

Incentive Auctions

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Why do market design?



"If you put the federal government in charge of the Sahara Desert, in five years there'd be a shortage of sand."

--Milton Friedman

Why do market design?



Alan Greenspan on
Wall Street
regulation:
“Let the market
rip!”

“I was partially
wrong in opposing
regulation of Wall
Street.”

Incentive auctions

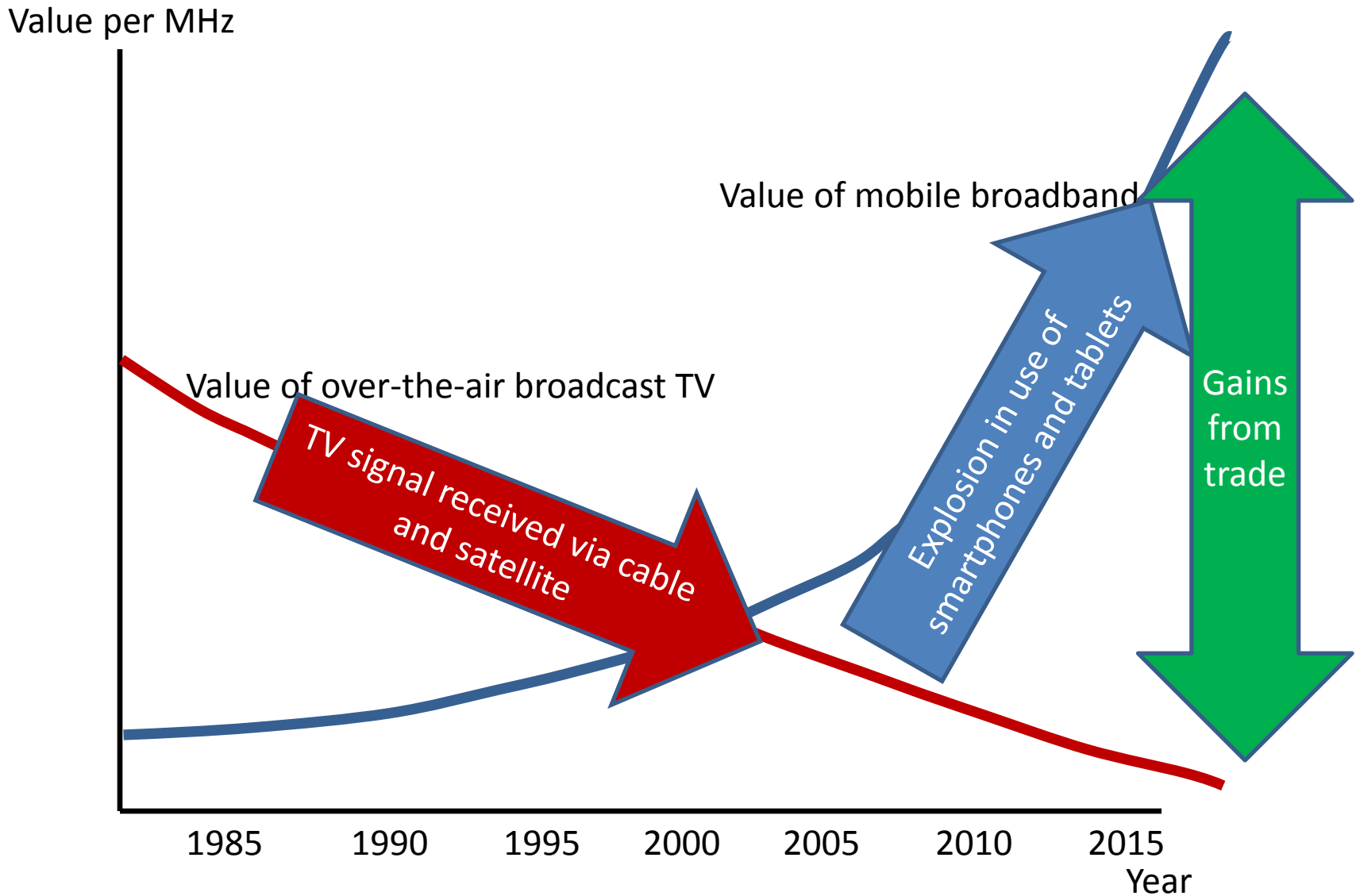


Auction includes essential regulatory steps to address market failures in the secondary market for spectrum

