least 17

CO-ORDINATION PROBLEM IN COMBO-AUCTION

	A	***B***
1	**4**	**0**
2	**0**	**4**

Assume a package bid of 1 on *AB*

1 bids p_1 on *A*

2 bids p_2 on *B*

Install Equation Editor and double-click here to view equation.

Install Equation Editor and double-click here to view equation.

HOW TO ORGANISE A COMBO-AUCTION?

Bidders: $i \in I$

Lots : $k \in K$

Bid : (p,x)

$p \in \mathbb{R}_+$

$x : K \to \{0,1\}$

Install Equation Editor and double-click here to view equation. : **bids from *i* on *t***

B^t : **bids**

$\delta: B^t \to \{0,1\}$ **Acceptance rule**

$W^t = \{b \in B^t \; ; \; \delta_b = 1\}$

ALLOCATION:

$$\text{Max} \quad \Sigma_b \ \delta_b \, p_b$$

$$\text{s.t.} \quad \Sigma_b \ \delta_b \ p_b \leq 1$$

ACTIVITY RULE:

Install Equation Editor and double-
click here to view equation.

Install Equation Editor and double-
click here to view equation.

INCREMENT RULE:

Search price vector π

$$<\pi, x_b> = p_b \qquad \text{voor } b \in W^t$$

$$<\pi, x_b> \geq p_b \qquad \text{voor } b \in B^t$$

UNFORTUNATELY "EMPTY CORE PROBLEM"

AB	**4**
AC	**4**
BC	**4**
ABC	**5**

$$\pi_A + \pi_B + \pi_C \geq 6$$

$$\pi_A + \pi_B + \pi_C = 5$$

CONCLUSION

- **Auctions, when well designed, are success, more successful than alternatives**

- **Future: more complex auctions**

- **Proper design will become more important: engineering**

- **Interaction with legal system: constraints imposed**