Approximation in Complex Pricing Mechanisms

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Motivation

For multi-product firms, complex pricing mechanisms, such as bundling, increase profits over simple component pricing

- Caveat...
  - Can be difficult to implement
  - Assume perfect knowledge of the demand environment
- Recent research in mechanism design has proposed simpler pricing strategies that can approximate the optimal strategy

Bundling of Goods

- Component Pricing (CP)
  - Set price for each good
  - No bundle discount offered
  - k prices
- Pure Bundling (PB)
  - Set price for bundle
  - Goods not offered for separate sale
  - 1 price
- Mixed Bundling (MB)
  - Set price for each good
  - Set price for each combination of goods
  - $2^k - 1$ prices
- Bundle Sized Pricing (BSP)
  - Set price for a single good
  - Set price for each bundle size
  - k prices

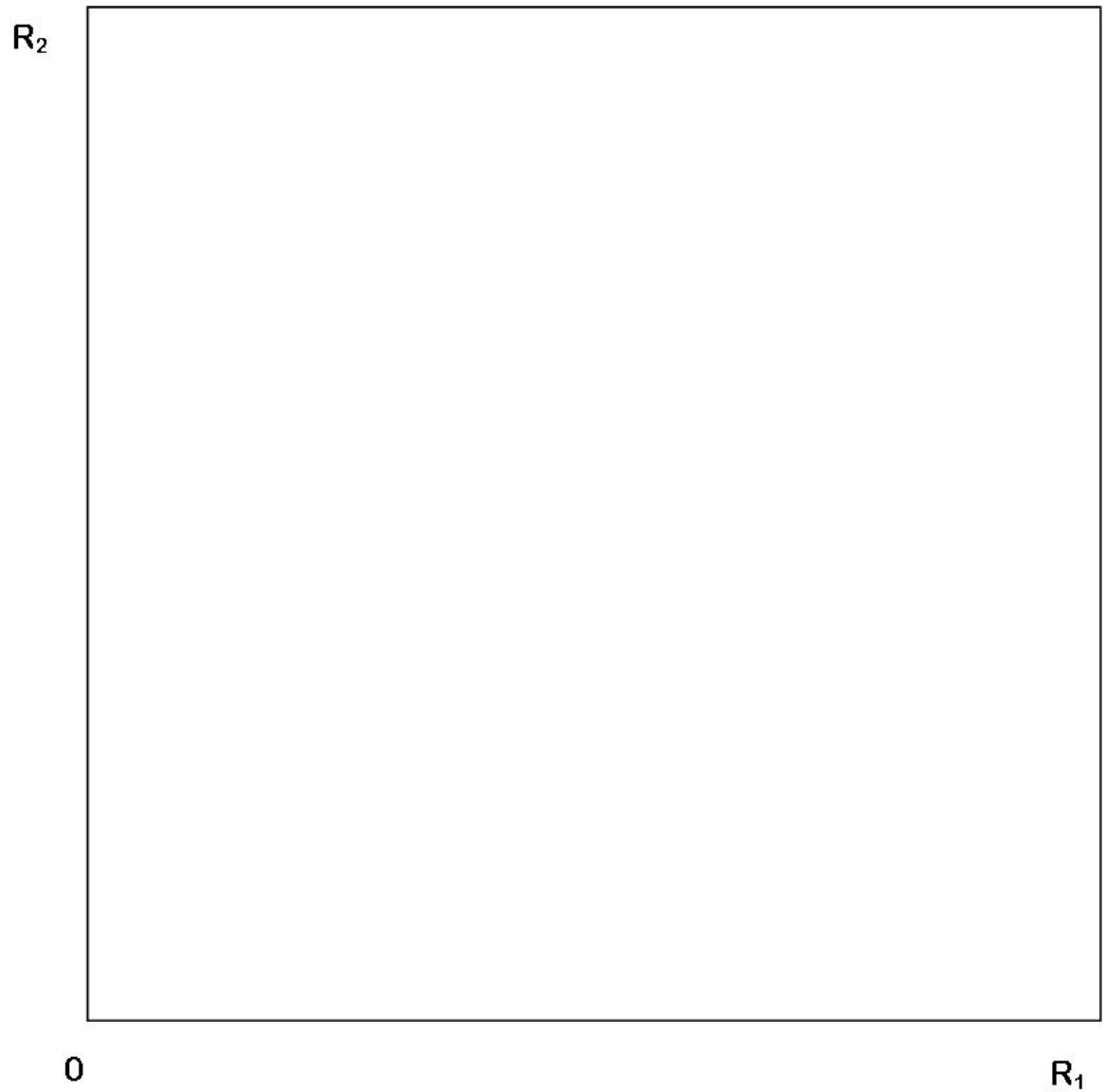
Research Questions

1. How robust is the profit maximizing pricing mechanism to gaps in a firm's knowledge regarding...
   a. The demand for the goods?
   b. The correlation between consumers' value for the goods?
2. Among existing popular pricing strategies, which is the most robust to the absence of information regarding a and b?
3. What is the impact of different pricing strategies on both firm profits and social welfare?