Letter from 112 economists, 6 April 2011

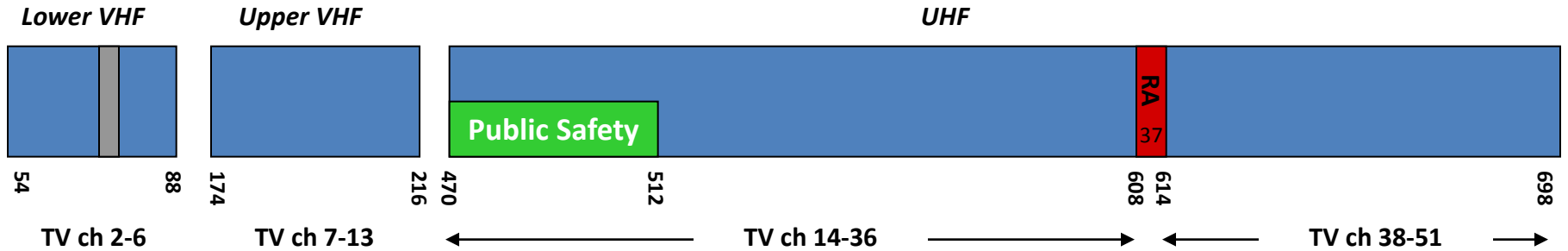


Motivation

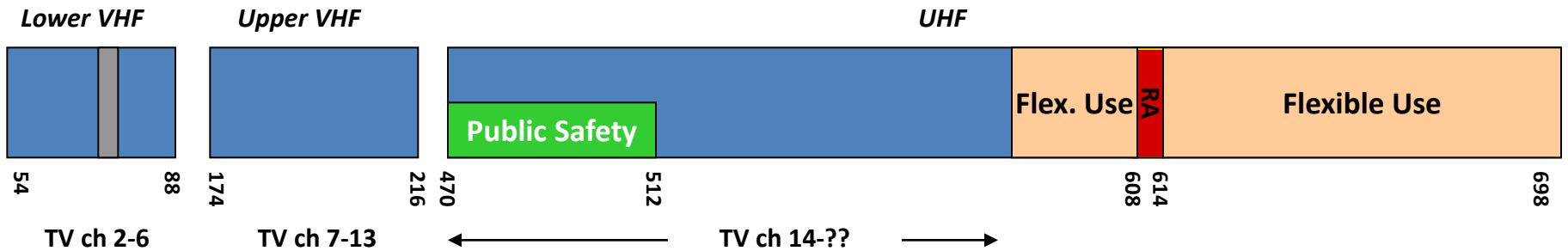


VHF and UHF bands

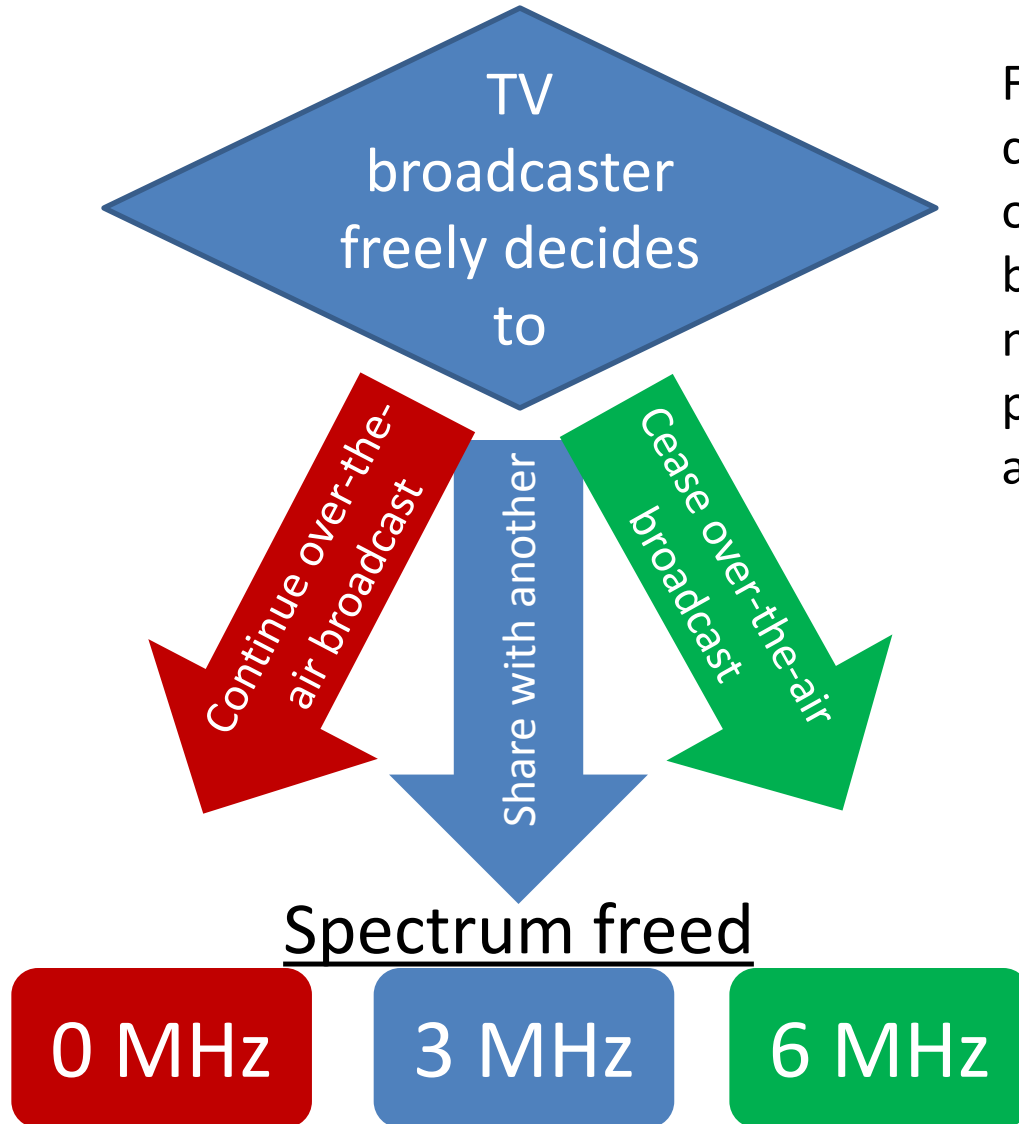
Current uses (TV broadcast)



Possible future uses



Voluntary approach



For simplicity, I assume that channel sharing is only 2:1; other possibilities could also be considered, including negotiated shares with particular partners announced at qualification

Why voluntary?

- *More likely to quickly clear spectrum*
 - Broadcasters benefit from cooperating
- *Lower economic cost of clearing*
 - Spectrum given up only by broadcasters who put smallest value on over-the-air signal
- *Market pricing for clearing*
 - Avoids costly administrative process
- *Efficient clearing*
 - Clear only when
value to mobile operator > value to TV broadcaster

