# Frictions in Markets and Other Institutions

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# A Prima Aprilis call for introducing friction

…excessive ease in transactions can generate costs, known in the jargon as a *facile externality*

The Economist, April 1, 2017


Was this only a Prima Aprilis joke?

# Frictions

- Physical world:
  - The force resisting the relative motion of objects
- Socio-economic world
  - Everything that prevents markets from being perfectly competitive
  - "Cost" of engaging in one expressive behavior rather than another, and of moving among different types of behavior (D. McGowan, 2003)
  - All kinds of impediments to human interactions and relationships

$\Rightarrow$ All frictions are hindrances and should be removed or reduced … *shouldn't they*?

# Good frictions

- Frictions are viewed in commerce as detrimental
- But, in other areas they are positive:
  - Child proofing
  - Suicide reduction
  - Road accident prevention
  - Theft prevention
  - *not to mentions shoes, car breaks, etc.*


# The costs of frictions

No market is frictionles:

- Information useful in transactions is neither free nor effortlessly available.
- Change of suppliers or move from one market to another incurs effort and costs.

Costs of frictions in the US were $630 billion in labour market (Korus, 2015) and roughly 40% of $2.5 trillion in health care expenses (Smith, 2011)

Unemployment may occur because of frictions rather than because supply exceeds demand (Mortensen and Pissarides, 1999).

# Removing frictions in commerce

- The goal of frictionless commerce, also known as contextual commerce, is for any customer to buy a product or service when and where they wish with as few clicks or other steps as possible (Rouse, 2015)
- The Internet -- a nearly perfect market: information is instantaneous and buyers can compare the offerings of sellers worldwide; fierce price competition, dwindling product differentiation, and vanishing brand loyalty (Kuttner, 1998)

**One click, free delivery**

**Zero clicks, free deliver**

# … frictions with frictions

Frictions in online commerce:

- **Inefficient prices: price dispersion is pervasive and** significant (up to 30%) (Baye, 2006)
- Low levels of cross-brand competition (Herrer, 2016)
- Reputation and price stickiness (Tadelis, 2016)
- Search friction and seller heterogeneity (Fradkin, 2014)
- Product heterogeneity

**Can online auction mechanism be the answer?**

# Agenda

1. Rationality and learning
2. Premises
3. Standard model
4. Experiments
5. Inefficiencies
6. Learning through negotiations

# Rationality and learning

- Economists admit that people and organizations do not adhere to the rationality principle
  - Behavioral economics (Thaler, 2016)
  - Utility augmentation (Bolton, 2000; Fehr, 1999)
- Effects of learning during the transaction
  - E.g., trust building reduces costs of future transaction (Bromiley, 1989)
  - Can trust and other socio-economic traits acquired during transactions affect these transactions?

# Learning

- Standard micro-economic models do not account for learning that takes place when the transaction participants interact.
- Auctions – the most efficient exchange mechanisms
  - Make learning impossible
  - Effectively reduce social welfare (mechanism allocative efficiency)

The argument: learning not only may result in an increase of future social capital but it may have direct and immediate positive effect on transaction outcomes.

# Premises

Market efficiency can be increased when frictions to transactions that involve configurable and made-to-order products and services are added.

1. Friction reduction in market transactions through auctions has its hidden costs.
2. Transactions are efficient only under the assumption that is not realistic in many markets of the modern economy.
3. The efficiency loss can be regained through the introduction of frictions.

# Efficient transaction mechanism

Online auctions (Kalagnanam, 2004; Krishna, 2009)

1. Allocative efficient – maximize social welfare
2. Outcome – an efficient solution
3. Auction owner's utility - maximized

Given the above:

If the auction owner is the buyer and the sellers are the producers, then online auctions create a perfectly competitive market (almost).

- Efficient price; equal to marginal cost
- Efficient use of resources

# A standard model

$I = \{1, \ldots, n\}$ – seller index set, $b$ denotes the buyer;
$\mathbf{x} = [x_1, \ldots, x_m]$ – vector of the good's attributes, $\mathbf{x} \in X$, X – feasible set

$u_i(\mathbf{x})$ – $i$'s utility ($\mathbf{x} \in X$; $i = 1, \ldots, n$): $u_i(\mathbf{x}) = x_1 - v_i(\mathbf{x}_{-1})$

where $x_1$ is numeraire (typically price) and $\mathbf{x}_{-1}$ is the vector of all non-price attributes; $\mathbf{x} = [x_1, \mathbf{x}_{-1}]$ and $v_i(\mathbf{x}_{-1})$ is strictly convex (twice differentiable with $v_i' > 0$; $v_i'' \geq 0$)

Similarly, buyer's $b$ utility is defined by

$u_b(\mathbf{x}) = v_b(\mathbf{x}_{-1}) - x_1$

where $v_b(\mathbf{x}_{-1})$ is strictly concave (twice differentiable with $v_b' > 0$; $v_b'' < 0$, and bounded from above)

# Reverse auction model

**Auction mechanism is efficient, if $\mathbf{x}^*$** ($\mathbf{x}^* \in$X) maximizes social welfare, i.e.,

$$\sum_{i\ I} u_{\mathrm{i}}(\boldsymbol{x}^*) = \max_{x \in \mathrm{X}} \sum_{i\ I} u_i(\boldsymbol{x}).$$

The winning bid, tuple ($i^*$, $\mathbf{x}^*$) is the solution of the following problem:

$$(i^*, \boldsymbol{x}^*) = \arg\max_{i\ I,\ \boldsymbol{x}\ X} \big(u_b(\boldsymbol{x}) + u_i(\boldsymbol{x})\big).$$

And, the maximum social welfare $U(b, I)$ from transaction involving buyer *b* and *n* sellers is:

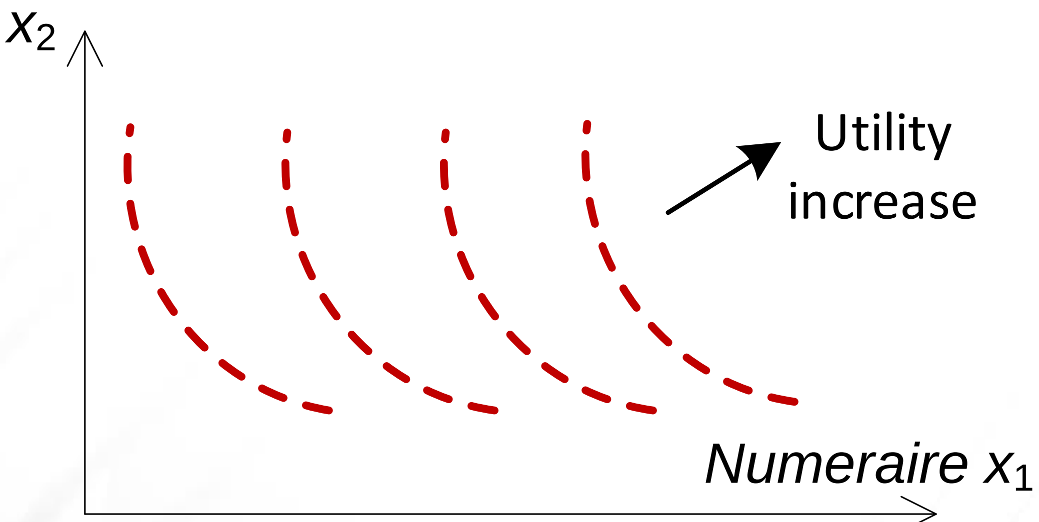
$$U(b, I) = \max_{x \in \mathrm{X}} \big(u_b(\boldsymbol{x}) + u_i(\boldsymbol{x})\big) = v_b(\boldsymbol{x}^*_{-1}) - \ v_{i*}(\boldsymbol{x}^*_{-1}).$$

# Efficient auction mechanism

Theorem: Auction mechanism is efficient iff one of these condition is met:

- $U_i(\mathbf{x})$ is linear and $U_{s+1}(\mathbf{x})$ – quasi-linear,
- $U_i(\mathbf{x})$ is quasi-linear and $U_{s+1}(\mathbf{x})$ – linear,
- $U_i(\mathbf{x})$ and $U_{s+1}(\mathbf{x})$ are quasi-linear

and the numeraire is price.

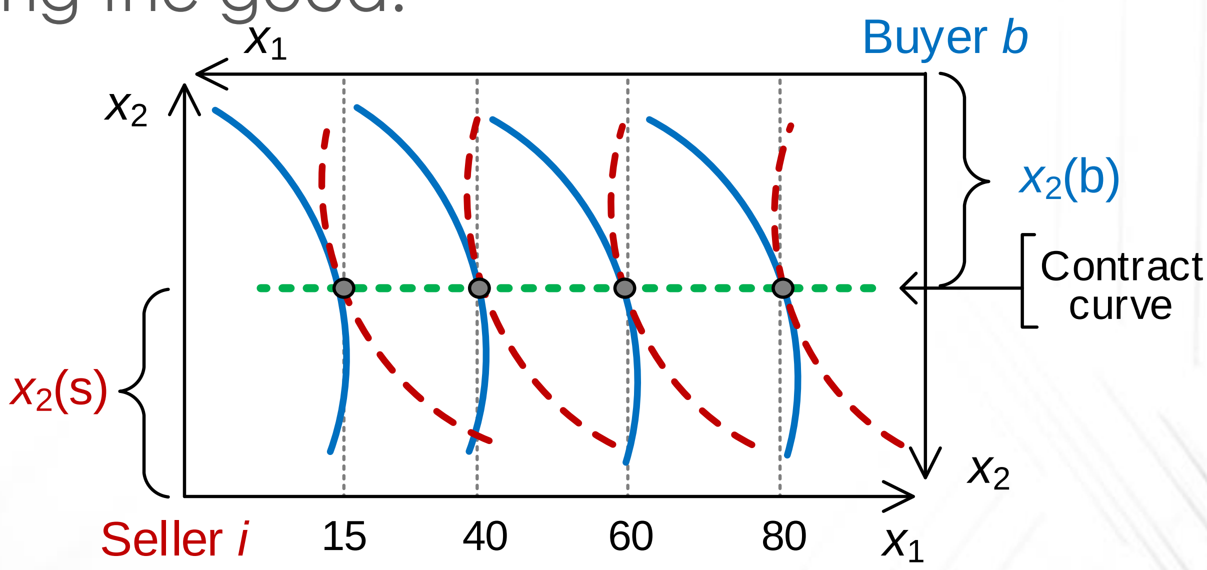



Indifference curves

# Efficient good configuration

Because $(\partial u(\mathbf{x})/\partial x_1 = 1$ we get that buyer's *b* valuation of good $\mathbf{x}_{-1}$ does not depend on the money which she has to pay.

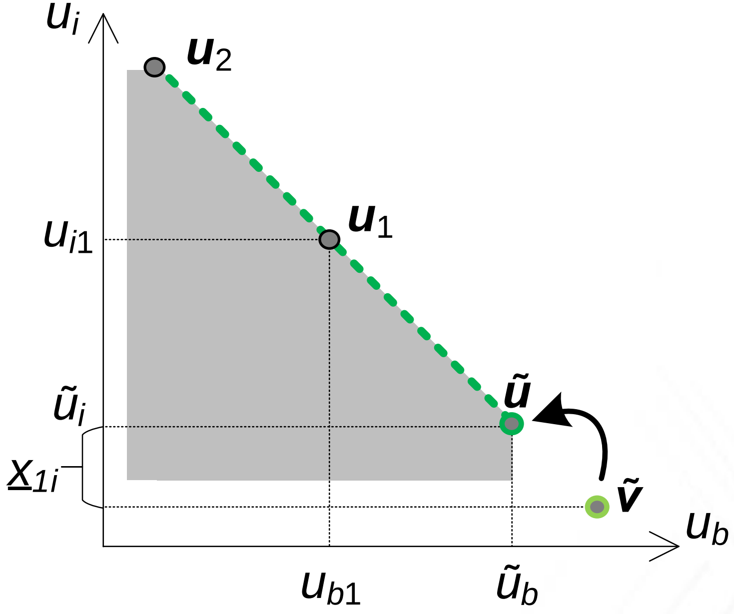
Similarly, seller's *i* ($i \in I$) valuation (costs) does not depend on the money he receives upon selling the good.