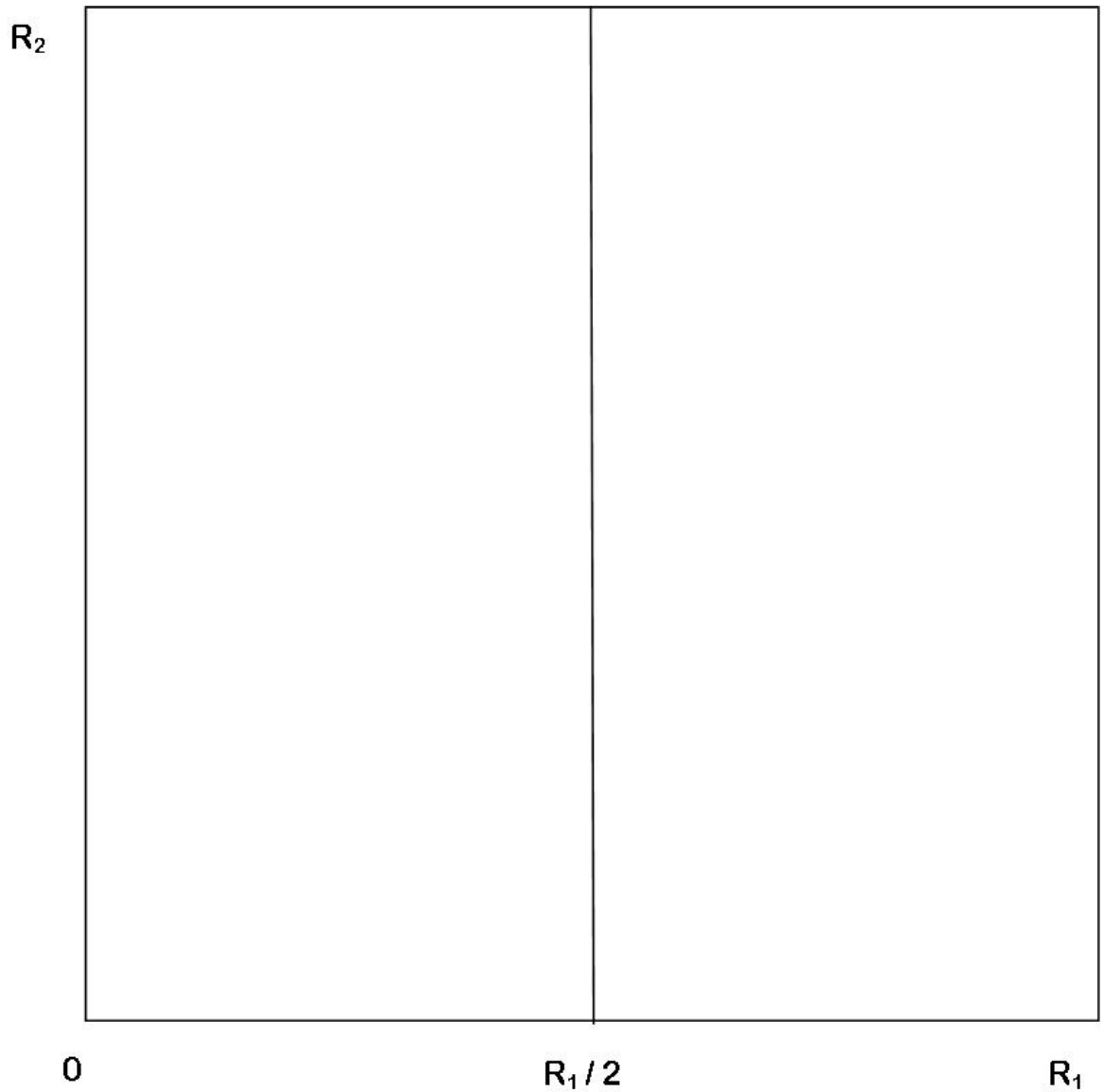
Theoretical Origins

- Literature begins with Stigler (1963)
- Adams and Yellen (1976) develop the first model in two-good space
- Assume no economies of scope in production
- Demand is uniform and independent

