

# Auctions for Gas Supply Contracts in Colombia

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- The CREG has commissioned us to design an auction for natural gas contracts in Colombia
- The required tasks include the specification of:
  - The contracts to be sold in the auctions (Task 1)
  - The overall conceptual design of the auction (Task 2)
  - The detailed auction rules (Task 3)

# Goal

- Improve *transparency* and *efficiency* of the gas market:
  - Keep the auction as *simple* as possible, while allowing participants to express their preferences and trade the contracts they are most interested in
  - Trade *standardized* contracts in order to enhance competition, transparency and liquidity
  - Trade *substitute* contracts  
(2 contracts are substitutes if the demand for one contract increases when the price of the other contract increases)

# Substitute Contracts

1. Firm, interruptible and conditional firm contracts, with same duration, start date and delivery point
2. Contracts with different delivery points, same start date and duration
3. Contracts with different durations, same start date and delivery point

(With *complement goods*: bidders face exposure risk; market clearing prices may not exist; there may be multiple equilibria)

# Initial Recommendations

## for Auction Contracts and Frequency

- Standardized contracts (see report by Paul Milgrom): firm; interruptible; conditional firm
- Annual auctions
- 10/20 MBTUDs lots (to maximize participation by small buyers and sellers)
- Same start date for all contracts (to make contracts substitute), 6/12 months after the date of the auction
- 2 durations: 1 and 5 years
- Indexation

# Auction Designs

- **Simultaneous auction** for substitute products, so that bidders (and sellers) can observe the prices of other contracts, when deciding how much to bid for a contract
- 2 suitable auction designs:
  1. **Simultaneous Ascending Auction**
  2. **Simultaneous Sealed-Bid auction**

# Simultaneous Ascending Auction

- Suggested by Peter Cramton
- Used for spectrum, electricity and gas auctions worldwide
- Bidding takes place in **discrete rounds**
- In each round:
  - The auctioneer announces a new price for each contract
  - Bidders declare the quantity of each contract that they are willing to acquire at the current prices
- Between rounds, the auctioneer increases the price of contracts with excess demand

# Simultaneous Ascending Auction

- The auction terminates when there is no excess demand on any contract
- The auction determines one price for each contract
- All winning bidders pay the **same prices**
- The auction facilitates **price discovery** (when bidders are unsure about their valuations and value other bidders' information)
- Producers declare supply schedules:
  - Quantity offered of each contract
  - May offer more at higher prices



# Information Policy

- Before the auction, the auctioneer announces the total supply of each contract
- After each round, the auctioneer reports:
  - *Excess demand* for each product
  - *Prices* for all contracts for next round  
(determined from extent of excess demand)
- Additional information about individual bidders' demand may also be announced to facilitate price discovery but ...  
more information also facilitates coordination among bidders and collusion

# Activity Rule

*A bidder cannot increase the total quantity of contracts he demands during the auction*

- As prices rise, bidders can only maintain or reduce their total demand
- This induces bidders to bid actively and according to their true preferences, thus avoiding “sniping” and improving price discovery

# Switching

- A bidder's demand for one contract depends on the prices of other contracts
  - E.g., when the price of firm contracts increases compared to the price of interruptible contracts, a bidder may prefer to reduce his demand for firm and increase his demand for interruptible
- Bidders should be allowed to “switch” their demand between the various contracts as prices changes (subject to the activity rule)

# Potential Problems with the Simultaneous Ascending Auction

- Because of discrete price increments between rounds and switching,  
*the ascending auction may not select the exact market-clearing prices and/or may end with excess supply*
  - E.g., a bidder switches demand away from a contract and causes total demand to be lower than supply
- Possible partial solutions are:
  1. Intra-round bidding
  2. The auctioneer reduces prices when the auction terminates with excess supply

# Intra-round bidding

- Allows bidders to express their demand for a contract at any price between the start-of-round price and the end-of-round price of that contract
  - E.g., a bidder can declare the precise price at which he is willing to reduce his demand for one contract
- But does not allow bidders to switch demand between contracts based on their *exact relative prices* because a bidder cannot condition his bid for one contract on the (intra-round) prices of other contracts
- So the simultaneous ascending auction may limit bidders' expression of their preferences

