Market Impacts of Pooling Intermittent Spectrum

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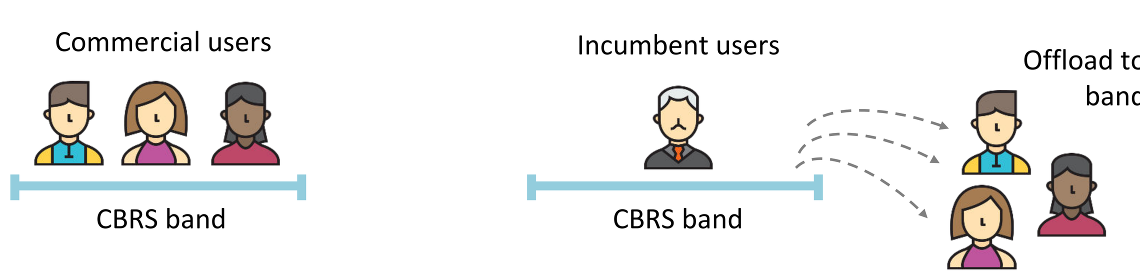
BACKGROUND

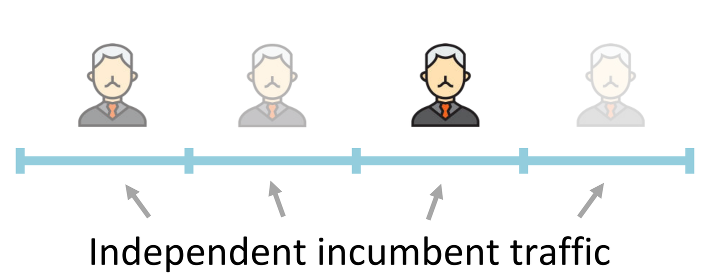
For temporal-based sharing as in CBRS, one cost to commercial users from sharing is that they have a lower priority to access the spectrum than federal incumbents.



This can make the spectrum **intermittently available** to a commercial service provider (SP), which in turn can reduce the value of that band of spectrum.

RESEARCH QUESTIONS

We consider an approach to mitigate the impact of intermittency through **pooling** multiple intermittent bands of spectrum, where each band's availability is **independent** of the others.



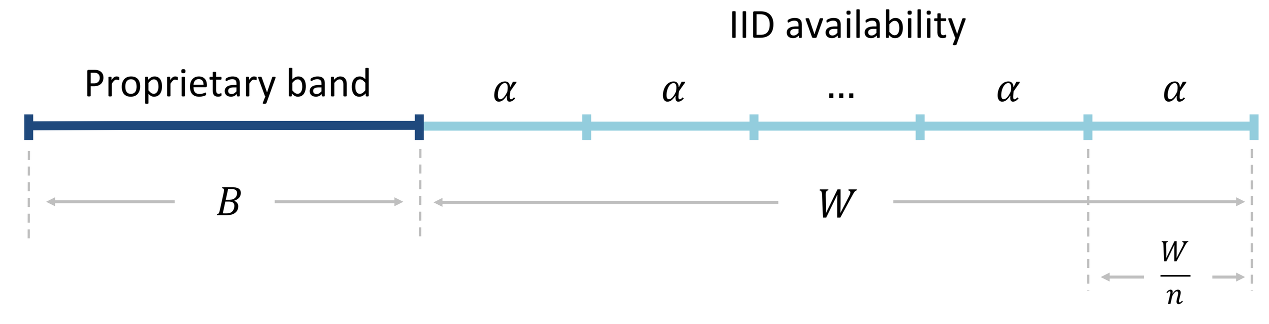
Our objective is to study the market impacts of pooling intermittent spectrum:

- How much benefit can an SP get from pooling?
- How does pooling affect the congestion incurred by users?
- How many bands are needed to achieve a considerable pooling gain?
- How does it affect the bidding if the spectrum is auctioned?