Bundling Two Goods



Bundling Two Goods



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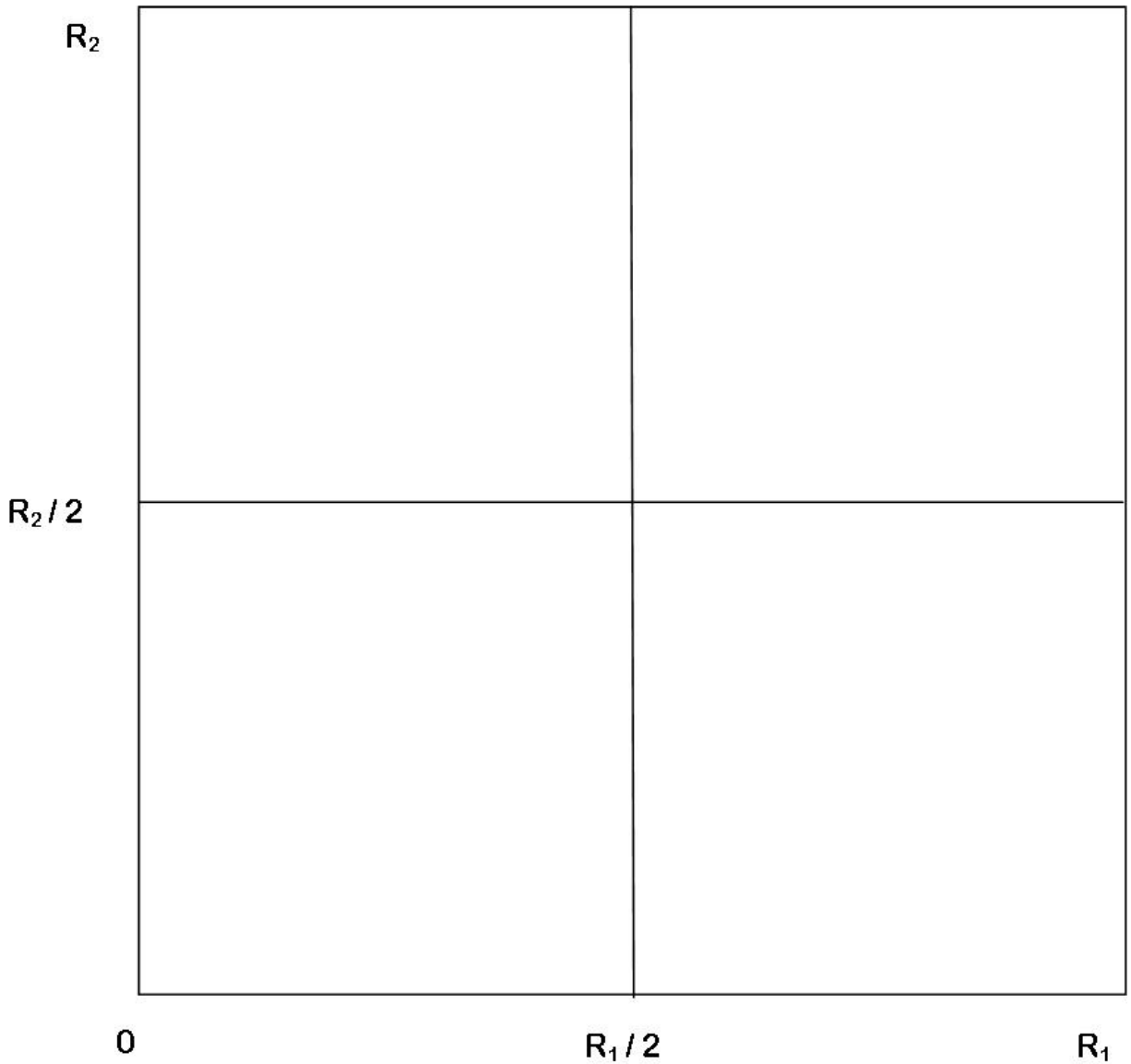