Two approaches



Too complex
due to
repacking



Reverse
auction to
determine
supply

TV
broadcaster
freely decides
to

Continue over-the-
air broadcast

Share with another

Cease over-the-air
broadcast

Spectrum freed

0 MHz

3 MHz

6 MHz

- Mostly single channel
- Price discovery less important

=>

- Sealed-bid auction or descending clock
 - Price to cease
 - Price to share

Washington DC

0 MHz

3 MHz

6 MHz

$P = \$30$

Reverse
auction to
determine
supply

$S = 48$

7

Price = $\$30/\text{MHzPop}$

13

9

26

22

31

18

41

37

47

44

35

Washington DC

0 MHz

3 MHz

6 MHz

$P = \$20$

Reverse
auction to
determine
supply

$S = 36$

7

Price = \$20/MHzPop

13

9

26

22

31

18

41

37

47

44

35

Washington DC

0 MHz

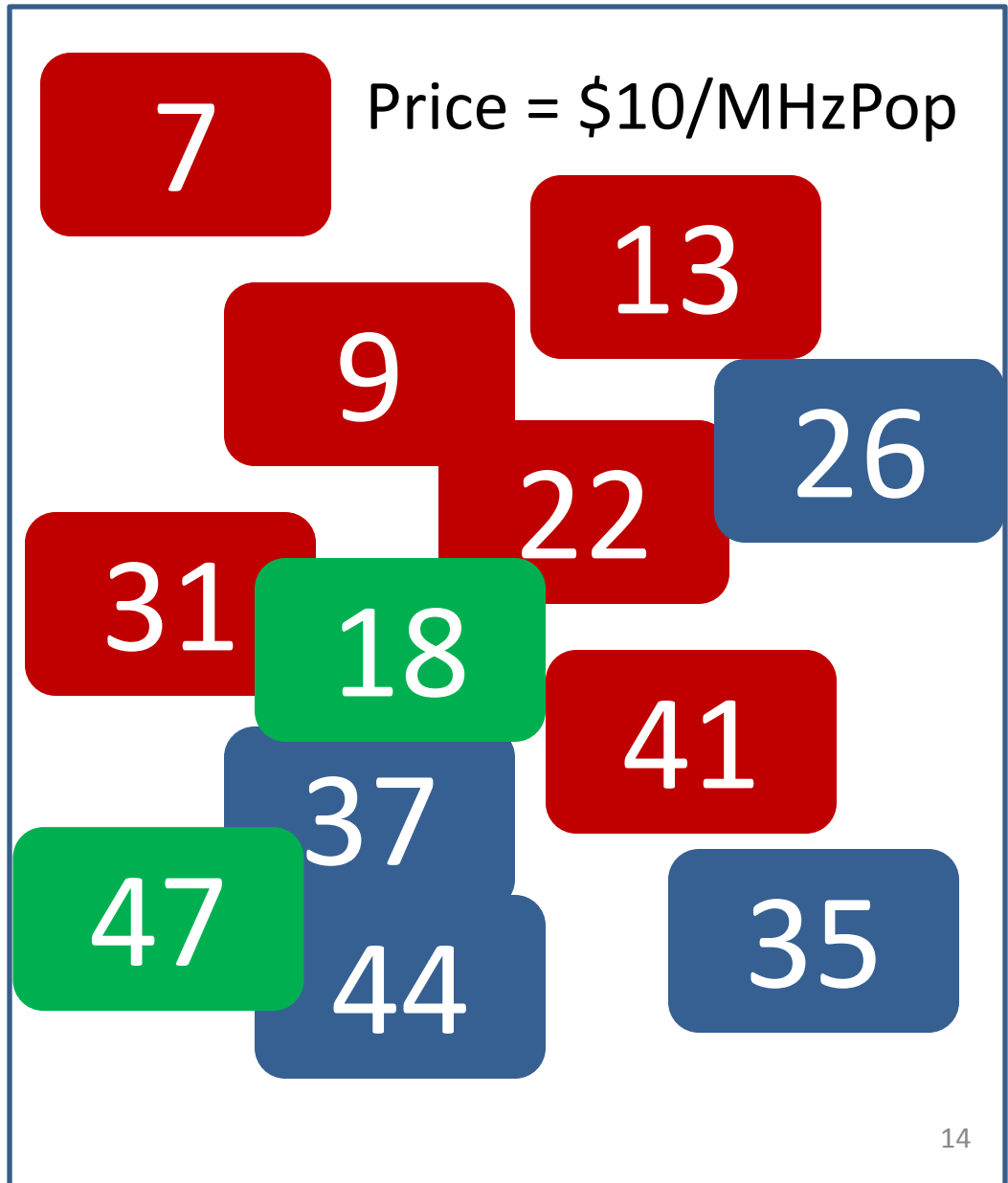
3 MHz

6 MHz

$P = \$10$

Reverse
auction to
determine
supply

$S = 24$

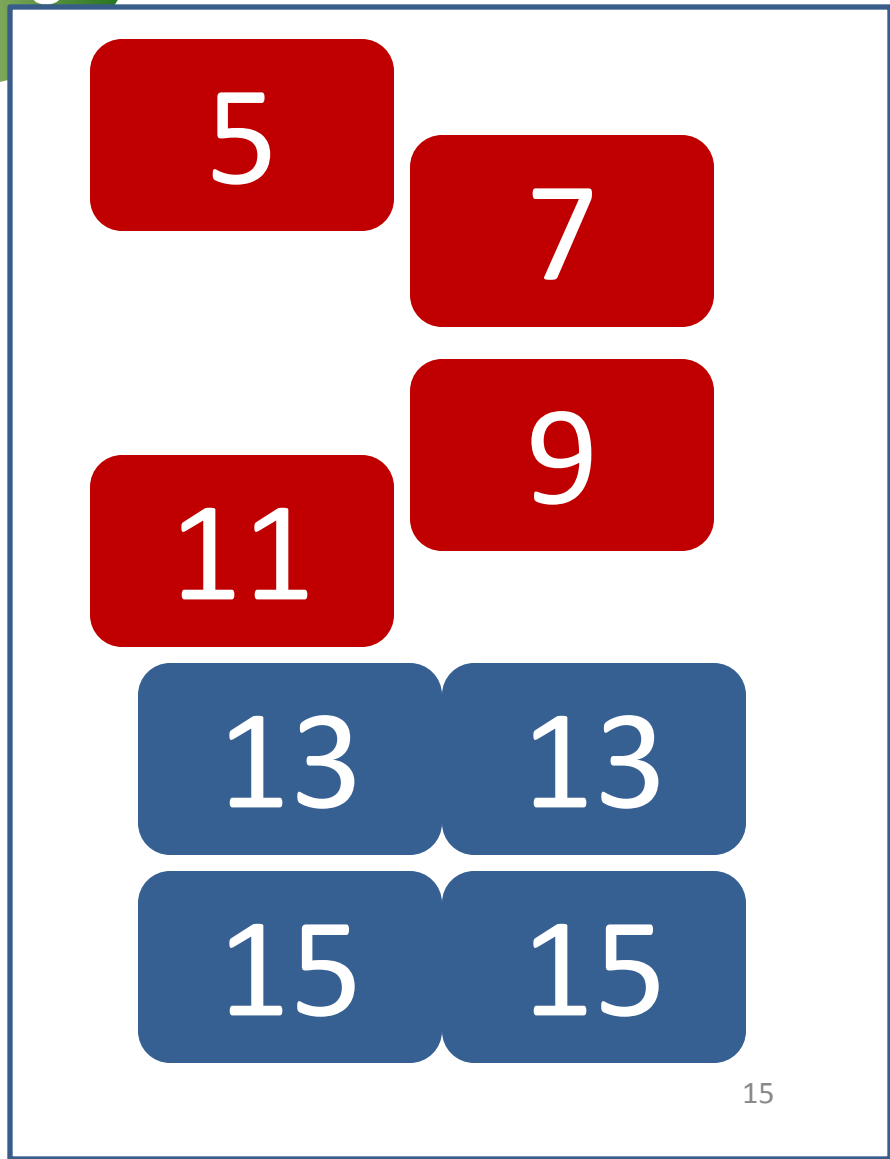
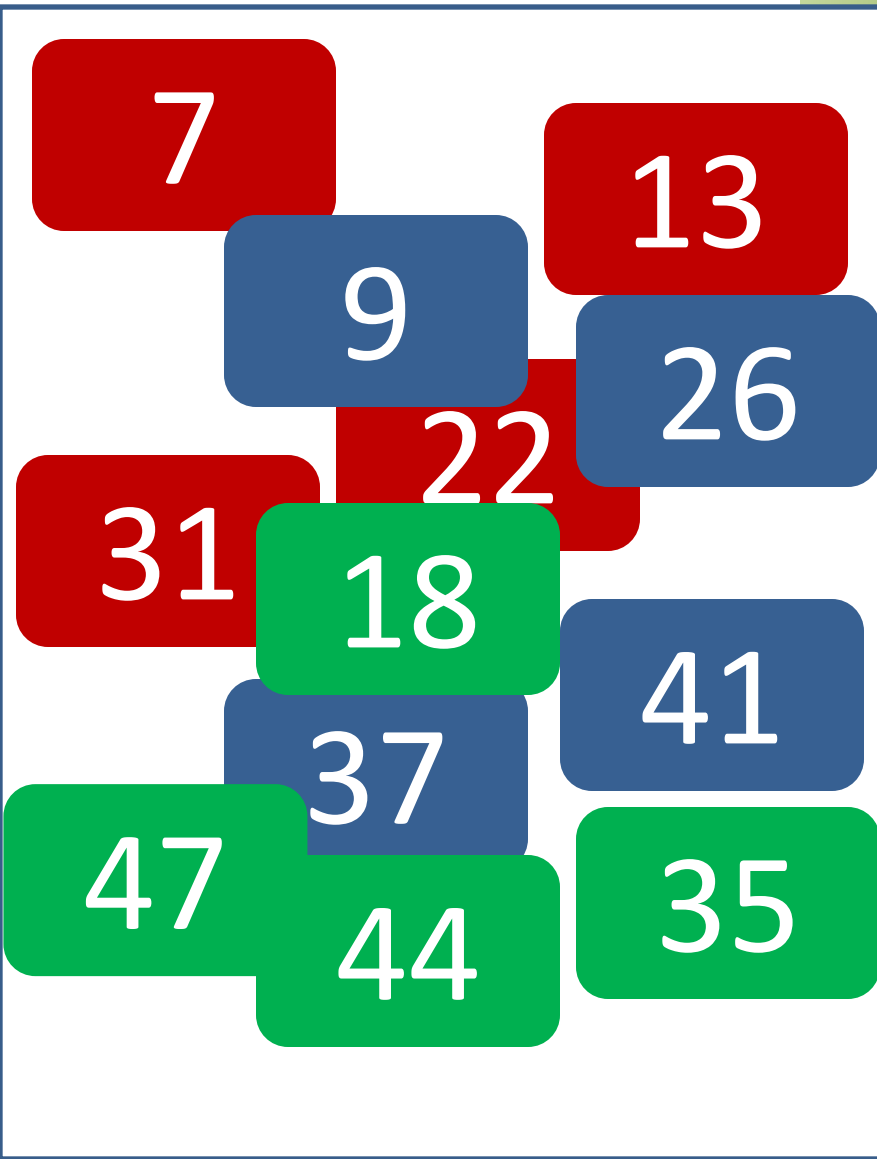