# Intra-round bidding

- A bidder cannot condition his bid for one contract on the (intra-round) prices of other contracts
- Example: A bidder prefers to acquire firm rather than interruptible contracts if and only if  $p_F - p_I < 4$
- Suppose that, in one auction round,
  - the price of firm increases from 10 to 13
  - the price of interruptible increases from 7 to 8
- The bidder wants to bid for
  - firm at the beginning of the round when  $p_F - p_I = 3$
  - interruptible at the end of the round when  $p_F - p_I = 5$
- But the bidder cannot indicate the precise **relative price** at which he is willing to switch from firm to interruptible
  - E.g., he prefers firm at intra-round prices of 11 and 7.5
  - E.g., he prefers interruptible at intra-round prices of 12 and 7.5

- The simultaneous ascending auction has many **desirable properties**:
  - All contracts are sold simultaneously
  - Bidders are able to substitute between the products as prices change
  - Bidders receive the contracts they prefer given the auction prices for all contracts
  - All winning bidders pay the same price for identical contracts

... and some **disadvantages**

*Is there another auction mechanism that has the same desirable properties of the simultaneous ascending auction, but not its disadvantages?*

# Simultaneous Sealed-Bid Auction

- New auction design proposed by Paul Milgrom (2009) and Paul Klemperer (2010)
- Used by the Bank of England to provide liquidity to banks
- Allows bidders to express preferences for **multiple substitute contracts**,  
in **sealed-bid** format
- Selects the **exact market clearing prices** for all contracts



# Simultaneous Sealed-Bid Auction

- Winning bidders **do not pay their bids**,  
but the market clearing price for each contract  
they acquire,  
exactly as in a simultaneous ascending auction

# Bids in Simultaneous Sealed-Bid Auction

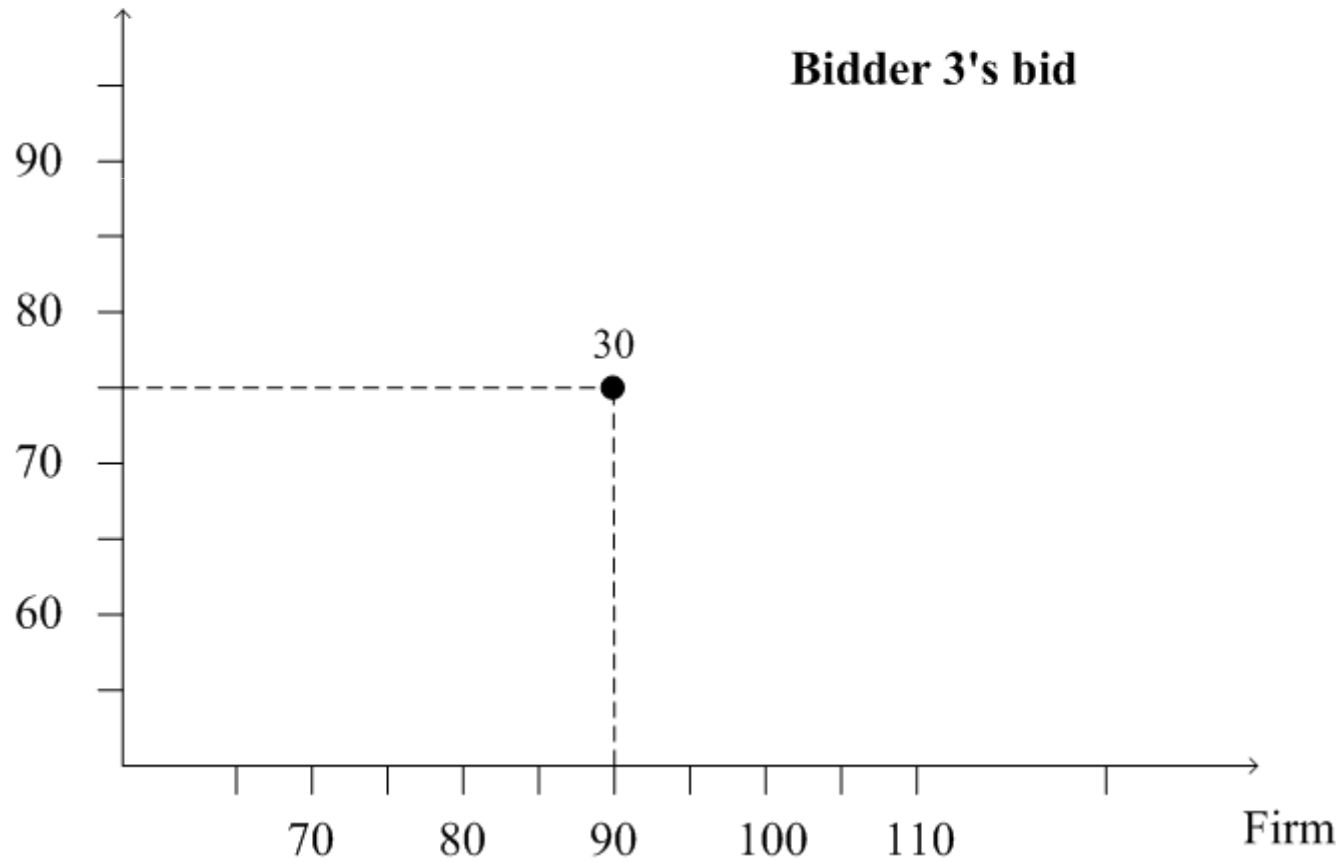
- Suppose there are only 2 contracts:  
firm and interruptible
- Bidder 3:
  - is willing to buy 30 units of **either** firm **or** interruptible contracts
  - is willing to pay up to 90 for each firm contract and up to 75 for each interruptible contract
- Hence, bidder 3 prefers interruptible contracts only if they are cheaper than firm contracts by at least  $90 - 75 = 15$