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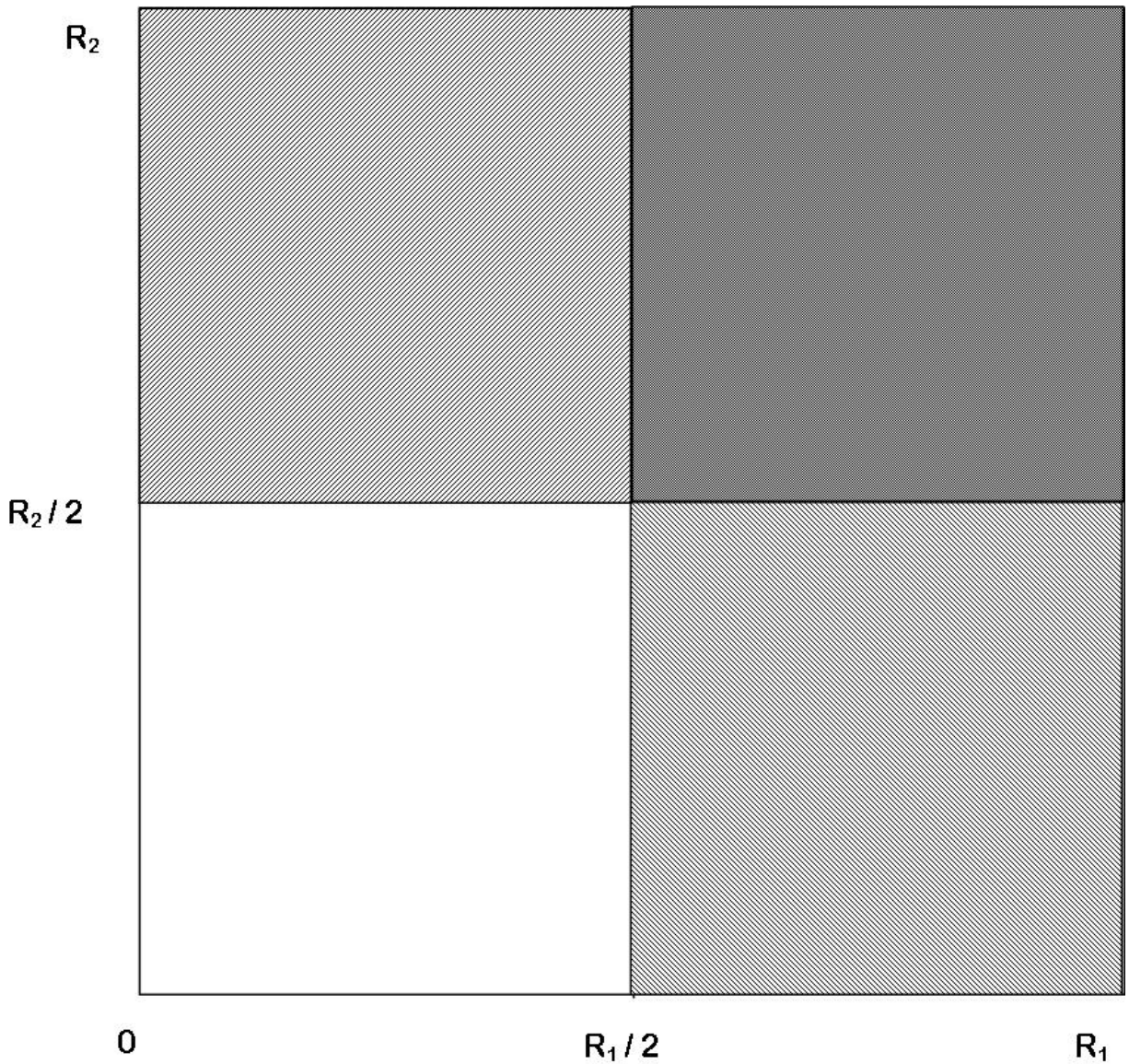