P = \$20

S = 36

Mandatory
repacking

Supply =
160 MHz





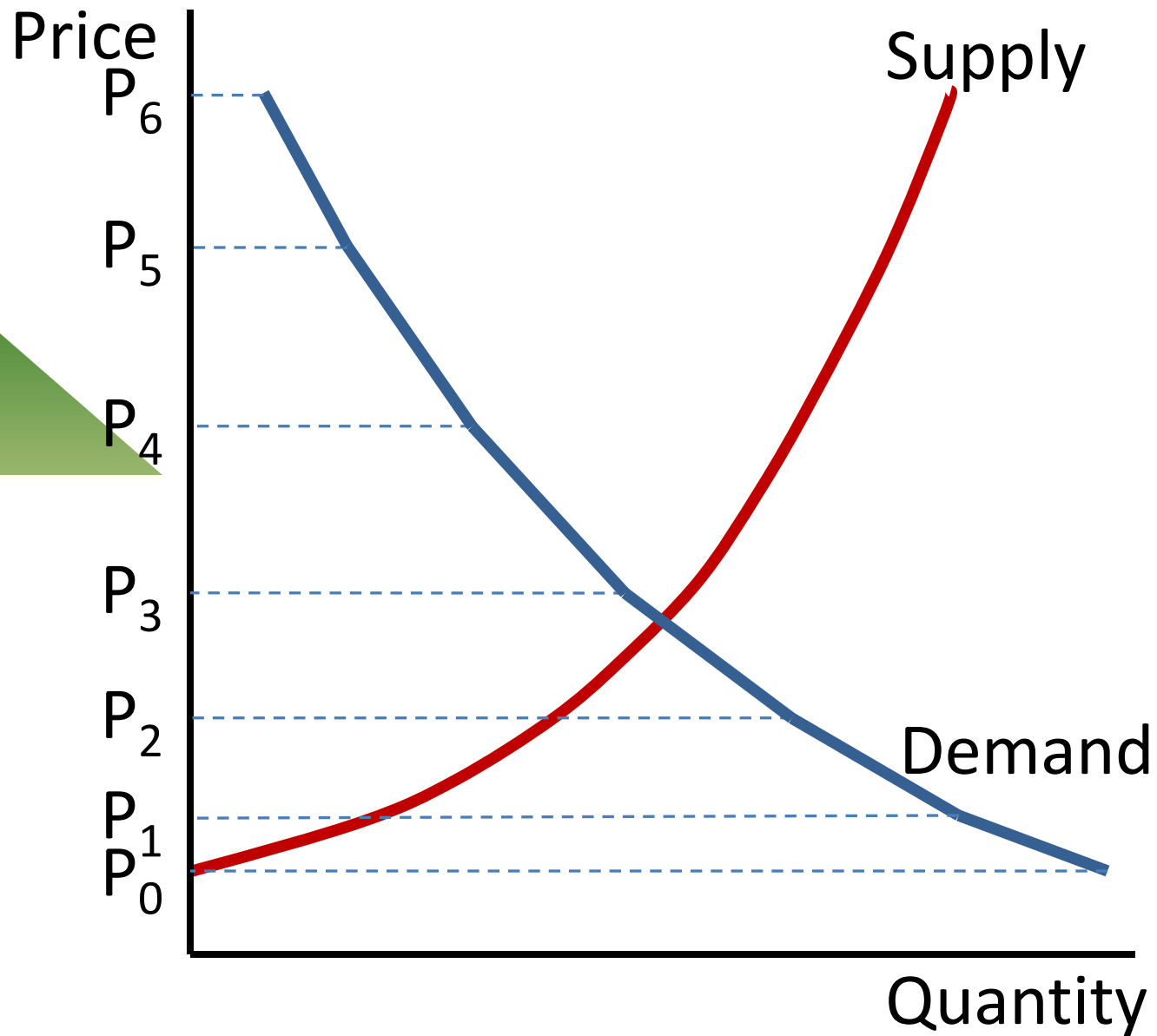
Forward
auction to
determine
demand

- Mobile operators want large blocks of contiguous paired spectrum for LTE (4G)
 - One to four 2×5 MHz lots
- Complementarities strong both within and across regions
- Package clock auction ideal
 - Within region complementarities guaranteed with generic lots
 - Across region complementarities achieved through optimization of specific assignments

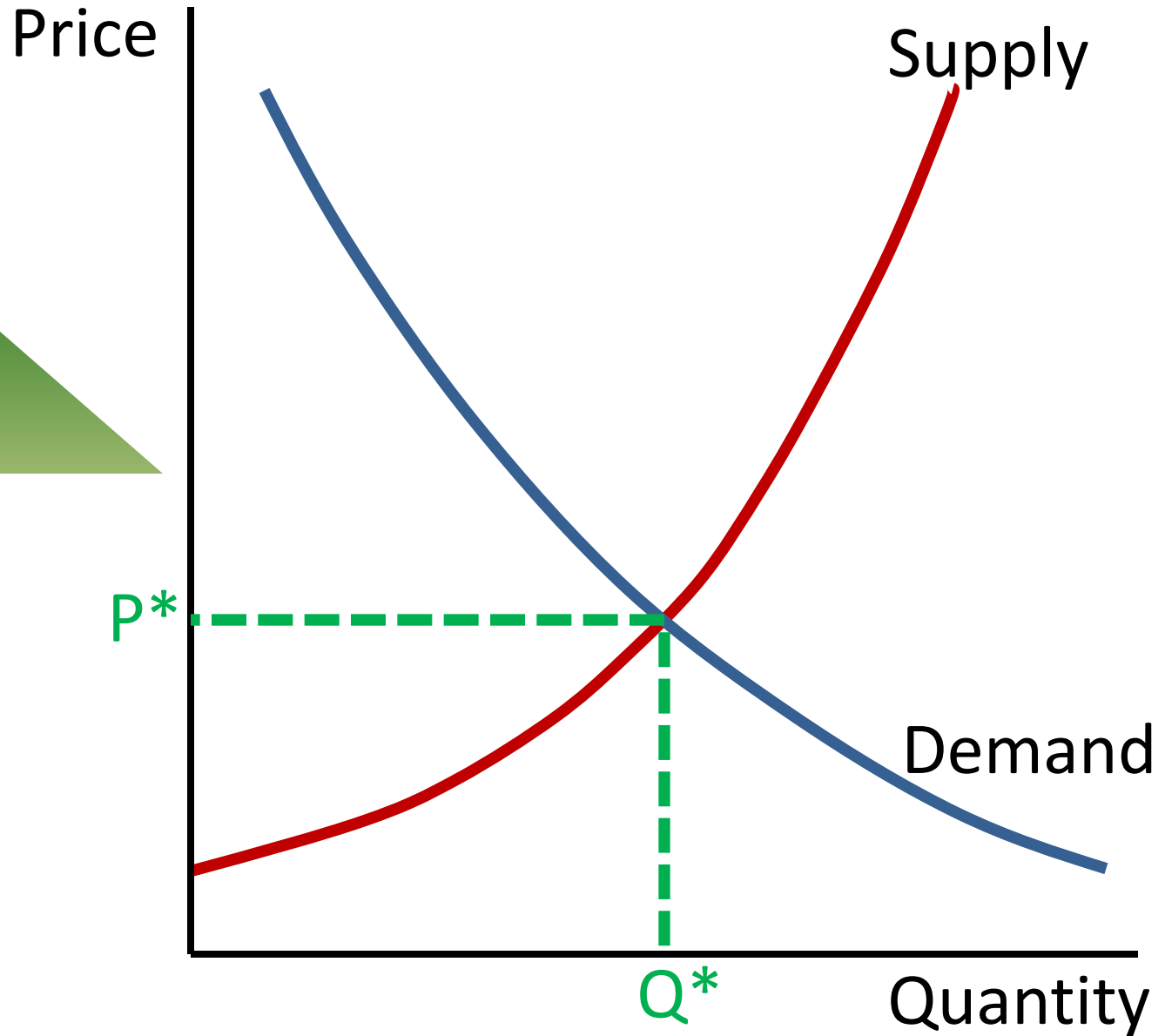
Package clock auction: Overview

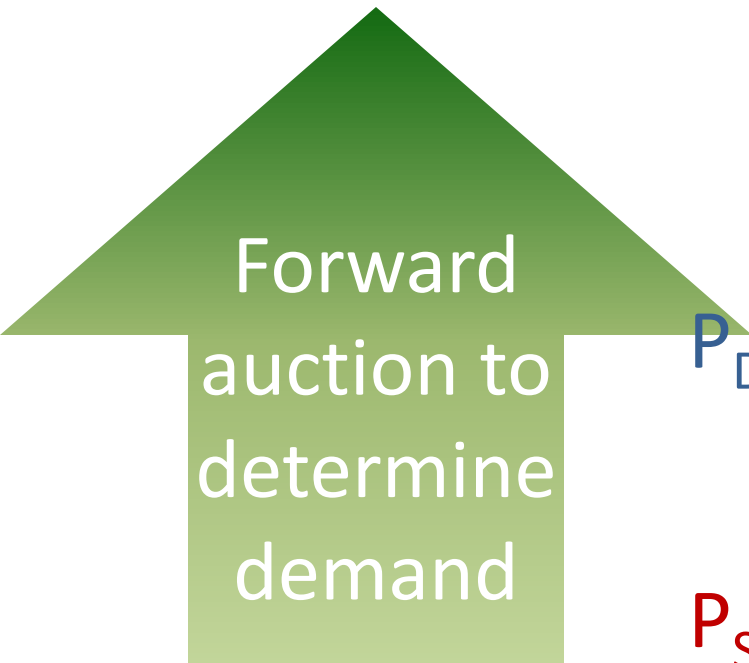
- Auctioneer names prices; bidder names package
 - Price increased if there is excess demand
 - Process repeated until no excess demand
- Supplementary bids
 - Improve clock bids
 - Bid on other relevant packages
- Optimization to determine assignment/prices
- No exposure problem (package auction)
- Second pricing to encourage truthful bidding
- Activity rule to promote price discovery