- Bidder 3:
  - is willing to buy 30 units of **either** firm **or** interruptible contracts
  - is willing to pay up to 90 for each firm contract and up to 75 for each interruptible contract

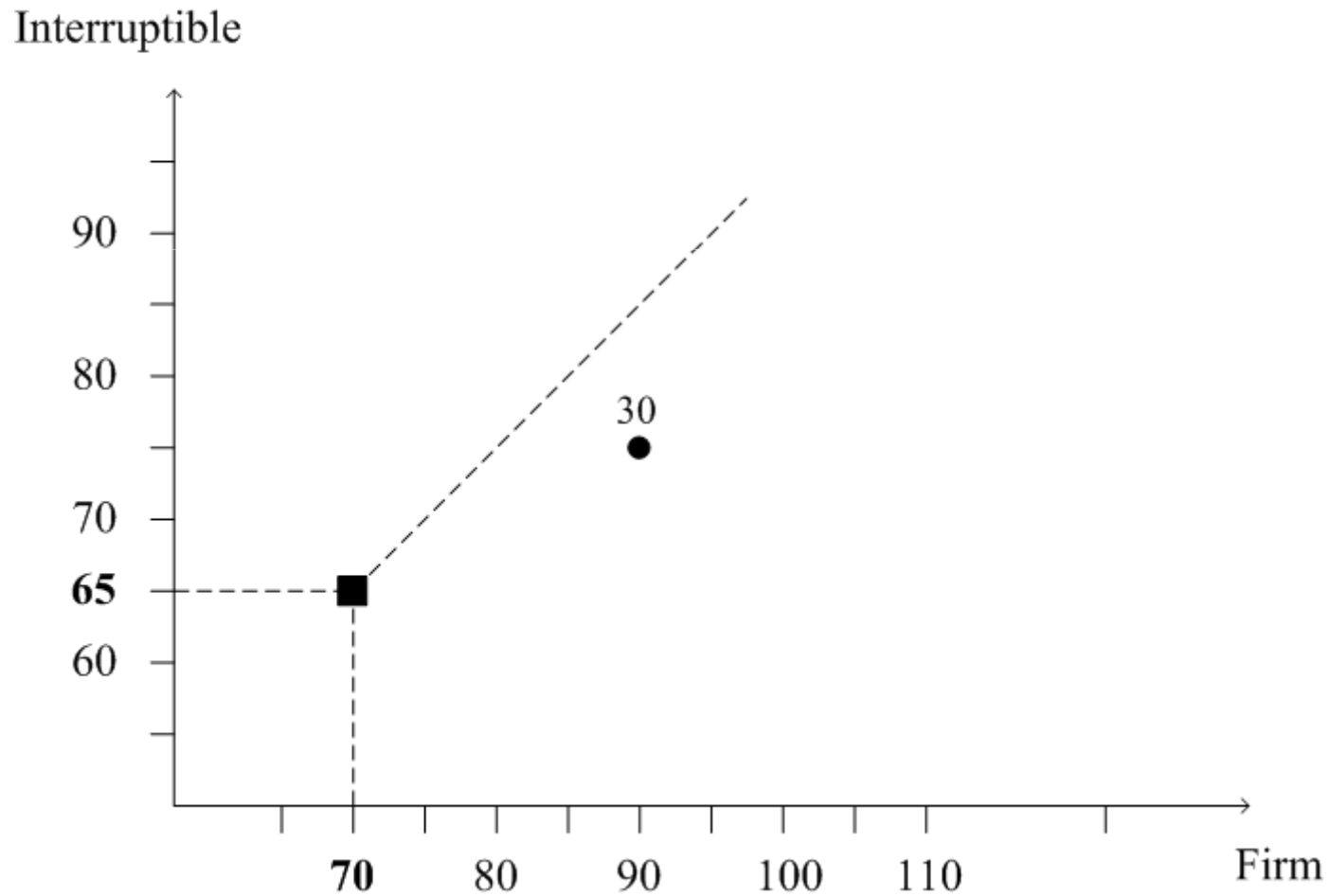
Bid	Product	Price
1	Firm	90
2	Interruptible	75
	Total quantity: 30	