Model & RESULTS

Model

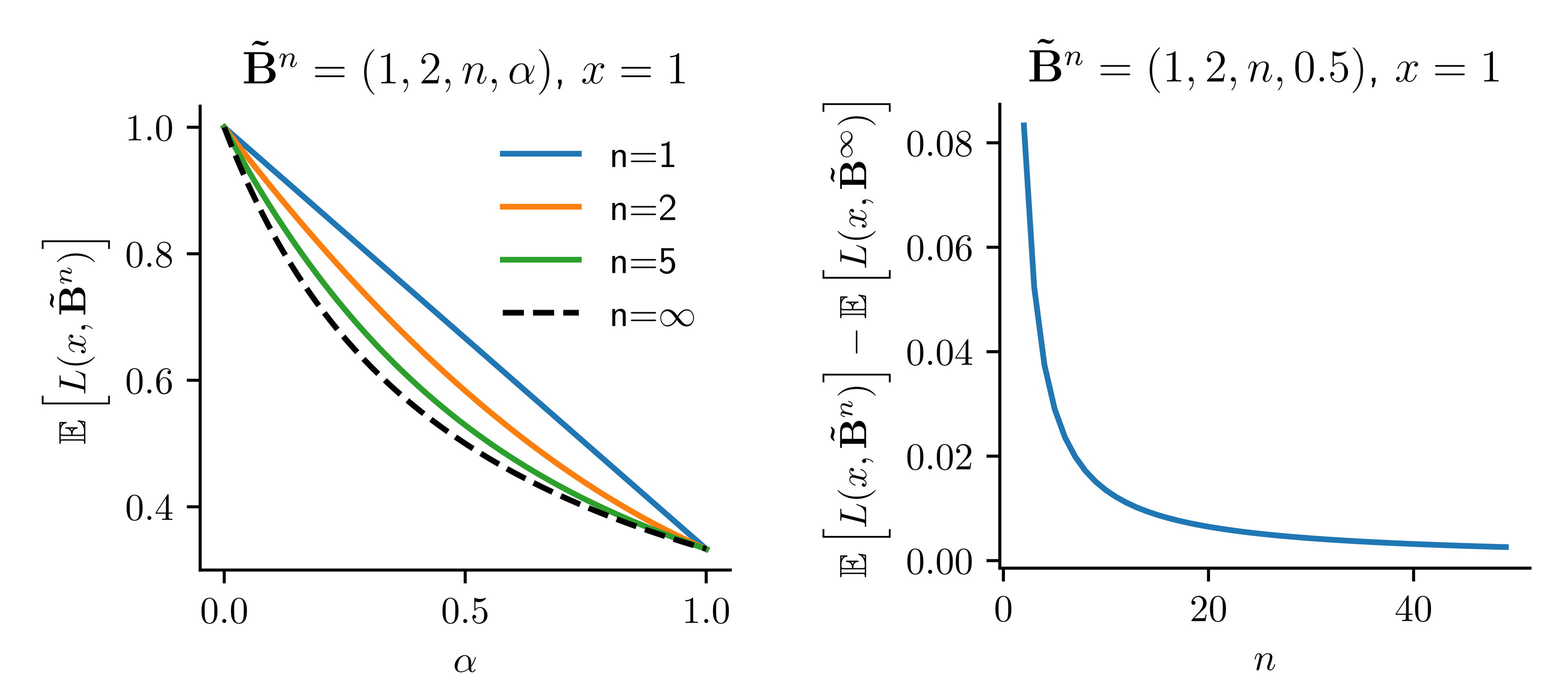
- Each SP has a **proprietary band** with bandwidth B and n **licensed shared bands** with an aggregate bandwidth W.
- Each shared band is available to the SP with probability α, and we assume **IID availability** across all shared bands.



- The congestion (latency) incurred by users is modeled as a linear function of user density: $l(x, B) = \frac{x}{B}$.

Results

$\boldsymbol{n = 1}$ **vs** $\boldsymbol{n > 1}$: We compare the market outcomes of pooling n independent shared bands (W/n each) with that of using a single band with bandwidth W:

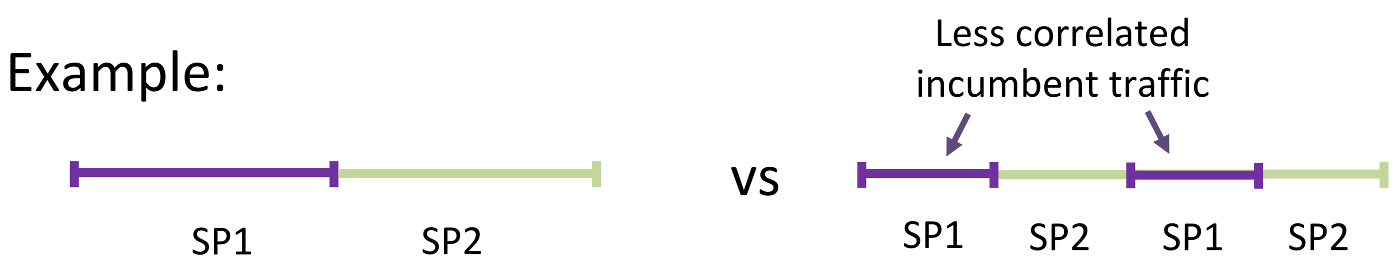


- **Pooling achieves less latency**: Compared to using one single shared band, having multiple independent sub-bands can reduce the latency incurred by users.