Forward
auction to
determine
demand

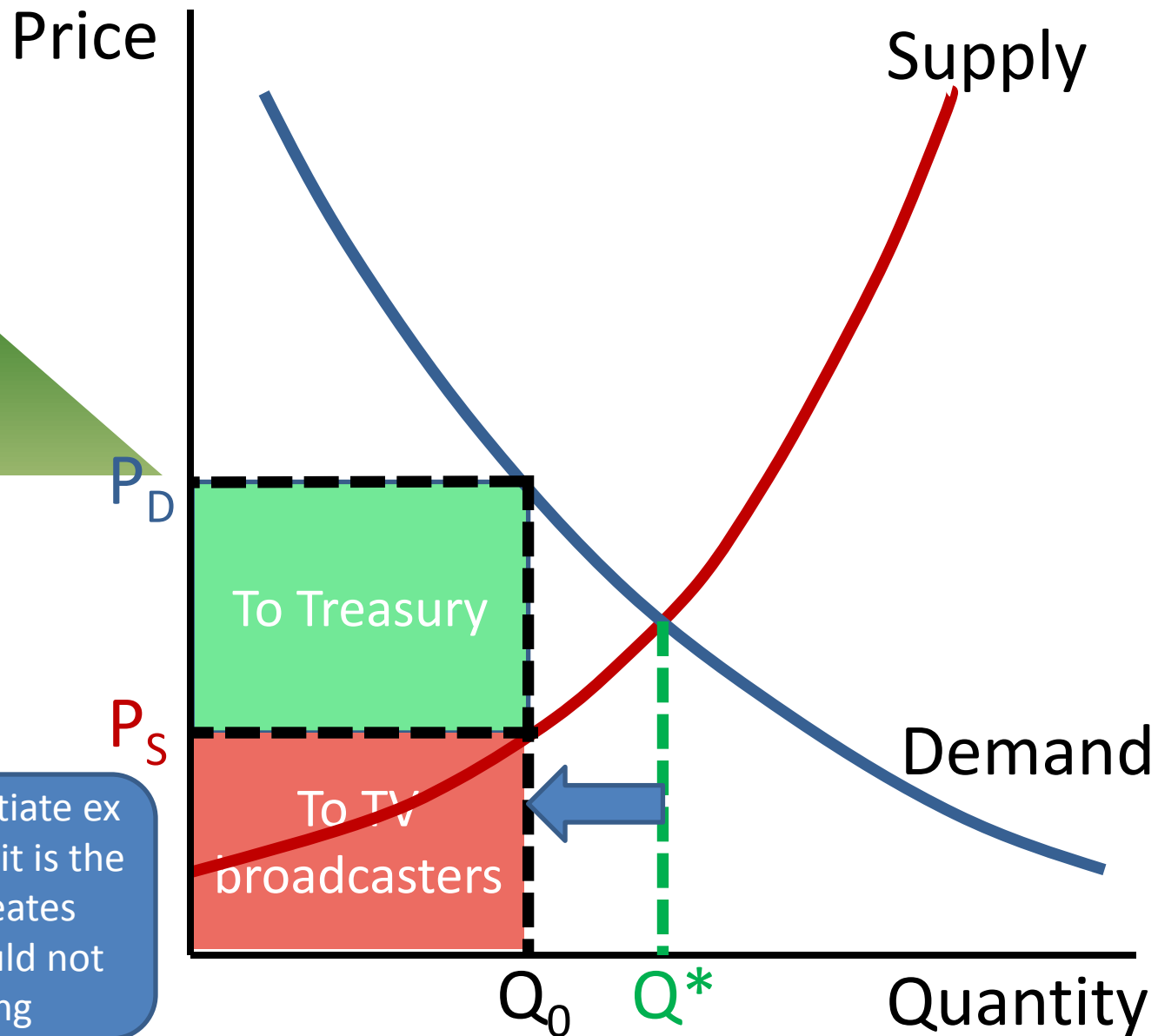


Forward
auction to
determine
demand





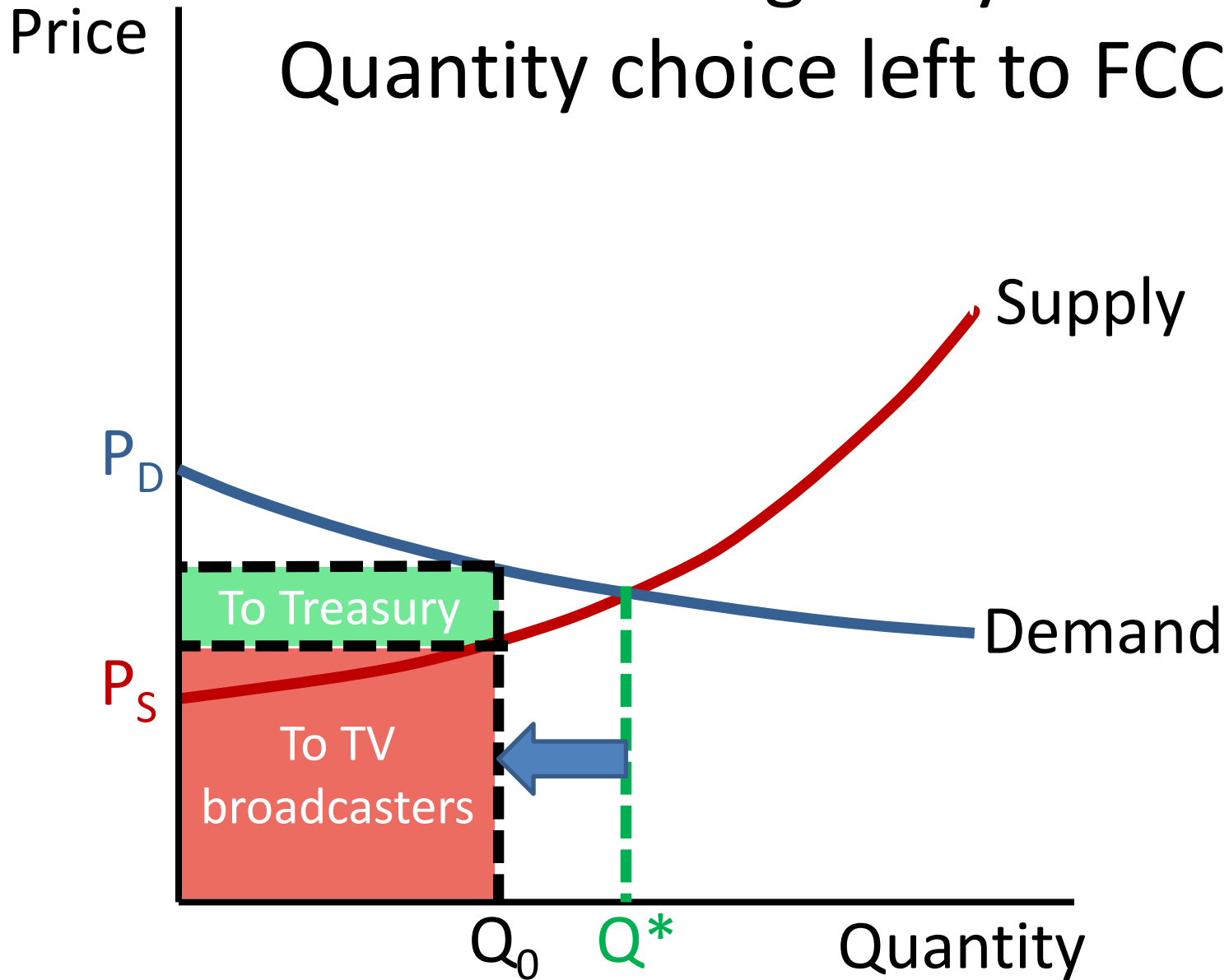
Broadcasters cannot negotiate ex post with operators, since it is the FCC's repacking that creates value; ex post trades would not benefit from repacking