Bid	Product	Price
1	Firm	90
2	Interruptible	75
	Total quantity: 30	

Interruptible



- Suppose the auction prices are 70 for firm and 65 for interruptible
- Bidder 3 is allocated 30 firm contracts since:
  - Margin on firm =  $90 - 70 = 20$
  - Margin on interruptible:  $75 - 65 = 10$

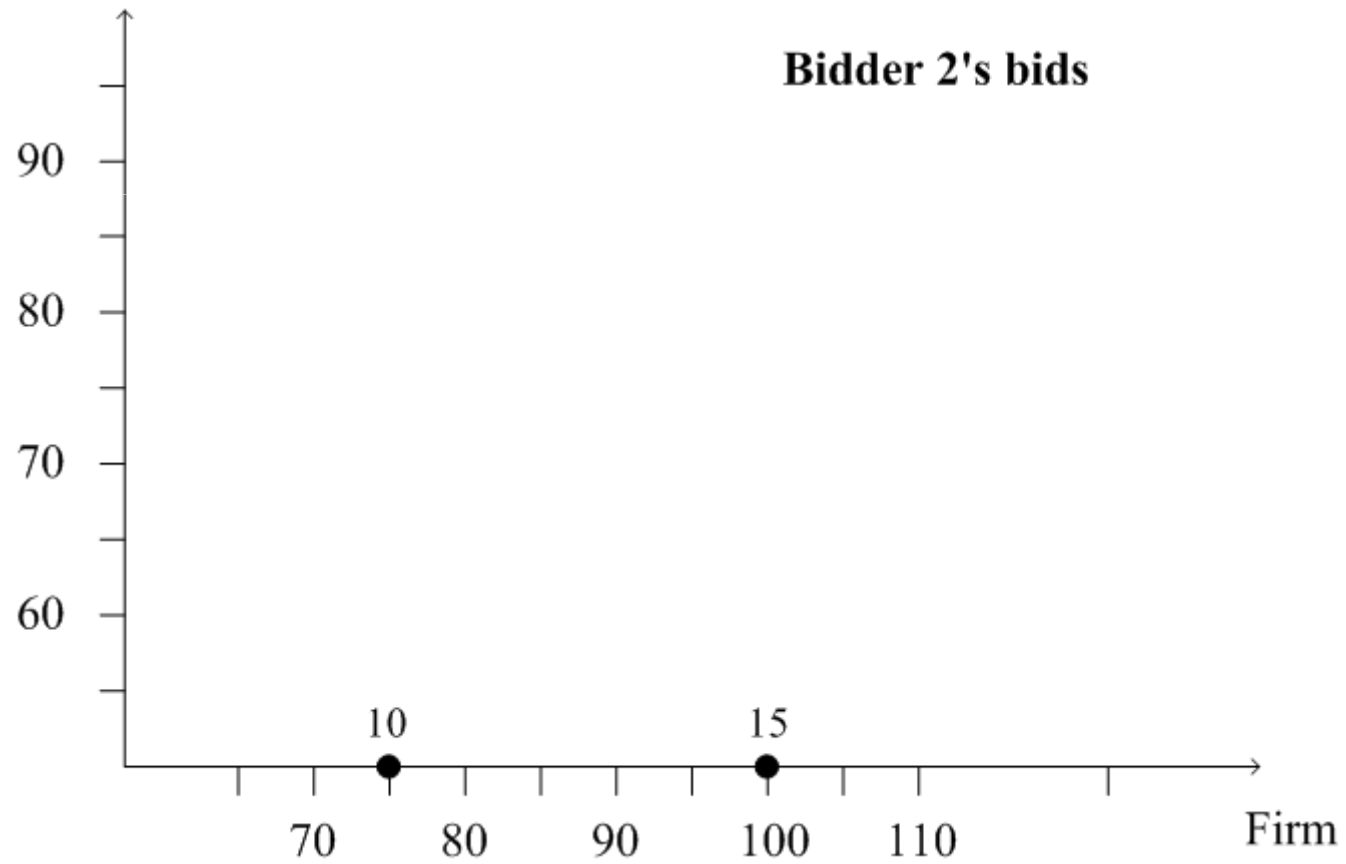


- Bidder 2:
  - is willing to buy 15 firm contracts at price at most equal to 100
  - is willing to buy another 10 firm contracts at price at most equal to 75

Bid	Product	Quantity	Price
1	Firm	15	100
2	Firm	10	75

Bid	Product	Quantity	Price
1	Firm	15	100
2	Firm	10	75

Interruptible



- Bidder 1:
  - is willing to buy 20 units of firm contracts at any price
  - is also willing to buy another 10 units of either firm or interruptible contracts
  - For the additional 10 units, is willing to pay up to 80 for firm and up to 70 for interruptible contract