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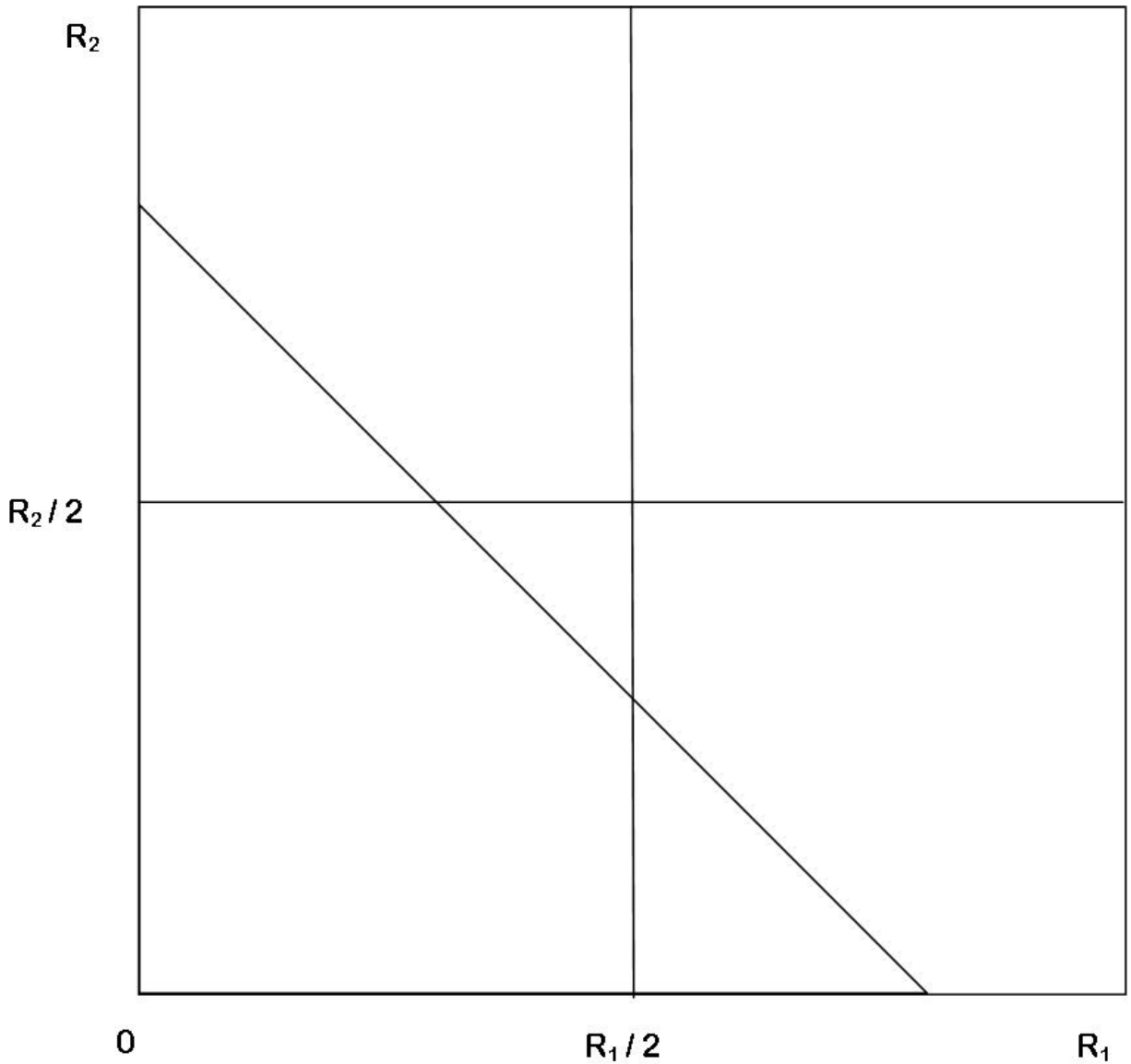