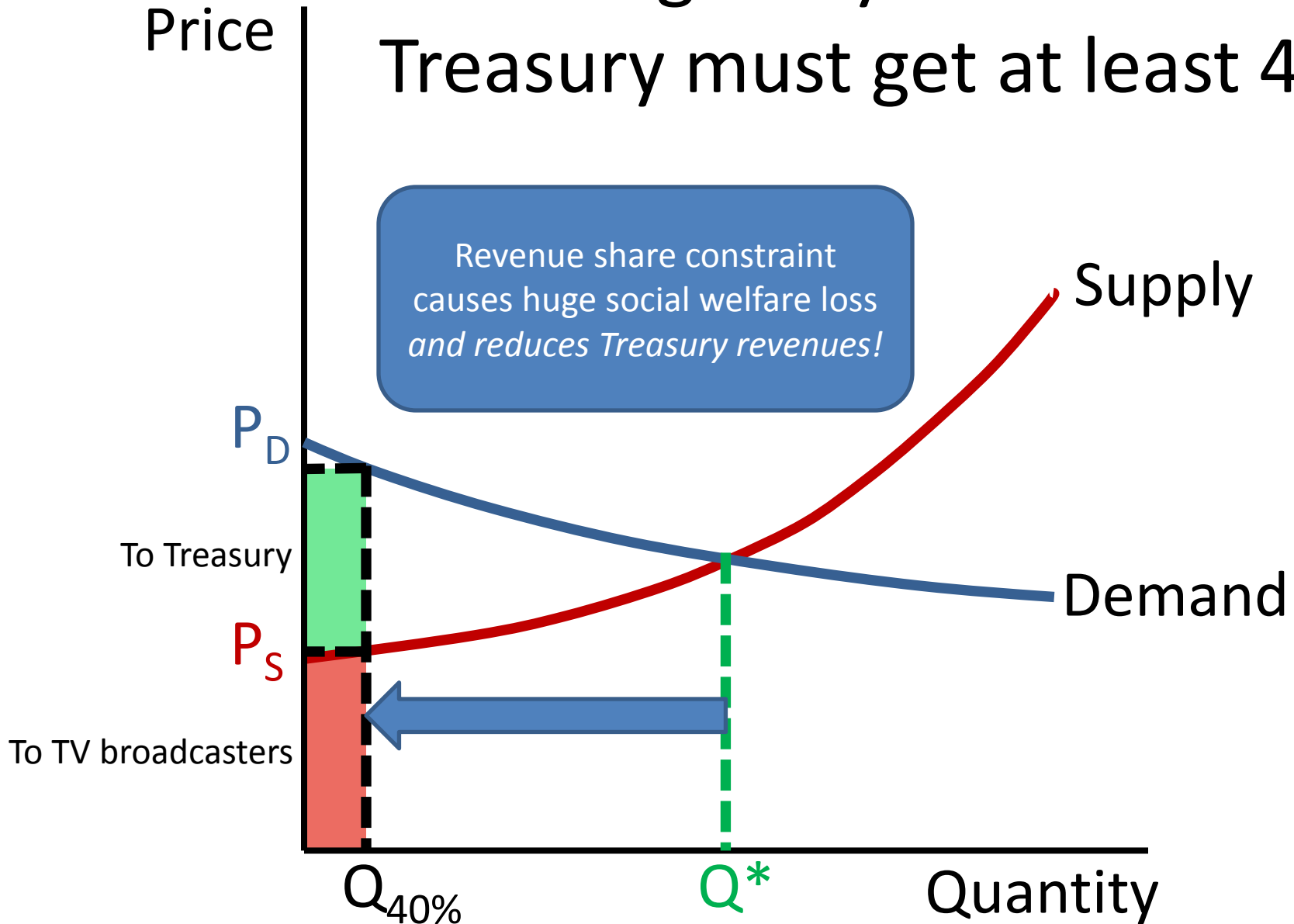
Ways Congress can screw up

- Impose restrictions on which broadcasters can participate in the auction
 - Destroys competition in reverse auction
- Make repacking purely voluntary
 - Reverses status quo—FCC can relocate stations
 - Creates holdout problem in reverse auction
- Too greedy
 - Impose specific requirement on government revenue share (e.g., Treasury gets 40% of revenue)

Not too greedy: Quantity choice left to FCC



Too greedy constraint: Treasury must get at least 40%



Ways FCC can screw up

- Impose restrictions on which broadcasters can participate in the auction
 - Destroys competition in reverse auction
- Make repacking purely voluntary
 - Reverses status quo—FCC can relocate stations
 - Creates holdout problem in reverse auction
- Adopt poor auction design
- Fail to address competition concerns

Statutory language: Motivation

- Since 1993, the FCC has demonstrated an outstanding ability to design and implement auctions
- As a result of this outstanding record, Congress should provide the FCC with broad auction authority focused on key objectives
 - Transparency
 - Efficiency
 - Protections to assure success

Statutory language: Objectives

- Transparency
- Efficiency: Put spectrum to its best social use
- Protections to assure program success
- Protections to assure best available science and practice

Statutory language: Transparency

- Unless explicitly and narrowly justified to limit potential collusive behavior among bidders, *all elements of the market from qualification, to bidding, to award, to performance will be publically disclosed*
- Modern methods will be developed to promote the immediate disclosure of essential market elements in simple and powerful data bases

Statutory language: Efficiency

- Auction design based on long-run efficiency objective:
Put spectrum to its best use
 - Often consistent with best private use, *but*
 - Adjustments to reflect divergence between social and private value, as a result of competition issues in downstream market for wireless services
 - Important role for competition policies within auction
 - Important role for competition policies after auction
 - Important role for unlicensed spectrum
- Efficient auction format that
 - Accommodates both selling and buying of spectrum rights
 - Fosters effective price and assignment discovery in a multiple round format
 - Has a pricing and activity rule that encourages bidders to express true preferences throughout the auction process
- Bands, standards, and other rules optimized to achieve objective of long-run efficiency
- Auction design established in collaborate consultation with industry and other stakeholders, but led with critical input from auction design experts with substantial experience in a diversity of auction design settings

Statutory language: Protections for participants

- Qualification
 - Rigorous and open qualification to bid
 - Deposit proportional to expected volume as a bid guarantee
- Performance
 - Clear rights and obligations for buyers and sellers
 - Simple methods to guarantee performance for parties at risk
- Competition
 - To assure competition in the auction and long-run competition in the downstream market for wireless services,
 - The FCC adopts a suitable competition policy within the auction
 - The FCC adopts a suitable regulatory policy in the wireless market

Statutory language: Protections for best practice

- The FCC auctions must be designed consistent with the best science and practice
 - Expert auction design services procured via competitive bid
- The FCC auctions must be implemented consistent with best science and practice
 - Expert auction implementation services procured via competitive bid
- Independent market monitor
 - An independent expert (individual) shall be retained with four-year terms by the Chair of the FCC
 - Independent market monitor is not a current government employee
 - Independent market monitor reports directly to the Chair of the FCC
 - Independent market monitor has available all confidential information on the market
 - Independent market monitor reports on a regularly basis (annual report and two biannual reports) on the state of the market
 - Identifies potential problems
 - Makes recommendations on addressing potential problems
 - Independent market monitor is not a judge and does not make rulings

Background

Package Clock Auction

Package clock auction: Overview

- A package bid is an all-or-nothing bid for a portfolio of products
- When bidding on individual lots, a bidder is exposed to the risk of winning only some of a complementary set of products
- Package bidding eliminates the exposure problem by allowing bidders to bid on packages of products
- At the same time, package bidding can help to alleviate the demand reduction problem in which larger bidders inefficiently reduce demand in order to win spectrum at lower prices

Package clock auction: Overview

- Auctioneer names prices; bidder names package
 - Price increased if there is excess demand
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- Supplementary bids
 - Improve clock bids
 - Bid on other relevant packages
- Optimization to determine assignment/prices
- No exposure problem (package auction)
- Second pricing to encourage truthful bidding
- Activity rule to promote price discovery

Package clock auction adopted for several recent and upcoming auctions

- UK 10-40GHz spectrum
 - February 2008, 27 rounds, £16 million
- UK L-band spectrum
 - May 2008, 33 rounds, £8.3 million
- UK 800MHz and 2.6GHz
 - First-quarter 2012
- Netherlands 2.6GHz spectrum
- Belgium 2.6GHz spectrum
- Austria 2.6GHz spectrum