Product	Quantity	Price
Firm	20	any

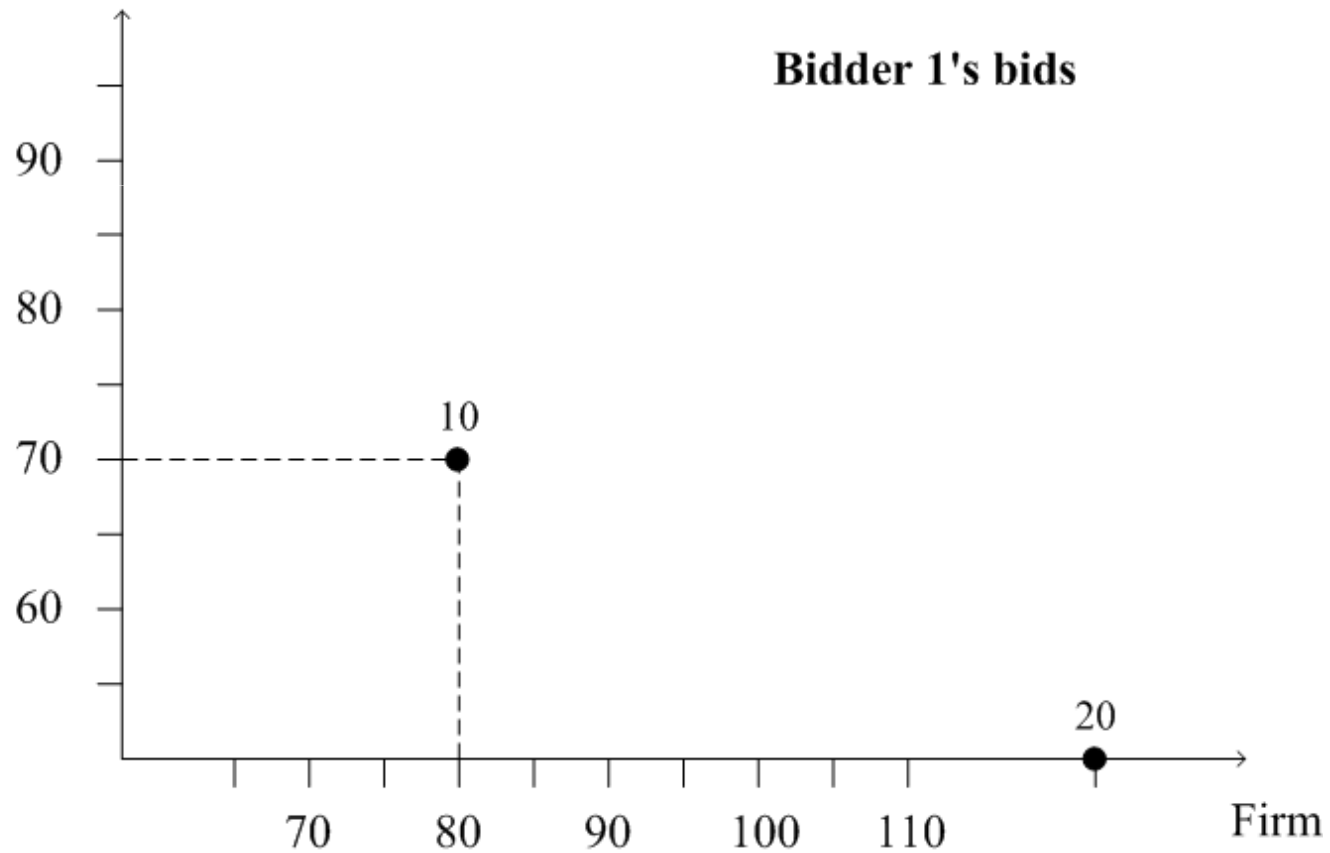
Bid	Product	Price
1	Firm	80
2	Interruptible	70
	Total quantity: 10	