Edgeworth box

# Efficient frontier and social welfare

Efficient frontier in the utility space for pair (*b*, *i*) is an interval with slope -1. This reflects the *win-lose situation* in which one participant's gain is the loss for the other participant and the gain equals loss and vice versa.



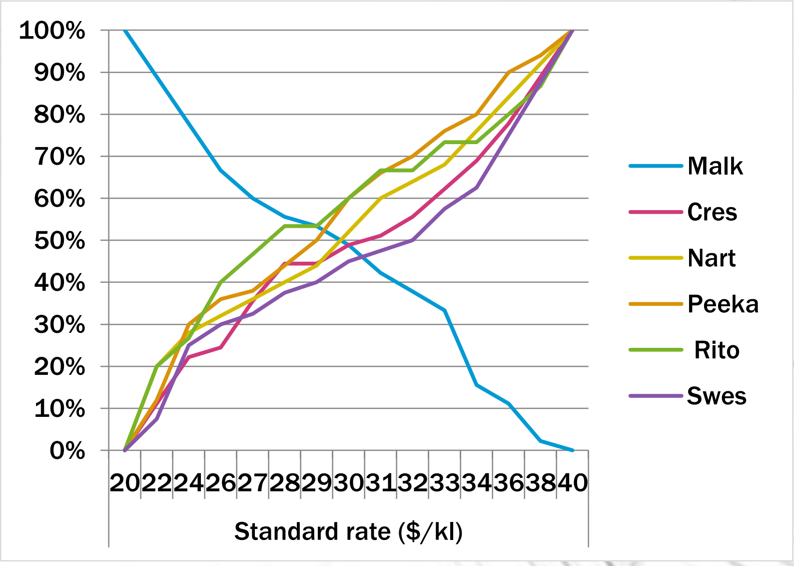

$$u_{s+1}(\widehat{\boldsymbol{x}}) + u_{i^*}(\widehat{\boldsymbol{x}}) = v_{s+1}(\widehat{\boldsymbol{x}}_{-1}) - \hat{x}_1 + \hat{x}_1 + v_{i^*}(\widehat{\boldsymbol{x}}_{-1})$$

# Experiments: Utilities

Can the allocative efficiency, solution efficiency, and owner optimality be experimentally verified?

- Online auctions and negotiations
- Business case: based on a real-life contract negotiations; three issue
- Piece-wise convex/conc utilities (i =1, 2, 3)

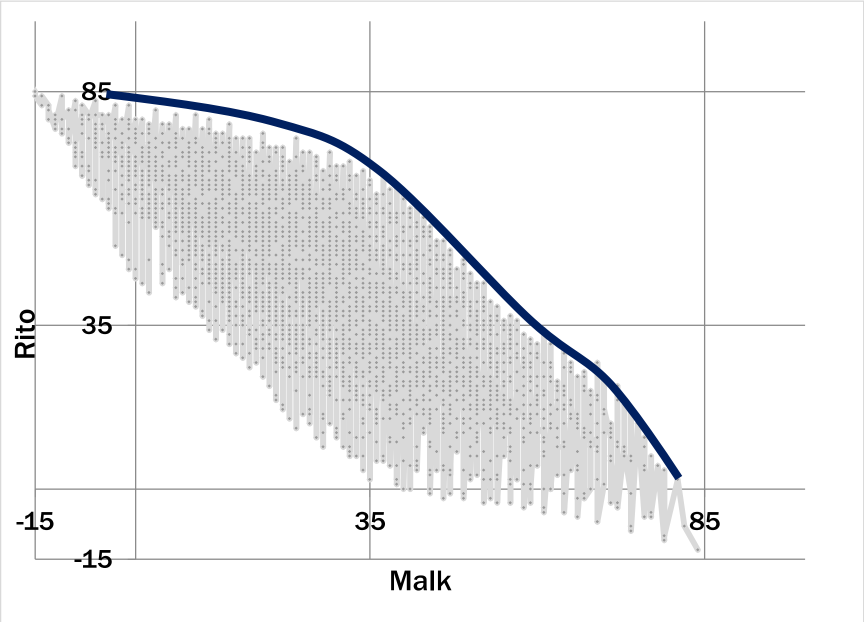
$$u_s(\boldsymbol{x}) = \sum f_{sj}(x_1).$$