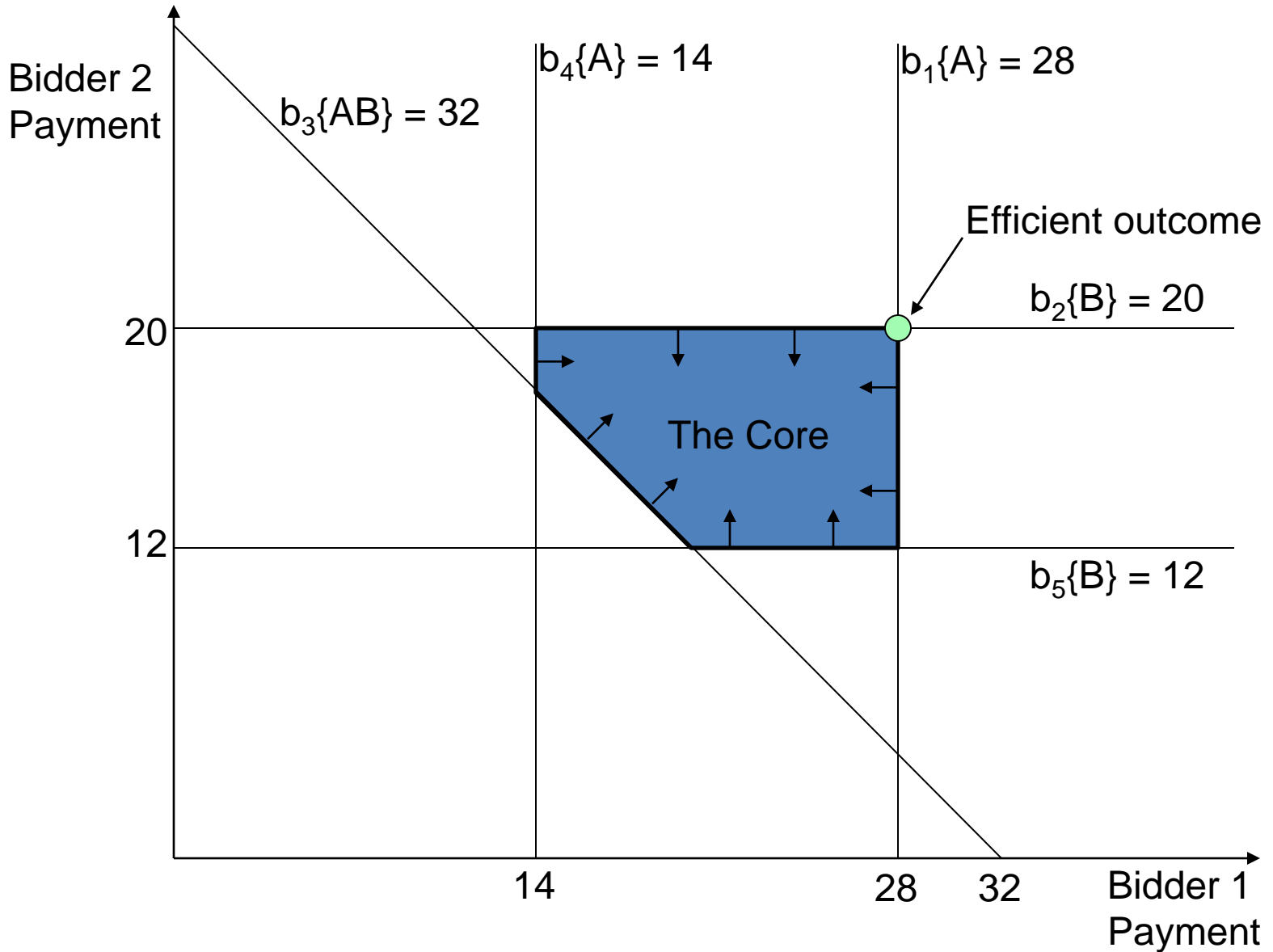
Bidder-optimal core pricing

- Minimize payments subject to core constraints
- Core = assignment and payments such that
 - Efficient: Value maximizing assignment
 - Unblocked: No subset of bidders offered seller a better deal

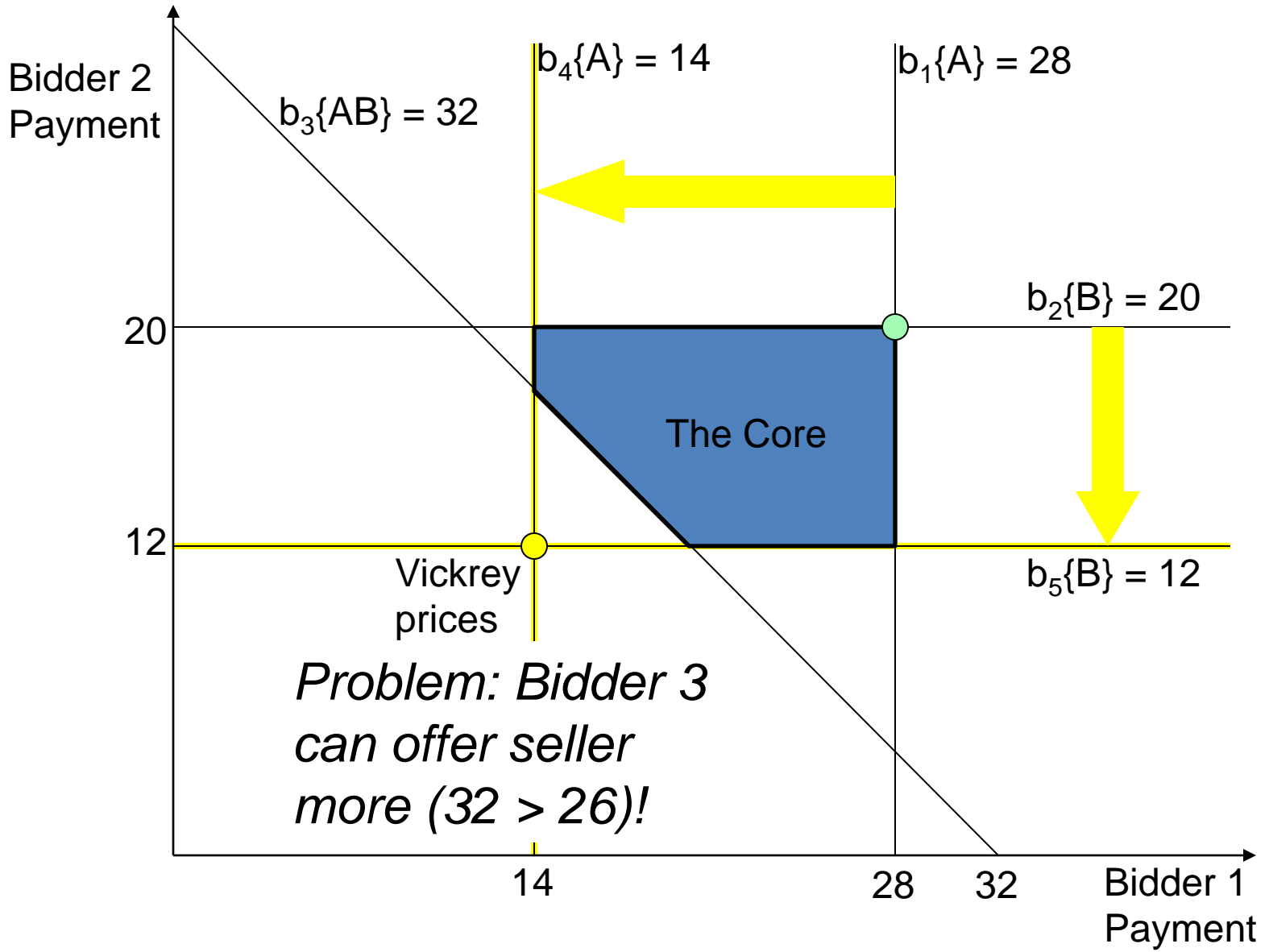
Five-bidder example with bids on {A,B}

- $b_1\{A\} = 28$
 - $b_2\{B\} = 20$
 - $b_3\{AB\} = 32$ Vickrey prices:
 - $b_4\{A\} = 14$ $p_1 = 14$
 - $b_5\{B\} = 12$ $p_2 = 12$
- Winners
-