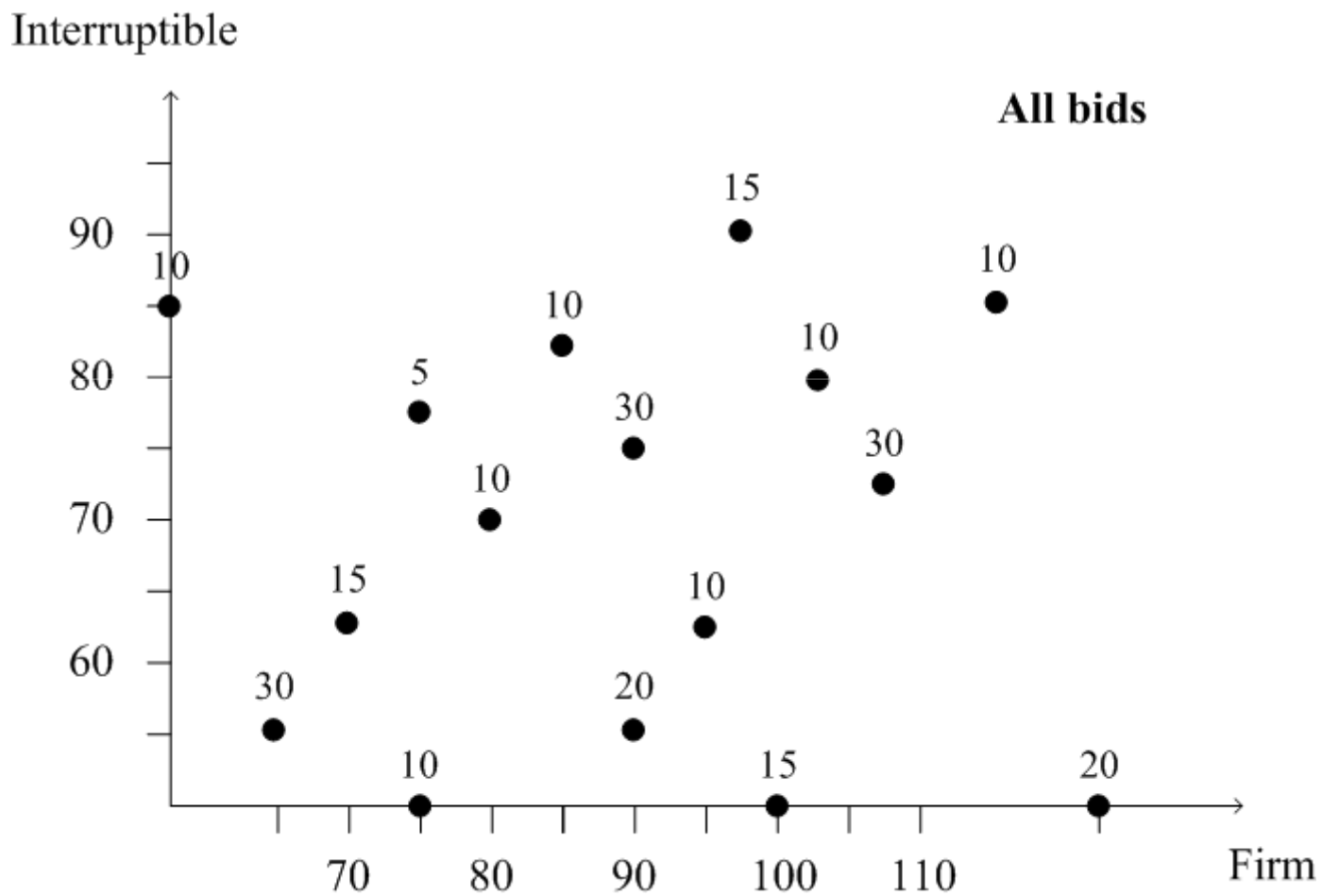
Product	Quantity	Price
Firm	20	any

Bid	Product	Price
1	Firm	80
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	