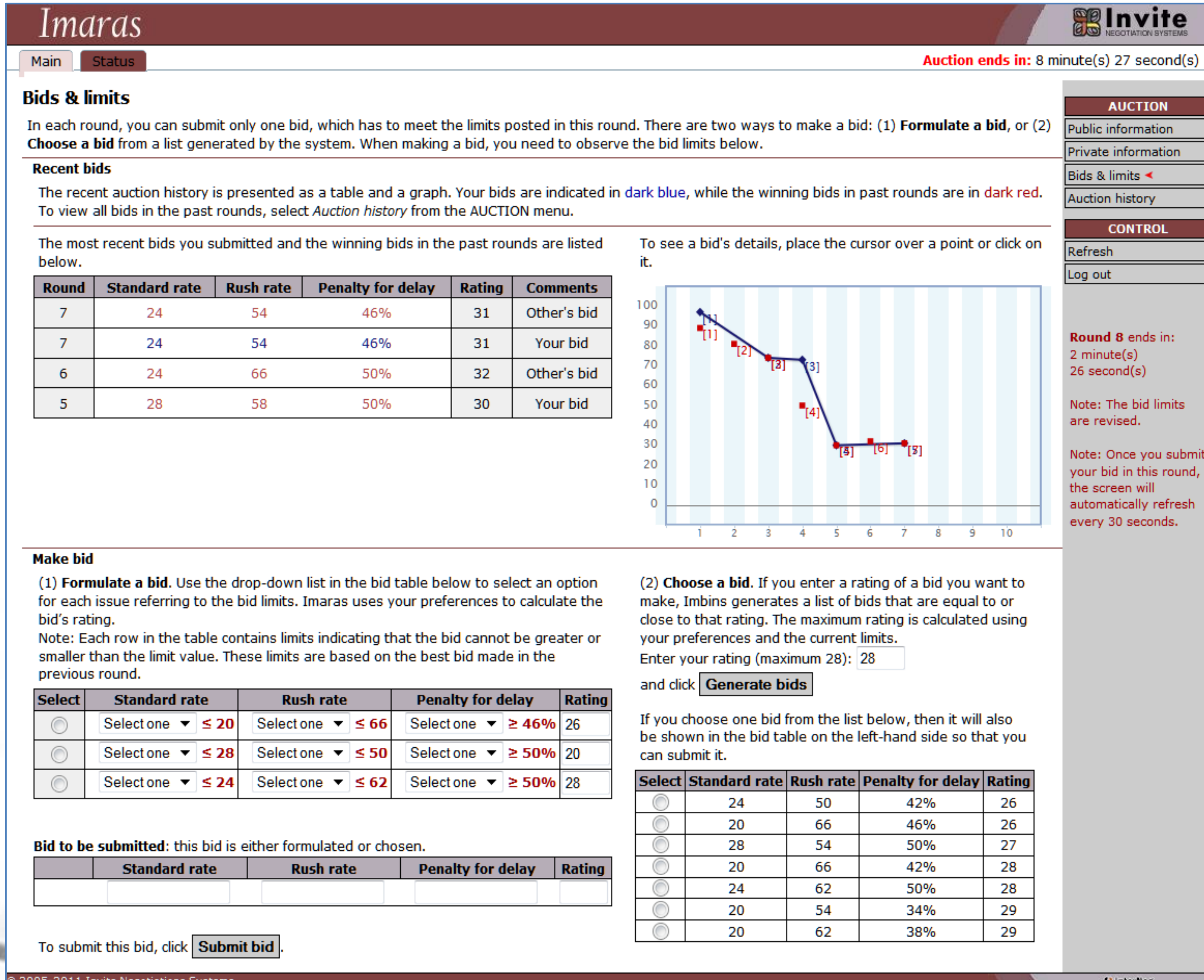
# Experiments: Case

Feasible set: convex

Efficient frontier: concave



# Imaras auction system



Imaras | Invite NEGOTIATION SYSTEMS

Main | Status

**Auction ends in:** 8 minute(s) 27 second(s)

## Bids & limits

In each round, you can submit only one bid, which has to meet the limits posted in this round. There are two ways to make a bid: (1) **Formulate a bid**, or (2) **Choose a bid** from a list generated by the system. When making a bid, you need to observe the bid limits below.

**Recent bids**

The recent auction history is presented as a table and a graph. Your bids are indicated in dark blue, while the winning bids in past rounds are in dark red. To view all bids in the past rounds, select *Auction history* from the AUCTION menu.

The most recent bids you submitted and the winning bids in the past rounds are listed below.

| Round | Standard rate | Rush rate | Penalty for delay | Rating | Comments |
|---|---|---|---|---|---|
| 7 | 24 | 54 | 46% | 31 | Other's bid |
| 7 | 24 | 54 | 46% | 31 | Your bid |
| 6 | 24 | 66 | 50% | 32 | Other's bid |
| 5 | 28 | 58 | 50% | 30 | Your bid |

To see a bid's details, place the cursor over a point or click on it.



**Make bid**

(1) **Formulate a bid**. Use the drop-down list in the bid table below to select an option for each issue referring to the bid limits. Imaras uses your preferences to calculate the bid's rating.
Note: Each row in the table contains limits indicating that the bid cannot be greater or smaller than the limit value. These limits are based on the best bid made in the previous round.

| Select | Standard rate | Rush rate | Penalty for delay | Rating |
|---|---|---|---|---|
| ○ | Select one ≤ 20 | Select one ≤ 66 | Select one ≥ 46% | 26 |
| ○ | Select one ≤ 28 | Select one ≤ 50 | Select one ≥ 50% | 20 |
| ○ | Select one ≤ 24 | Select one ≤ 62 | Select one ≥ 50% | 28 |

**Bid to be submitted**: this bid is either formulated or chosen.

| | Standard rate | Rush rate | Penalty for delay | Rating |
|---|---|---|---|---|
| | | | | |

To submit this bid, click **Submit bid**.

(2) **Choose a bid**. If you enter a rating of a bid you want to make, Imbins generates a list of bids that are equal to or close to that rating. The maximum rating is calculated using your preferences and the current limits.
Enter your rating (maximum 28): 28
and click **Generate bids**

If you choose one bid from the list below, then it will also be shown in the bid table on the left-hand side so that you can submit it.

| Select | Standard rate | Rush rate | Penalty for delay | Rating |
|---|---|---|---|---|
| ○ | 24 | 50 | 42% | 26 |
| ○ | 20 | 66 | 46% | 26 |
| ○ | 28 | 54 | 50% | 27 |
| ○ | 20 | 66 | 42% | 28 |
| ○ | 24 | 62 | 50% | 28 |
| ○ | 20 | 54 | 34% | 29 |
| ○ | 20 | 62 | 38% | 29 |

**AUCTION**
- Public information
- Private information
- Bids & limits
- Auction history

**CONTROL**
- Refresh
- Log out

**Round 8** ends in:
2 minute(s)
26 second(s)

Note: The bid limits are revised.

Note: Once you submit your bid in this round, the screen will automatically refresh every 30 seconds.

