Towards Efficiency in Bilateral Trade: An Annotated Reading List

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This is an annotated reading list on research towards designing socially efficient mechanisms for bilateral trade and its generalizations.

Categories and Subject Descriptors: J.4 [**Computer Applications**]: Social and Behavioral Sciences—*Economics*

General Terms: Algorithms, Economics, Theory

Additional Key Words and Phrases: Approximation algorithms, bilateral trade, mechanism design

The classical Bayesian model is extremely widely adopted in the research on pricing and auction problems. In such a simple pricing setting, a buyer's value v on an item is drawn from a distribution F. The distribution F is publicly known but the realization v is only known to the buyer. A profit-maximizing seller with 0 cost for the item will choose to set a price p to optimize $p \cdot \Pr_{v\sim F}[v \geq p]$.

The 0-cost assumption does not hold in many situations. The seller might have a private value on the item just as the buyer does, and therefore will incur a cost if she sells it. In an alternative situation, the seller might need to pay a cost to produce the item before selling. Considering this and generalizing the pricing model naturally, we assume the seller also has a private cost c drawn from a public distribution G. F and G are typically assumed to be independent.

Myerson and Satterthwaite have a celebrated impossibility result in this setting: As long as F and G are continuous distributions with positive densities and they properly intersect, no truthful[1] mechanism can be socially efficient (i.e., always trading when $v > c$ and never trading when $v < c$).

In the face of this impossibility, many works have been dedicated to exploring what is possible. A common approach from Computer Science is to provide guaranteed approximations in the form of competitive analysis. Is it possible to get a good fraction of efficiency using truthful mechanisms? Can this be achieved via simple mechanisms? Are there other viewpoints to bypass this impossibility? Generalizations of bilateral trade such as double auctions and matching markets have also been extensively studied. In this annotated reading list, we introduce some papers on these topics as a starting point. Please note that many exciting and closely related papers are not included due to space constraints.

[1]Here, truthfulness refers to simultaneous satisfaction of Bayesian incentive compatibility, (interim) individual rationality, and (ex-ante weak) budget balance. The last condition means the mechanism itself should not lose money in expectation from subsidizing the agents.

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(1) Myerson, R. B. and Satterthwaite, M. A. 1983. Efficient Mechanisms for Bilateral Trading. *Journal of Economic Theory 29*, 2, 265–281.

This seminal paper lays the foundation of the bilateral trade model, characterizes truthful mechanisms, and states the textbook Myerson-Satterthwaite impossibility theorem. I recommend their paper to any reader interested in the topic.

(2) McAfee, R. P. 2008. The Gains from Trade Under Fixed Price Mechanisms. *Applied Economics Research Bulletin 1*, 1, 1–10.

This paper initiates the study of efficiency approximations of bilateral trade. McAfee shows that when the value distribution F has a higher median than the cost distribution G, a simple fixed-price mechanism can get half of the gains-from-trade (a natural measure of efficiency), compared with the first-best.

(3) Blumrosen, L. and Dobzinski, S. 2021. (Almost) Efficient Mechanisms for Bilateral Trading. *Games and Economic Behavior 130*, 369–383.

This paper extends the study of the approximate efficiency of fixed-price mechanisms. The measure of efficiency here is (mostly) the welfare, which mathematically equals to the gains-from-trade plus an instance-dependent constant and thus admits better approximation ratios.

(4) Brustle, J., Cai, Y., Wu, F., and Zhao, M. 2017. Approximating Gains from Trade in Two-sided Markets via Simple Mechanisms. In *Proceedings of the 2017 ACM Conference on Economics and Computation (EC)*, 589–590.

This paper provides constant-approximations to the second-best gains-from-trade using simple mechanisms. It is worth noting that such a result guides the research direction of finding an approximation to the first-best gains-from-trade, since considering the provided simple mechanisms is without loss of generality up to constants. This paper generalizes the duality framework in auction design to bilateral trade and more general two-sided market settings. For those familiar with or interested in the duality framework, this paper is especially recommended.

(5) Deng, Y., Mao, J., Sivan, B., and Wang, K. 2022. Approximately Efficient Bilateral Trade. In *Proceedings of the 54th ACM Symposium on Theory of Computing (STOC)*, 718–721.

This paper provides the first (unconditional) constant-approximation to the first-best gains-from-trade, resolving a frequently mentioned central open question in this area. The proof is quite short and can be an interesting read to a general audience.

(6) Fei, Y. 2022. Improved Approximation to First-Best Gains-from-Trade. In *Proceedings of the 18th Conference on Web and Internet Economics (WINE)*.

This paper improves the competitive ratio against the first-best gains-from-trade, for both the general setting and a specialized one, using clever methods of analysis. This paper is a good starting point for the future direction of optimizing competitive ratios in this setting.

(7) Babaioff, M., Cai, Y., Gonczarowski, Y. A., and Zhao, M. 2018. The Best of Both Worlds: Asymptotically Efficient Mechanisms with a Guarantee on the Expected Gains-From-Trade. In *Proceedings of the 2018 ACM conference on Economics and Computation (EC)*, 373.

This paper provides best-of-both-worlds gains-from-trade guarantees in two-sided markets. In general, best-of-both-worlds results aim to provide a solution satisfying multiple simpler properties simultaneously. For a reader interested in such results, this one is a good read in the context of (generalized) bilateral trade.

(8) Dütting, P., Fusco, F., Lazos, P., Leonardi, S., and Reiffenhäuser, R. 2021. Efficient Two-Sided Markets with Limited Information. In *Proceedings of the 53rd ACM Symposium on Theory of Computing (STOC)*, 1452–1465.

This paper shows that full knowledge of the value and cost distributions is not necessary for getting a good approximation to the first-best welfare for quite general two-sided markets – a single sample from each cost distribution suffices. Single-sample algorithms have been studied in auctions and prophet inequalities – this paper shows their power in (generalized) bilateral trade.

(9) Mao, J., Paes Leme, R., and Wang, K. 2022. Interactive Communication in Bilateral Trade. In *Proceedings of the 13th Innovations in Theoretical Computer Science (ITCS)*, 105:1–105:21.

Bayesian persuasion and information design in general is receiving increasing attention in the Economics and Computer Science communities. This paper considers Bayesian persuasion in bilateral trade and models the back-and-forth bargaining behavior in practice, bypassing the Myerson-Satterthwaite impossibility theorem. It is recommended to readers familiar with or interested in information design.