Total quantity: 10	

Interruptible



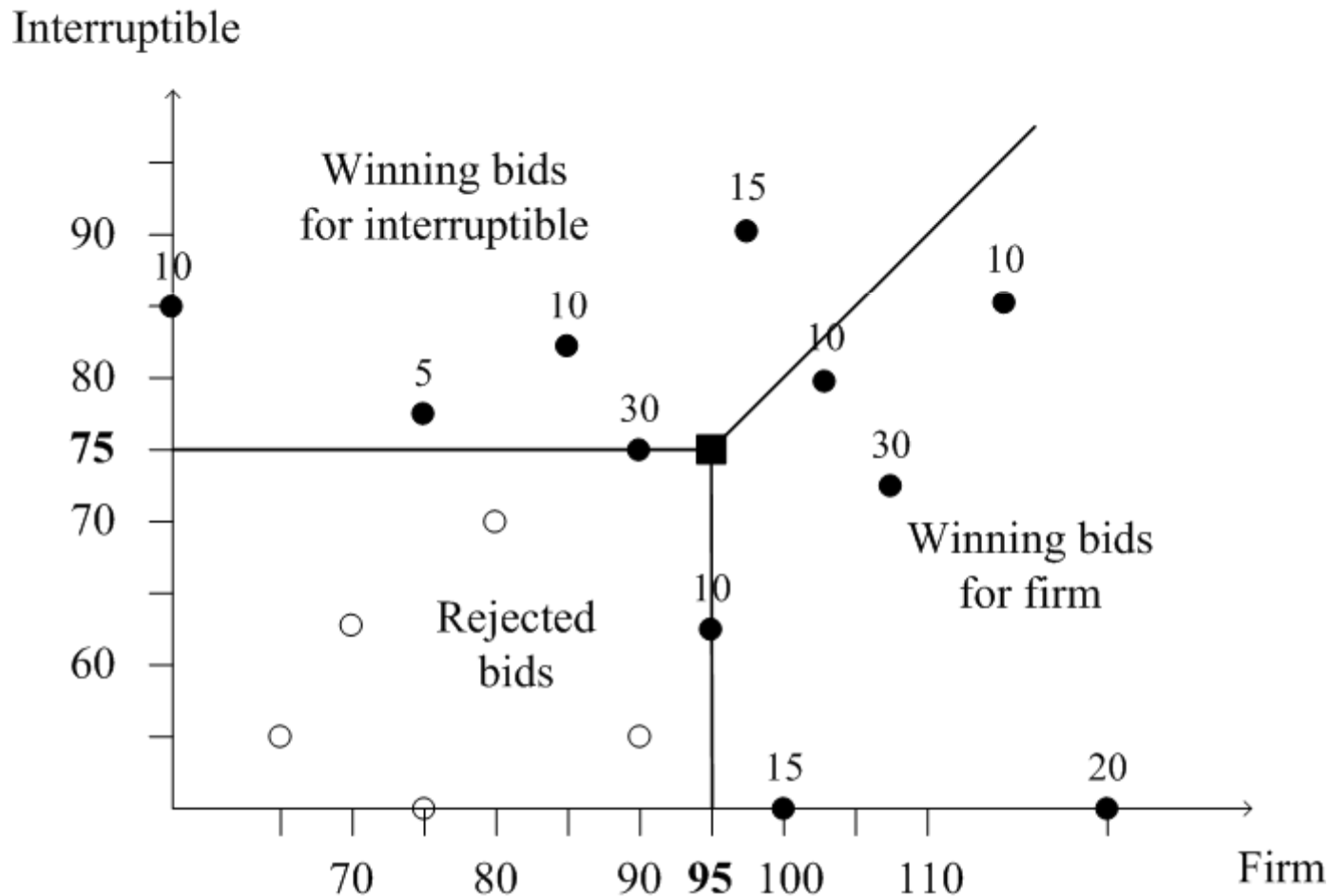
- *All bids* placed in the auction can be represented in this way:



# Auction Prices and Allocation

- After observing all bids, the auctioneer selects the **market clearing price** (at which demand is exactly equal to supply) for each contract
- Each winning bids by each bidder is allocated the contract that gives the bidder the highest surplus, given his price bids and the auction prices
- So bidders receive the contracts they would choose themselves at the auction prices, and should bid truthfully according to their preferences

- Suppose the total supply of firm contracts is 90 and the total supply of interruptible contracts is 60
- The auctioneer chooses the unique prices such that the total demand for firm is 90 and for interruptible is 60



# Advantages of **Simultaneous Ascending Auctions**

1. Information revelation and **price discovery**  
(with common values and bidders with different information)
  - Bidders can update their valuations for the contrants after observing the behaviour of other bidders  
*Do buyers know their valuations for gas contracts before participating in the auction?*
2. **Experience**
  - Used in many auctions around the world

# Advantages of Simultaneous Sealed-Bid Auctions

1. **Time** and speed
  - The auction terminates instantaneously, thus saving time and resources
2. **Accuracy** for the auctioneer
  - The auctioneer does not have to arbitrarily determine discrete price increments between rounds
  - The auction finds the exact market-clearing prices
3. **Accuracy** for bidders
  - Bidders do not have to take real-time decisions
  - Bidders can express their precise preferences
4. **Collusion**
  - By revealing more information to bidders, the simultaneous ascending auction facilitates collusion

# Complexity?

- In both auction formats, to guide their bidding bidders have to prepare tables like

Product	Quantity	Price
Firm	30	90
Interruptible	30	75

- The simultaneous sealed-bid auction is a **proxy version** of the simultaneous ascending auction
  - Bids in the sealed-bid auction are equivalent to bidding instructions in the ascending auction

# Conditional Firm Contracts

- Gas-fired power plants currently purchase about 45% of all firm contracts, and resell some of the gas acquired in conditional firm contracts
- Should power plants be allowed to sell conditional firm contracts in the auction?
  - They could use **swap bids** in the simultaneous sealed-bid auction to buy firm contracts and simultaneously sell conditional firm contracts
  - With swap bids, a power plant may want to pay a price higher than its stand-alone valuation for firm contracts, if it can simultaneously sell conditional firm contracts at a sufficiently high price
- Should producers be allowed to sell conditional firm contracts in the auction?



# Location-specific contracts?

- Should gas contracts specify the field from which the gas is delivered?
- Colombia-wide contracts
  - simplify the gas market and makes it more liquid but
  - requires the allocation of contracts to specific fields
- Trade-off between complexity-liquidity and risk connected to transport costs
- An alternative is to create a hub