The Core

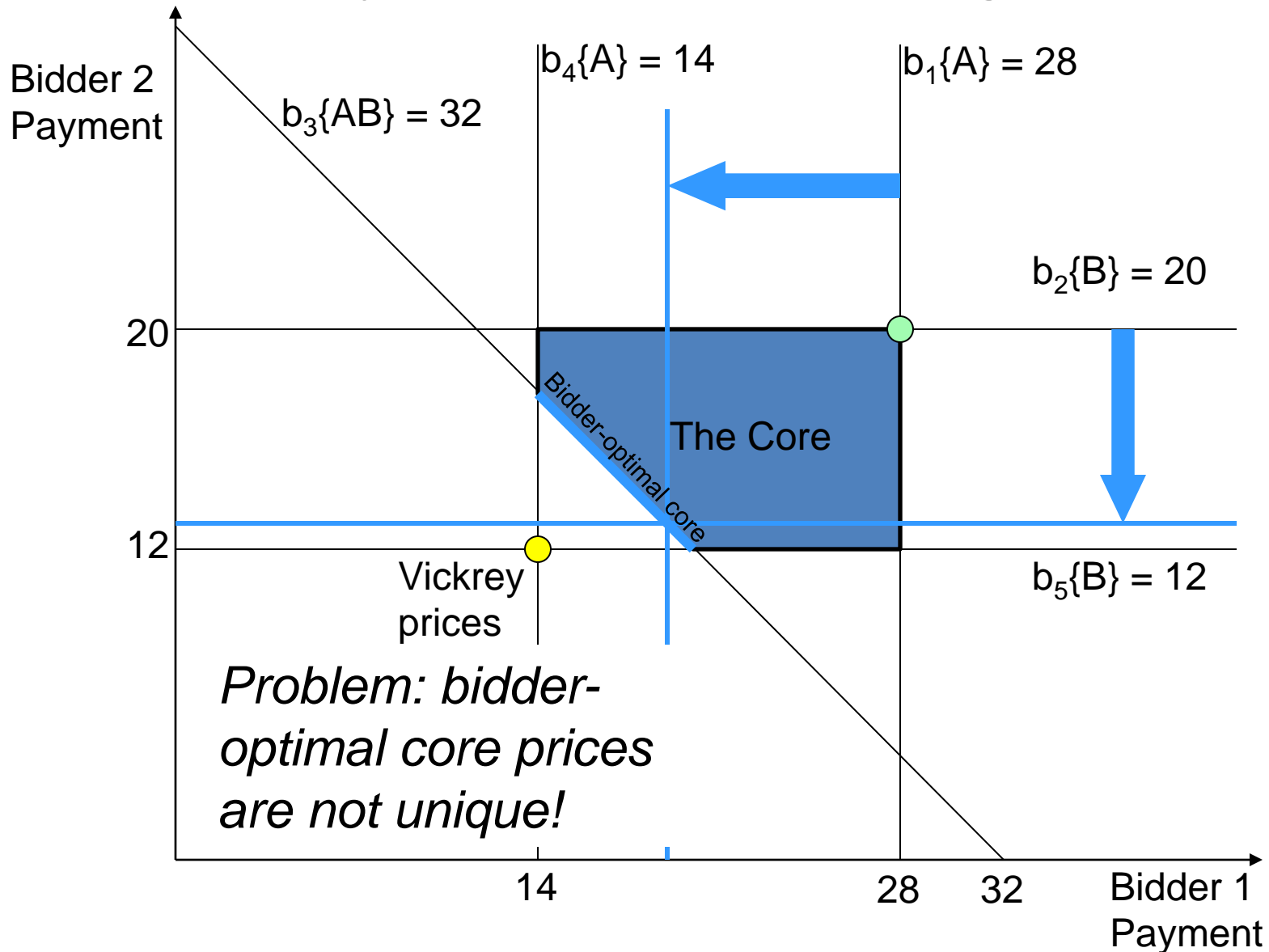


Vickrey prices: How much can each winner's bid be reduced (while holding others fixed)?

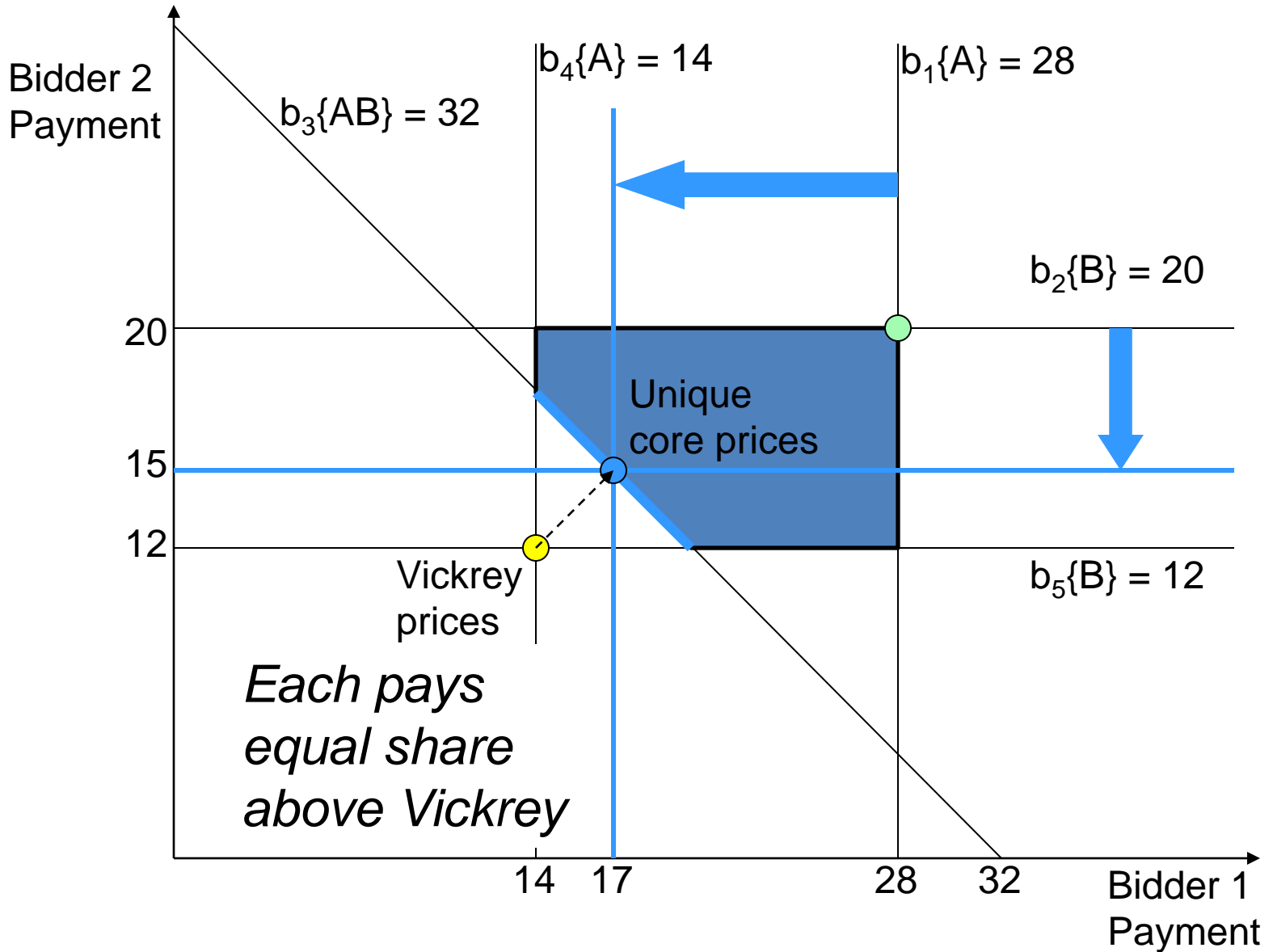


Problem: Bidder 3 can offer seller more ($32 > 26$)!

Bidder-optimal core prices: *Jointly* reduce winning bids as much as possible (while remaining within core)



Core point closest to Vickrey prices (Alternative: core point closest to linear prices)



Package clock auctions: Activity rule

- Activity rule based on revealed preference:
Bidders can only move toward packages that become better values
 - At time $t' > t$, package $q_{t'}$ has become relatively cheaper than q_t
(P') $q_{t'} \cdot (p_{t'} - p_t) \leq q_t \cdot (p_{t'} - p_t)$
 - Supplementary bid $b(q)$ must be less profitable than revised package bid at t
(S') $b(q) \leq b(q_t) + (q - q_t) \cdot p_t$

Properties with substitutes

- Bidding on most profitable package is best
- Clock yields competitive equilibrium with efficient assignment and supporting prices
- Final assignment = clock assignment

Properties in general

- Supplementary bids needed if excess supply
- Bidder can guarantee winning its final package by raising bid by final price of unsold lots