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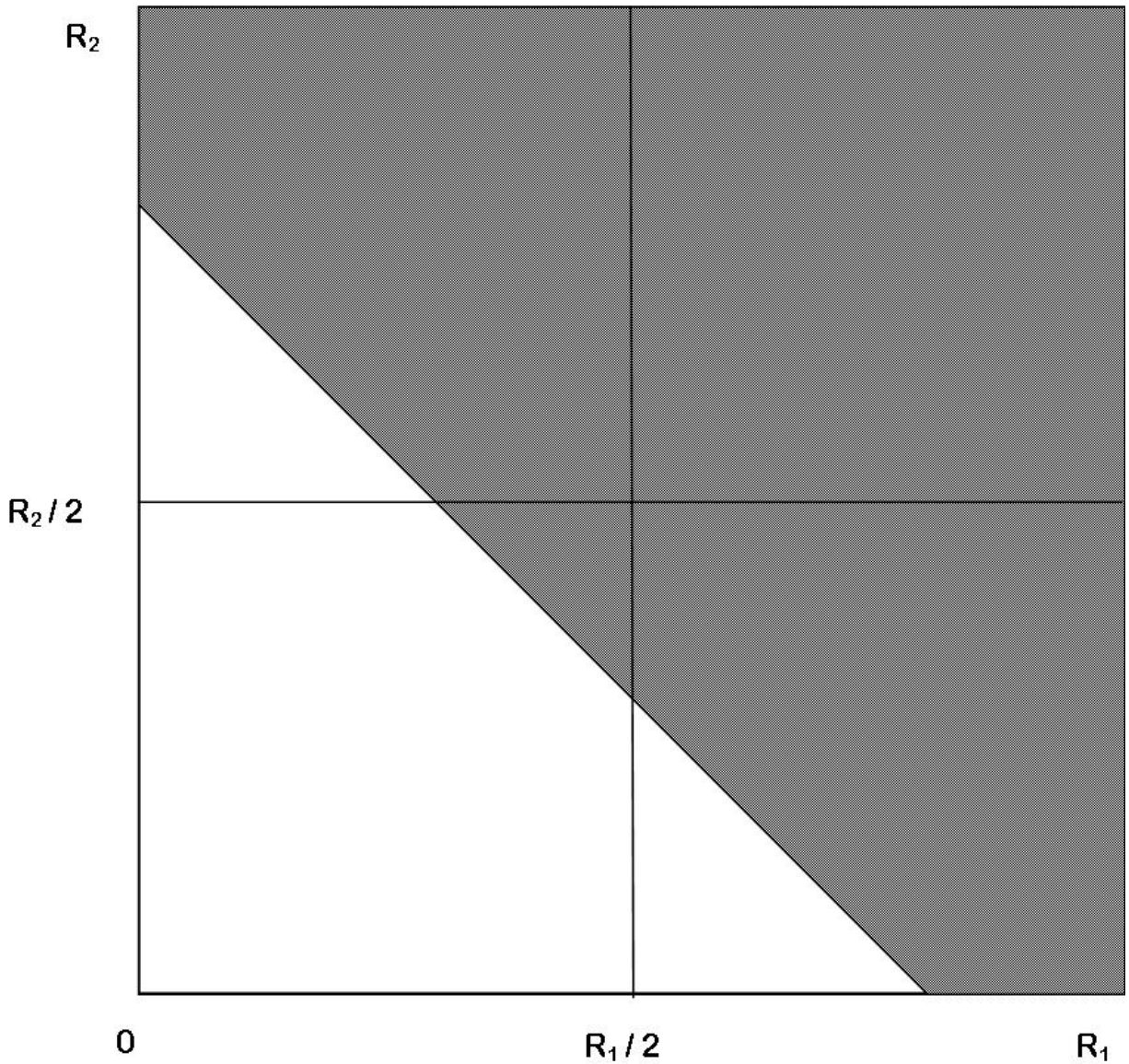

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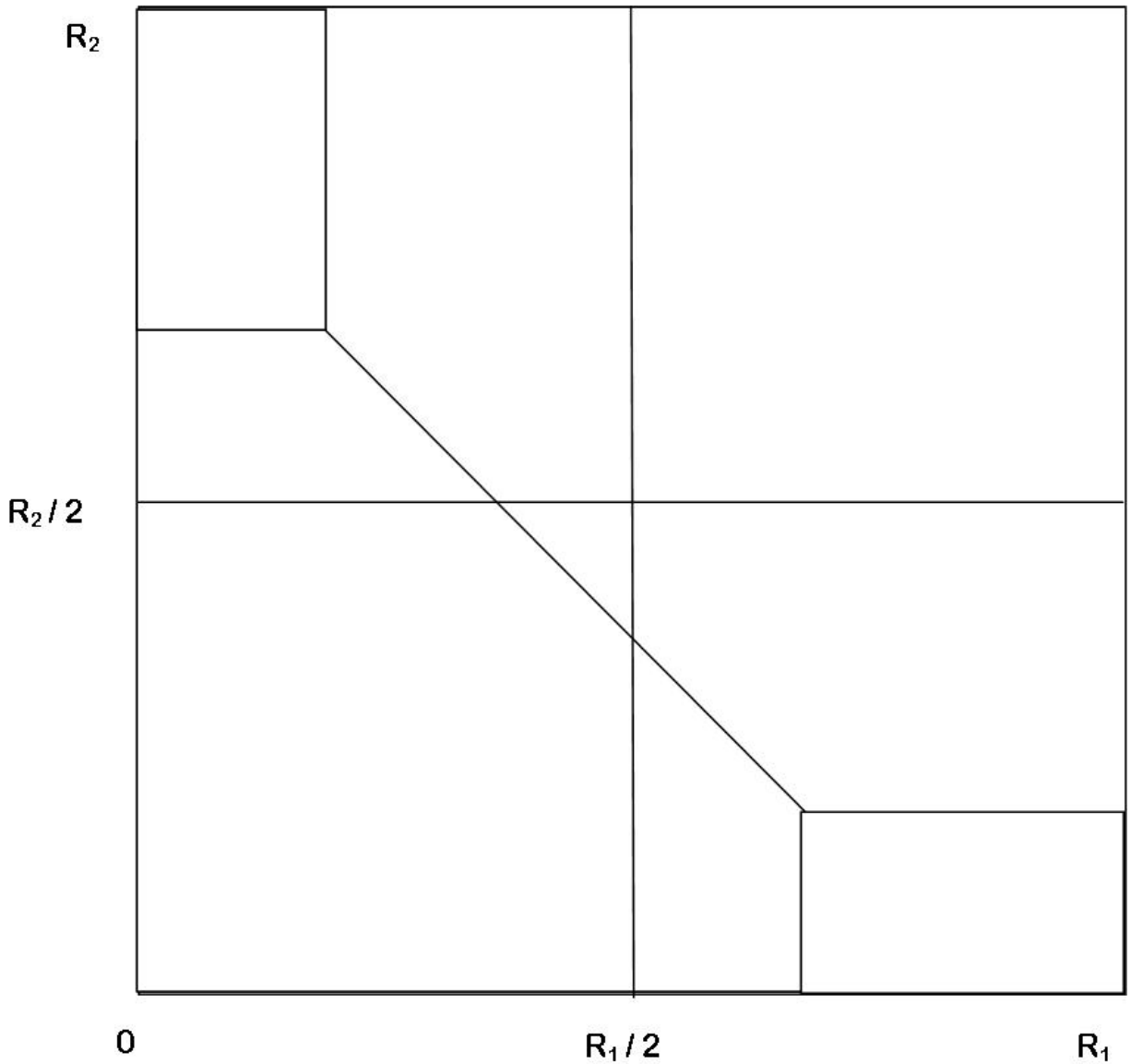