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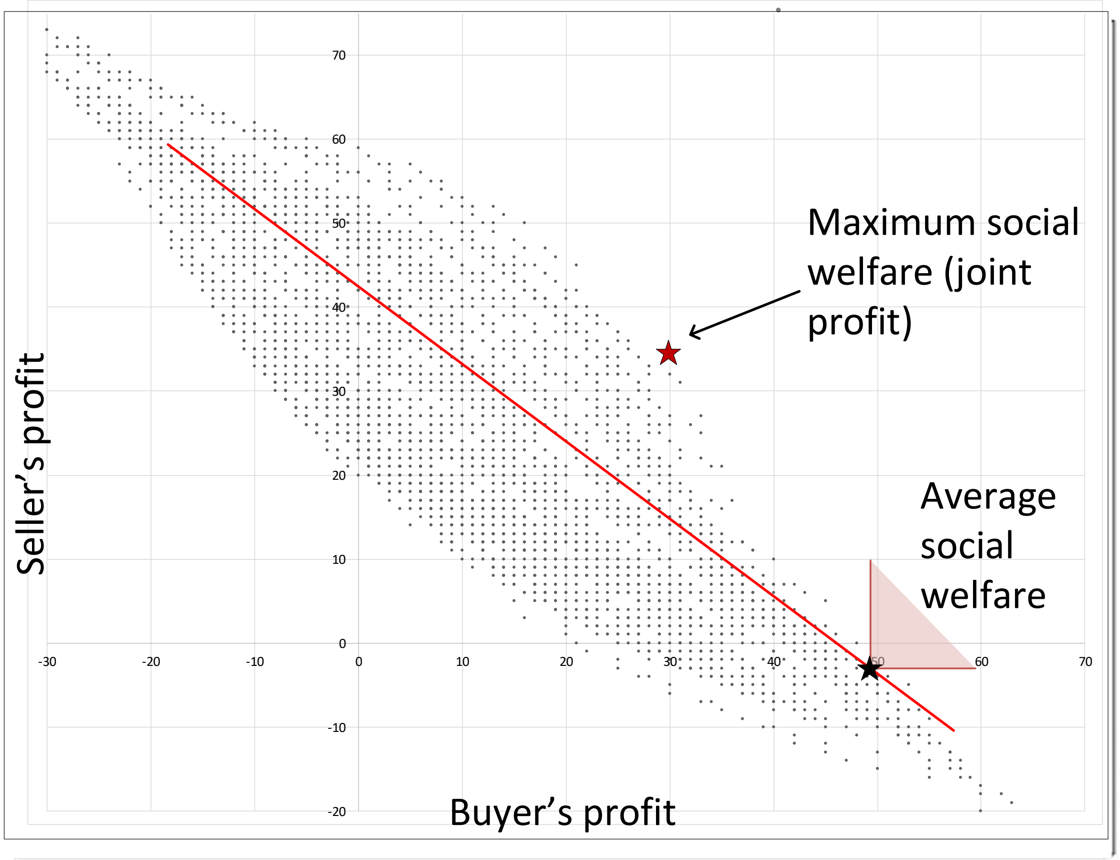
InterNeg

# Results

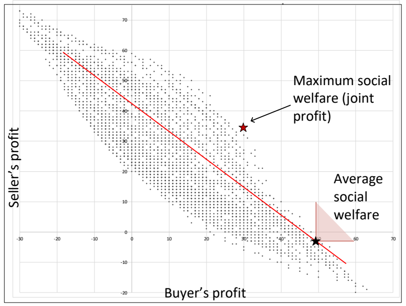
| | MARA | V-MBN | N-MBN |
|---|---|---|---|
| Agreement % | 100 | 100 | 100 |
| - Buyer's offer accepted (%) | — | 30 (71) | 24 (61) |
| - Seller's offer accepted (%) | 38 (100) | 12 (29) | 15 (39) |
| **Profits** | | | |
| - Buyers' profit (avg.) | $45.9^{*}$ | $20.8^{*,*}$ | $28.8^{*,*}$ |
| - Sellers' profit (avg.) | $-7.2^{*}$ | $18.8^{*\wedge}$ | $11.9^{*\wedge}$ |
| Solution inefficiency | | | |
| - Avg. distance ($L_1$) to efficient frontier | $0.74^{*}$ | $8.38^{*}$ | $7.32^{*}$ |
| - Avg. no. of dominating alternatives | $3.5^{*}$ | $81.5^{*,*}$ | $38.1^{*,*}$ |
| Mechanism allocative efficiency | | | |
| - Social welfare (avg. joint profit) | 38.7 | 39.6 | 39.7 |
| - Buyer/Seller profit ratio (%) | 39.5 | 40.3 | 40.2 |

# Experiments




Efficient frontier: Concave or linear with slope = -1 ?

# Results




Contrary to theory (Krishna, 2009), the experiments show that the auctions:

1. *do not* maximize the auction owner's utility
2. *do not* result in efficient winning bids
3. *are not* allocative efficient

The first two points are likely due to the participants' behavioral traits but allocative efficiency seems to conflict with the owner's utility maximization.

# Inefficiency

If the efficient frontier is concave or piece-wise concave, then the auction mechanism can maximize social welfare only when the following cost condition is added:

$\forall i \in I \; v_i(\mathbf{x}_{-1}) \geq v_i^*$,

where $v_i^*$: $(v_i^*, v_b^*) = \max_{\mathbf{x} \in X} (v_b(\mathbf{x}_{-1}) - v_i(\mathbf{x}_{-1}))$ , $i \in I$.

This condition is artificial and would make economy inefficient.

Theorem: If the condition is not met and the efficient frontier is continuous and concave, then the efficient winning bid can either maximize the buyer's surplus or be allocative efficient but not both.

# Configurations

Modern economy – production automation, mass customization, and significant role of services; capable of configuring and reconfiguring products during the transaction process.