Implication to policymakers:

Should provide SPs with **multiple less correlated** (in the sense of incumbent traffic) bands

Example:

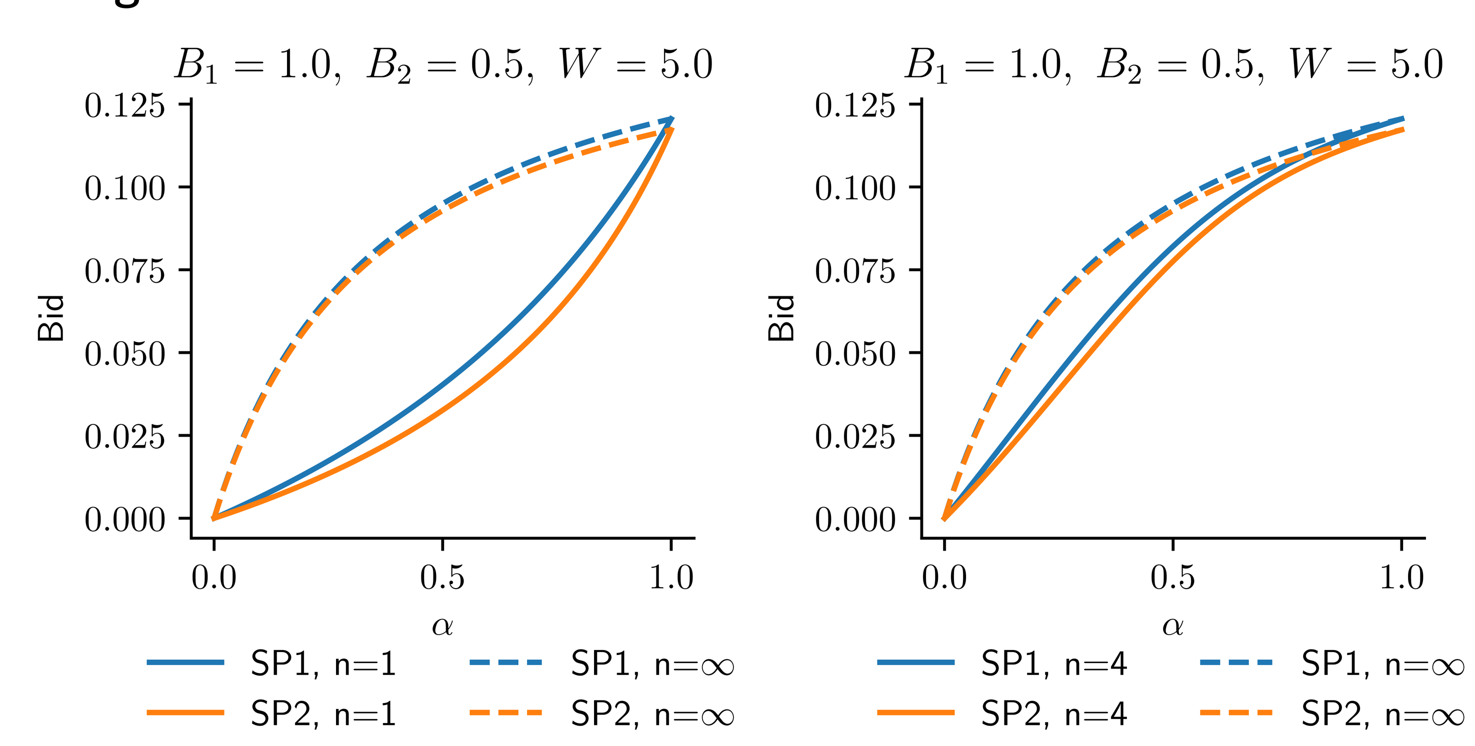


Preferred

- **Pooling gain is bounded**: Maximum pooling gain can be achieved by pooling an infinite number of bands (with finite aggregate bandwidth).
- **Fast convergence rate**: The pooling gain converges to the optimal case as $n \to \infty$ with order $\Theta(1/n)$.

Pooling is efficient. No need to have a large number of bands.

- **When a pool of intermittent bands is auctioned**: SPs are willing to submit large bids even when the availability is not high.



With pooling, a regulator can offer fewer bidding credits to small SPs to encourage competition.

REFERENCES

This work will be presented in DySPAN 2024:

K. Mu, R. A. Berry, "Market Impacts of Pooling Intermittent Spectrum", DySPAN 2024.