The First Combinatorial Spectrum Auction

Lessons from the Nigerian auction of fixed wireless access licences

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Background

- **2001:** Nigerian Communications Commission (NCC) announced plans to allocate licences for Fixed Wireless Access (FWA) services
- **Total of 80 licences across 31 states (2/3 per state)**
- **DotEcon, working with Radio Spectrum International,** designed the licensing process
- **Completed in June 2002 – 67 licences allocated, successful bids totalling 3.78bn Naira (US$38mn)**
About Nigeria

- Population 125mn +
- Wireline teledensity <1%
- Successful auction of GSM mobile licences in 2001
- Over 1mn mobile subs to private operators in their first year

FWA:
- Facilitate growing demand for internet access
- Extend telecoms to 2nd tier towns and cities
The challenge

- NCC objectives
  1. Transparency
  2. Efficiency
  3. Regional roll-out

- Lack of market information and potential winners’ curse
  - Suggests open, multi-round auction

- Unreliable infrastructure
  - Rules out remote bidding (e.g. over internet) and complex auction formats
Therefore, we developed a multi-stage process

- Obtain information about level and structure of demand
- Use to design simple & practicable auction with minimum efficiency loss
  - Single round sealed bid auction
  - Combinatorial bids possible, where there are synergies
Licence Application Stage

- Bidders submitted demands for licences at the reserve prices
- Bids were *binding* and *constraining* – provides incentive to reveal true preferences
- To allow bidders to manage aggregation risks, two special features:
  - Up to 5 separate, mutually exclusive combinatorial bids
  - Individual states marked as ‘critical’ or ‘non-critical’
Demand evaluation produced two key observations

1. Excess demand in many regions

2. Evidence of synergies between states, but varying by bidder

Auction stage required

Auction design must consider bidder aggregation risks
Our solution: A series of five sealed bid combinatorial auctions

- Publish results of demand evaluation – helps bidders to understand competitive environment
- Divide 22 states into 5 groups of 4-5 states
- Group together states where there are strong synergies
- Run separate one-shot combinatorial auctions for each group
  - Bidders can only bid for states and/or combinations of states that they originally applied for
  - Tailored bid forms for each bidder showing their options
- Use computer algorithm to determine set of bids that produces the highest total value
- Sequence auctions so most important groups come first
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<th>Combination</th>
<th>Reserve Price (Naira)</th>
<th>Amount Bid (Whole Naira)</th>
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Auction results

Auction 1
‘Critical regions’: Delta, Lagos, Rivers, Abuja
105 bids
49 combi. bids
N1.64bn revenues

Auction 2
South-west: Edo, Ogun, Ondo, Oyo
50 bids
22 combi. bids
N827mn revenues

Auction 3
South: Abia, Akwa Ibom, Bayelsa, Cross River, Ibo
21 bids
6 combi. bids
441mn revenues

Auction 4
North / Central: Gombe, Kaduna, Kano, Nassarawa, Plateau
22 bids
4 combi. bids
N351mn revenues

Auction 5
South / Central: Anambra, Benue, Ebonyi, Enugu
24 bids
7 combi. bids
N329mn revenues

• 45 bidders
• 48/50 licences sold
• 222 bids
• 88 combination bids
• N3.59bn (US$36mn) revenues
Some key observations

- Where transparency is crucial – auctions can offer a key advantage over other allocation systems
- There are ways around lack of infrastructure but these preclude complex SMRAs
- Understanding demand is crucial for auction design
  - Without the initial application stage, we could not have designed this auction
  - Many other spectrum auctions poor results (eg many 3G contests) owing to bad design
- Bidders can cope with sophisticated combinations – but grouping more than 5 states would add significant complexity
- Payment – Bidders paid what they bid, seen as transparent but created disparities that may have encouraged defaults
Future applications:

- Combinatorial bidding provides a tool for:
  - extending sealed bids to situations where separate sealed bids for each lot could produce grossly inefficient outcomes
  - Making a sealed bid more efficient where multi-rounds impractical or not cost-effective

- Klemperer (2002): sealed bids may also be more appropriate than multi-round auctions where:
  - competition is weak; or
  - collusion is a concern

- For telecoms, most likely applications are situations where:
  - there are large numbers of regional licences;
  - there are significant cross-regional synergies
  - value of individual licences is modest and demand uncertain; and/or
  - not possible to rely on local communications infrastructure to run auctions remotely