In the past, inflexible production processes and the marginal role of services in the past, required that goods be produced well before transactions.

⇨This difference means that while in the past, costs were known prior to transactions, today they are determined during transactions and they affect price.

But, quasi-linear utilities cannot model such economy because they allow that every seller has only one efficient configuration and the configurations are price independent

# Comments on quasi-linear utilities

Bergstrom and Varian (1985): "it is not in general possible to model a well-behaved exchange economy as a transferable game".

Luce and Raiffa (1957): situations in which quasi-linear utilities "can realistically happen remains obscure".

Ausubel and Milgrom (2006) : "requires that there is no effective budget limit to constrain the bidders and that the buyer, in procurement auction, does not have any overall limit on its costs of procurement. Although we have no data on how frequently these assumptions are satisfied, it appears that failures may be common in practice."

# Linear & Cobb-Douglas utilities

- Lewis and Bajari (2011) analyzed over 1300 contracts awarded by the California Department of Transportation (Caltrans) between 2003 and 2008 and showed that two-attribute auctions (*p*, *t*) are 20% more efficient than the price-only auctions.
- They represented the buyer's utility as a linear function of the form

$$u_b = v_b(t) - p = M - at - p$$

where *p* – price; *t* – time

# Cobb-Douglas utility

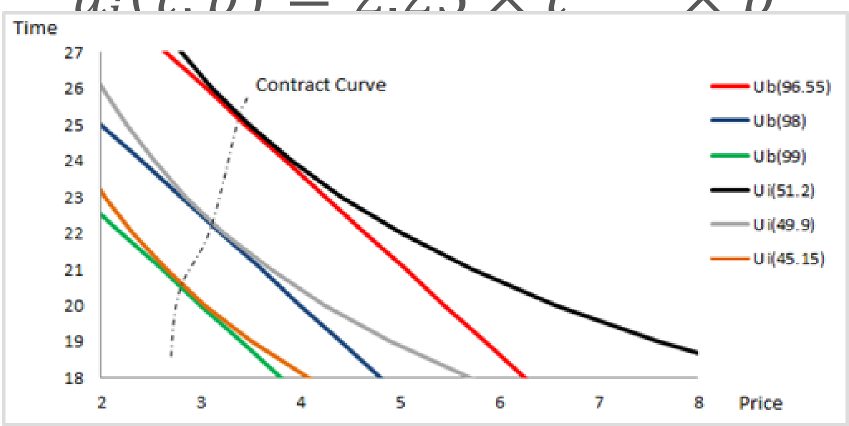
Example. Bridge construction: *p* – price; *t* – time.

Buyer's *b* utility is:

$$u_b = v_b(t) - p = 110 - 0.4t - p$$

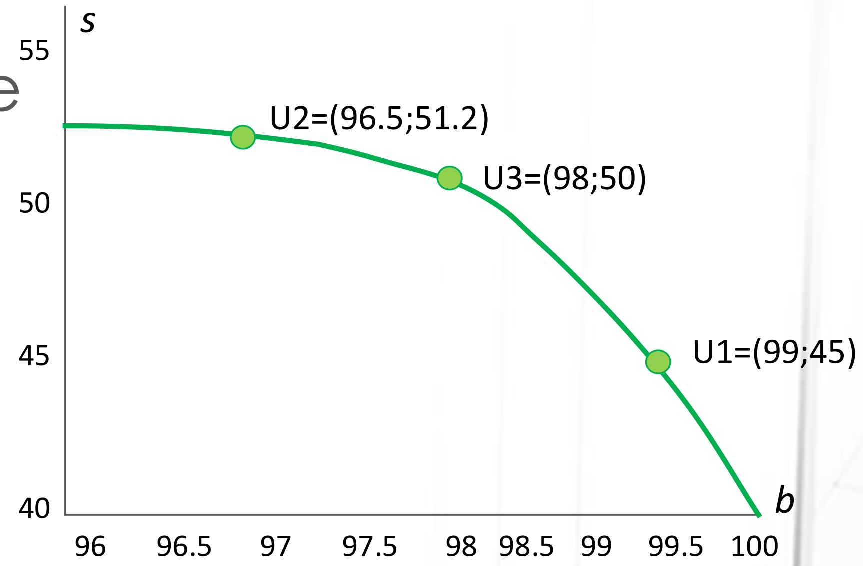
Contractor's *i* (*i*∈ *I*) utility is a Cobb-Douglas function with equal elasticity and increasing returns to scale
(*α* + *β* > 1):

$$u_i(t, p) = 2.25 \times t^{0.85} \times p^{0.3}$$



# Cobb-Douglas Economy

- Different points yield different social welfare
- If the winning bid is:
  U1 = (99; 45)
  then social welfare is 144
- It can be improved if the buyer accepts:
  U3=(98; 50)
  with social welfare of 158.



# Linear utilities

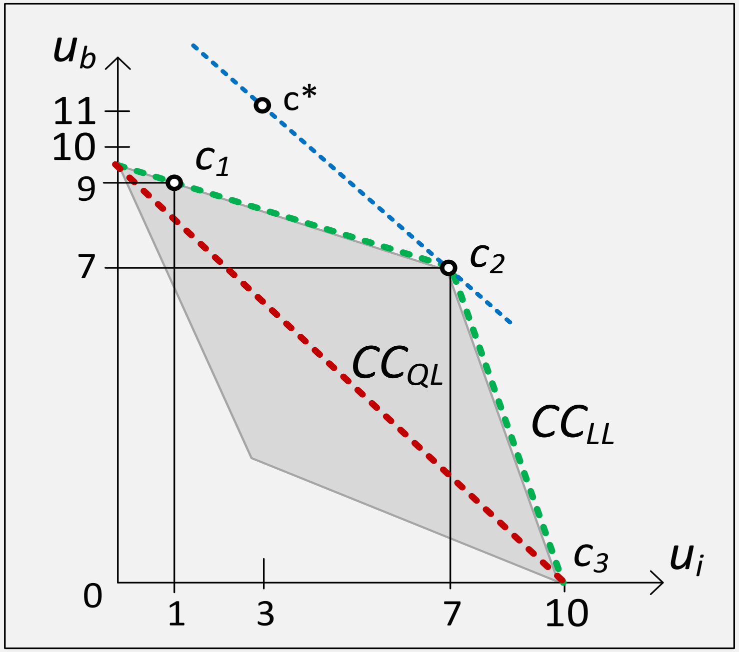
Example: A city (*b*) seeks a contractor to build a bridge.