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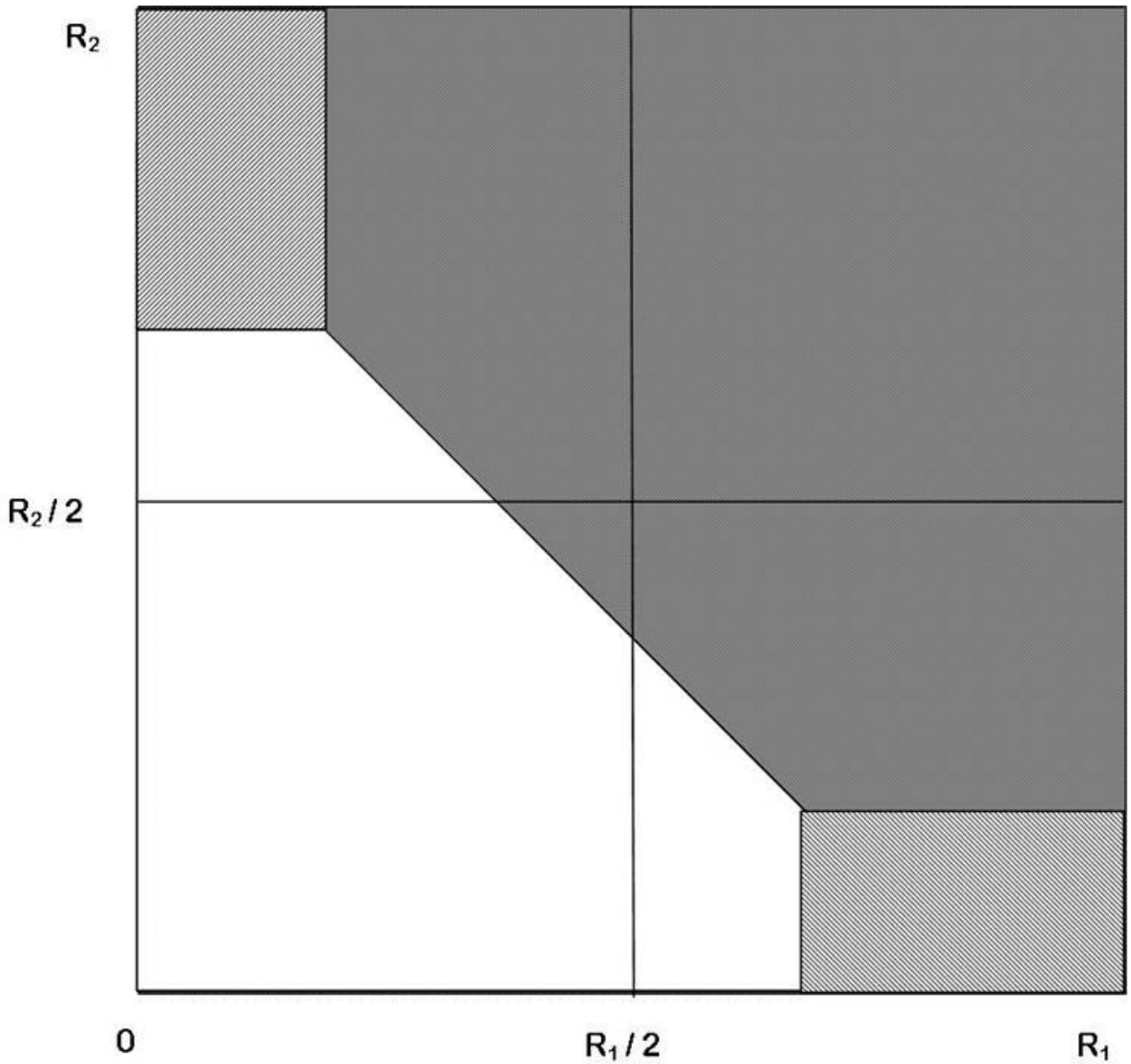

Immediate Extensions

- Schmalensee (1984) assumes Gaussian distribution for demand
- Long (1984) shows that MB is optimal if demand is independent or negatively correlated
- Lewbel (1985) shows MB is optimal if goods are substitutes and CP is optimal when goods are complements
- All assume the firm is a monopolist

Moving Beyond Two-Good Monopolists

- McAfee et al. (1989) establish sufficient conditions on the joint distribution of demand for bundling to be optimal
- Carbajo et al. (1990) show that profitability of bundles depends on whether competition is Cournot or Bertrand
- Chen (1997) shows that in many duopoloy cases PB dominates MB while in the monopoly case the opposite is true

Establishing Generalizability

- Until Eckalbar (2010), closed-form solutions for MB did not exist, which is why the theoretical literature is so scattered and piecemeal
- Even in Eckalbar, the solutions are for two-good monopolists facing demand distributions that are independent and uniform
- Under these assumptions, Eckalbar calculates optimal prices, quantities, profits, and consumer surplus

Methods of Application

- Closed-form solutions were only developed recently, and they exist only for the two-good case
- Because of this, empirical work has primarily been simulation based, showing what optimal prices might be under certain assumptions about demand
  - Venkatesh and Mahajan (1993), Bakos and Brynjolfsson (1999), Geng et al (2005), Chu et al. (2011)
- Some empirical work looks to estimate bundling's impact on price or consumer demand
  - Crawford (2008), Shi et al (2010), Shiller and Waldfogel (2011)

Intuition

- Bundling works by sorting consumers into groups
- This allows firms to more effectively price discriminate
- For many years bundling was assumed to reduce consumer surplus
- Eckalbar (2010) showed the impact on consumer surplus depends on assumptions regarding the demand space

Recall: Research Questions

1. How robust is the profit maximizing pricing mechanism to gaps in a firm's knowledge regarding...
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Defining Robust

1. *Effectiveness*: the average distance from the maximum achievable profit attained across all rounds and all environments
2. *Adaptability*: the most profitable strategy across environments
3. *Maximin*: the most profitable strategy in worst case scenario
4. *Convergence*: the most profitable strategy across rounds

Experimental Market

- Individuals play as multi-product monopolists in the lab
- Asked to set prices after which automated computer buyers make purchases
  - 1,000 computer buyers
  - In control, buyers will have independent and uniform demand
- Game lasts 40 rounds
- Rounds have a 30 second minimum time but no maximum time

Experimental Set-up

- Individuals assigned to one of two cohorts
  - Cohort 1: randomly assigned a single pricing strategy which they use in all rounds
  - Cohort 2: randomly assigned a different pricing strategy every 10 rounds
- At end of each round, individual is shown the prices they selected, the resulting quantity sold, plus the profit earned and the maximum achievable profit

Potential Variants

- Randomly vary demand space across individuals?
- Randomly vary demand space within individuals across rounds?
- Allow individuals to choose their own pricing strategy?
- Randomly vary the number of goods?
- Control group where demand is known?
- If individual finds optimal prices, do they keep playing, stop playing, or switch up demand environment?