$u_b(p, t) = 14 – 0.7\ p – 0.3\ t$

Contractor's *i* utility is

$u_i(p, t) = 0.3\ p + 0.7\ t$

where $1 \leq p \leq 10; 0 \leq t \leq 1$

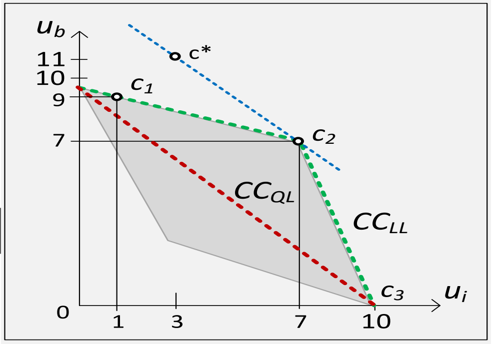



Feasible set and efficient frontier in utility space

# Linear utilities

If $i$ wins the auction and $p$ = 1; $t$ = 1
and $u_b(1, 1) = 9$; $u_i(1, 1) = 1$.

The winning bid's social welfare is 1



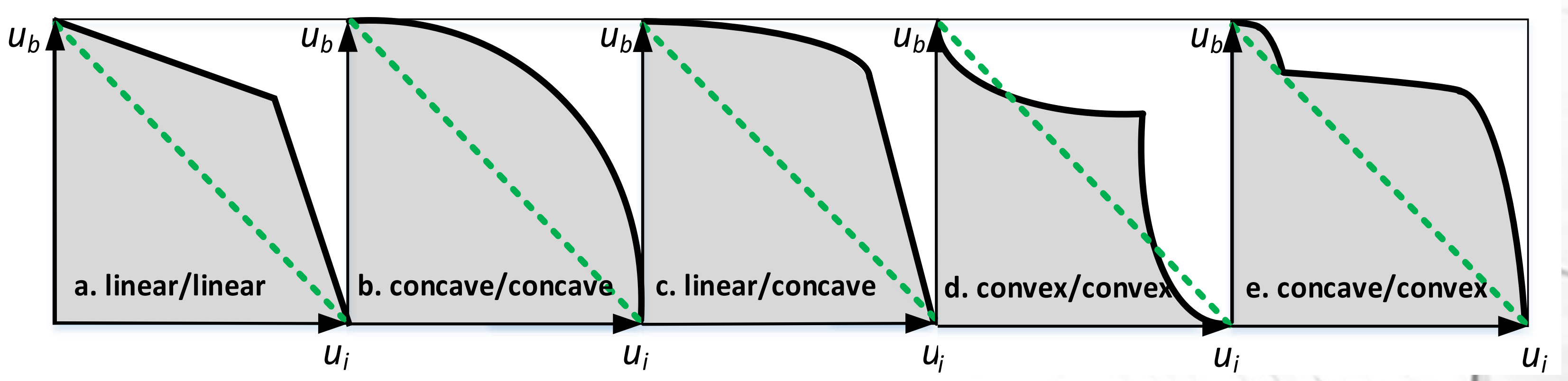

Another efficient alternative is $c_2$ = [7, 7], its social welfare is 14 and higher than the one obtained from $c_1$.

⇨ Alternative $c_2$ is allocative efficient but it does not maximize the buyer's utility.

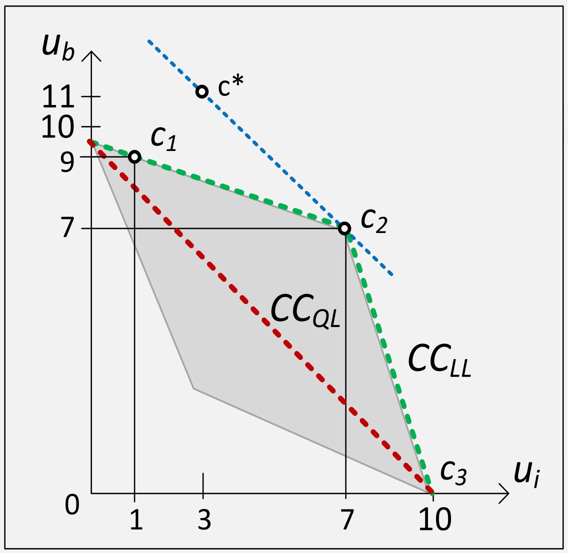
# Utilities and efficient frontier

If the efficient frontier is continuous and concave, then the efficient winning bid can:

- either maximize the buyer's surplus or
- be allocative efficient but not both



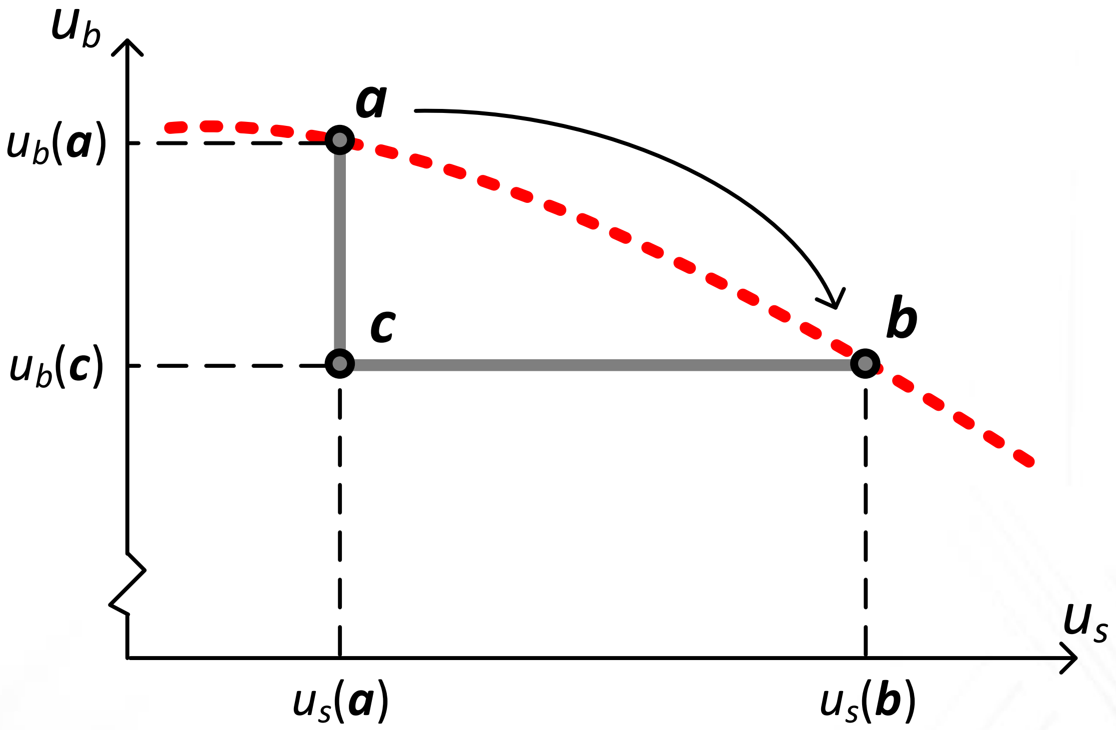
# Improving efficient solutio




- Alternative $c_2$ = (7; 7) causes loss of 2 utils for the City and gain of 6 utils for the contractor of. But, the City may not accept such a lo
- The contractor may offset this loss by providing an additional service at a cost not greater than 6 and which value for the City is at least 2
- The revised offer, e.g., $(u_b, u_i) = (11;3)$ dominates the original winning bid $(u_b, u_{i*}) = (9; 1)$.
- Alternatively, the contractor may gain access to additional resources that will allow to modify the original problem so that c* is feasible and interval [c*, $c_2$] is (part of) the

# Improving efficient solutions

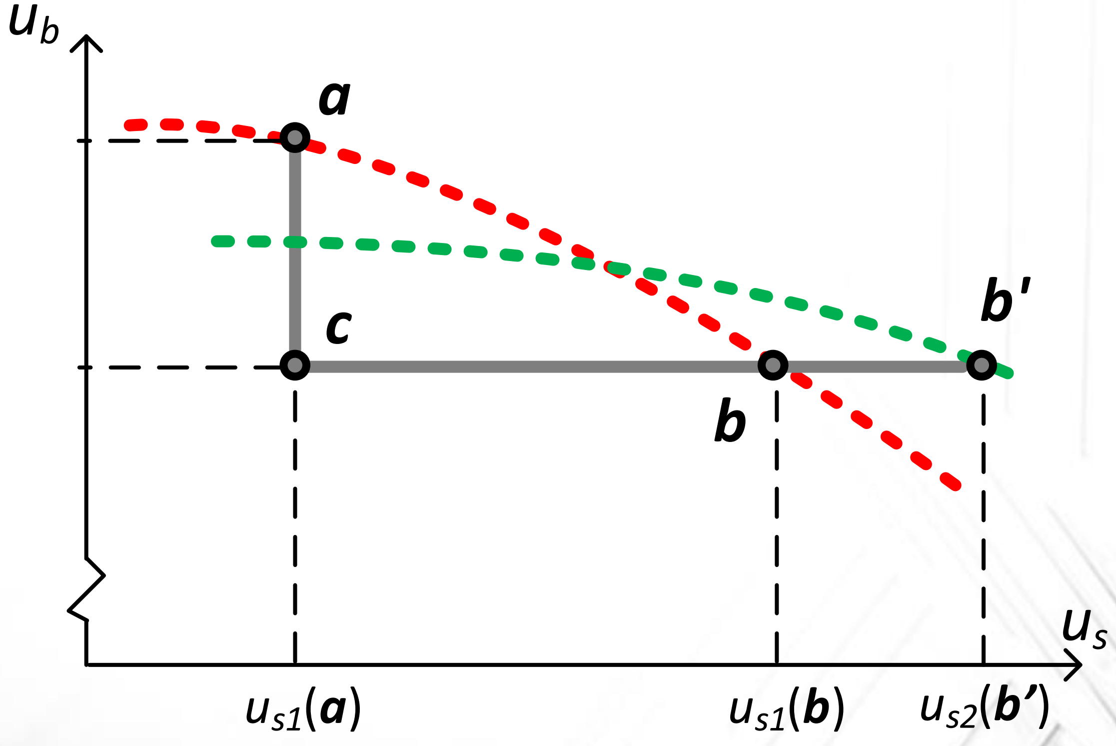
Concave efficient frontier and winning bid ***a*** and win-win contract ***b***



# Seller-determined multi-attribute auctions

The buyer may need to engage other than winning sellers.

Two sellers: *s1* and *s2*, winning bid ***a*** and win-win contract ***b'***



# Conclusion

When efficient frontiers are concave then the buyers may want to engage in post-auction multi-bilateral negotiations

The purpose of the negotiations is to seek joint improvements by either enlarging the feasible set or adding attributes (product features, additional services).

- ⇒ This revised mechanism requires learning, i.e., introduces friction but it can improve transaction outcomes for the participants and it  increases social capital

# Conclusion

Perhaps *The Economist's* article should not be seen as a prima aprilis joke because it is possible that *excessive ease in transactions generates costs* and *transaction efficiency may be improved when friction is introduced*.

Спасибо

Thank you