

## Introduction

- ▶ Much research shows that deterministic call markets (DCM) outperform continuous-time double auction markets (CDAs).
- ▶ We explore the extent to which adaptive call markets (ACMs) can “improve” the market over deterministic call markets.
- ▶ We consider market efficiency, spread and volume with the help of Agent-based modelling method and empirical game-theoretic analysis (EGTA).



## Parameters & Strategies

Parameter	$r$	$s_t$	$\bar{f}$	$\lambda_{i,t}$	$\theta$	$\beta$	
Value	0.8	$N(0, 100)$	500	$N(0, 400)$	$N(0, 50)$	0.2	
$\alpha_{\min}$	0	0	0	0	20	20	50
$\alpha_{\max}$	0	20	50	100	50	100	100

## Random Call Markets

- ▶ We compare the performance of CDAs, DCMs and Random Call Markets (RCMs) – where the length of clearing interval is generated from a distribution parameterised by a fixed length of time considering the thickness of the market, assigning 40, 80 and 160 agents to a thin market, a medium market and a thick market respectively.

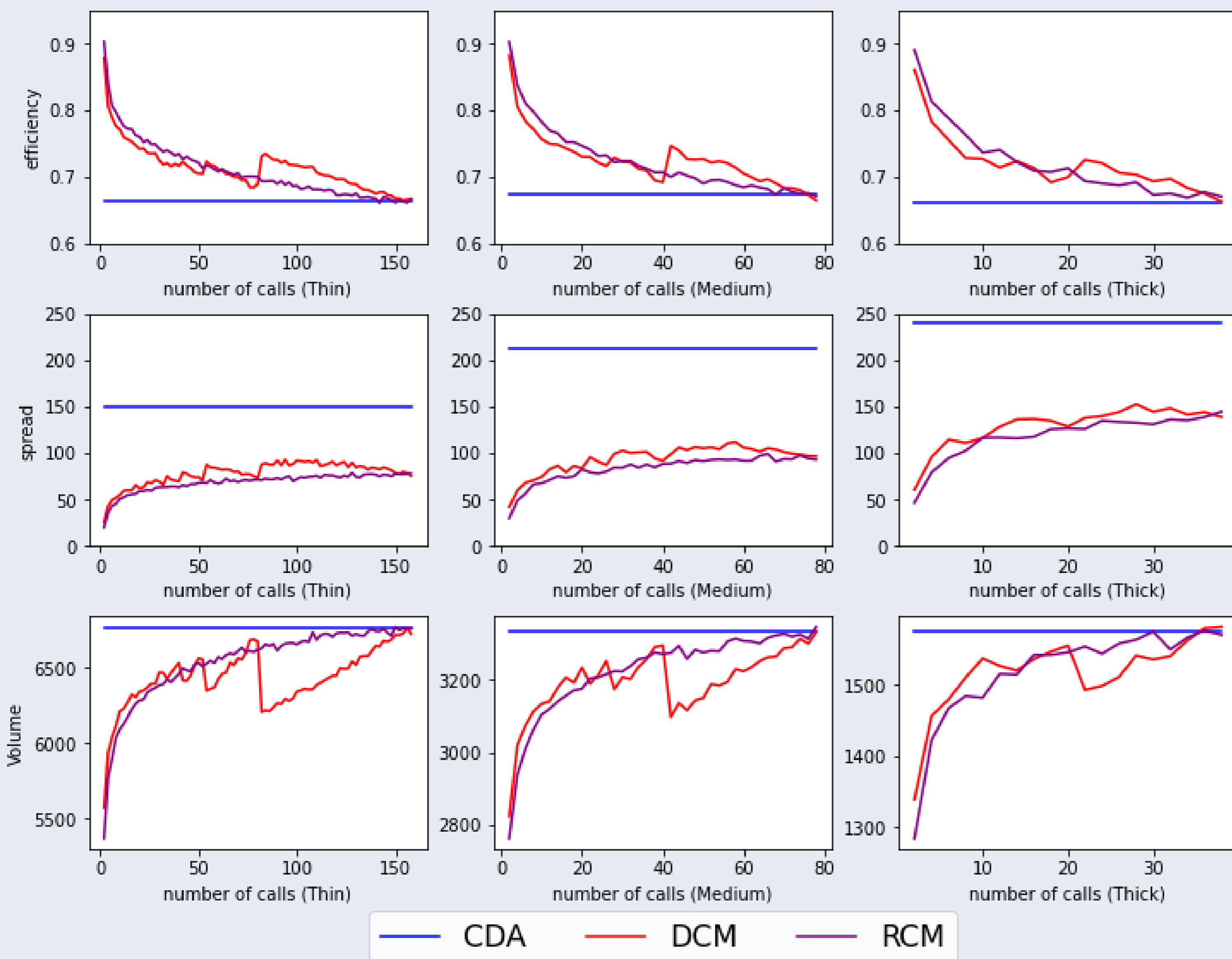


Figure 1: Market Measures: CDA vs DCM vs RCM

- ▶ The market performance depends only on the clearing frequency, whilst the generation of irregular clearing intervals is irrelevant.

## Volume-driven Adaptive Call Markets

- ▶ We consider two volume-based clearing rules. One (CVACM) tracks the aggregate volume during the clearing interval and clears when it reaches a threshold. The other one (EVACM) tracks the ratio between the cumulative volume of effective ask orders and bid orders
- ▶ We run experiments to test an extreme scenario where the cumulative bid order size is 100 times the cumulative ask order size. We set the extreme-volume threshold to be 20.

Table 1: Changes in Price in Extreme Scenarios

Type	DCM	RCM	CVACM	EVACM
Proportion of change	32%	35%	41%	21%

- ▶ Table 1 shows that EVACM is helpful in stopping “flash crashes” and vertical increasing, and in turn contributes to the stability of the market.

## Experiment Setup

- ▶ We introduce a mean-reverting stochastic process  $f_t$  to represent the true value at different times, defined as  $f_t = rf + (1 - r)f_{t-1} + s_t$
- ▶ The agent’s valuations is the sum of the common component:  $\lambda_{i,t} + f_t$  and the private component: a measurement of the personal valuation of holding a position through a vector  $\Theta_j$ .
- ▶ During each time interval  $[t, t + 1)$ , every agent has one opportunity to submit a limit order or take no action. Placing order strategy is the required surplus range  $[\alpha_{\min}, \alpha_{\max}]$ , where  $\alpha_{\min}$  is the minimum expected surplus and  $\alpha_{\max}$  is the maximum expectation. Each agent has entry rate  $\beta$  every time the fundamental value changes.

## Stability-driven Adaptive Call Markets

- ▶ Aiming at having a stable market, we analyse so called Stability-driven Adaptive Call Markets (SACMs).
  - ▶ Let  $M$  denote the mid-price right after the previous clearing and let  $M'$  be the virtual mid-price, updated as new orders are collected. A SACM with threshold  $d$  clears if  $\frac{|M - M'|}{M} \leq 100d$ , where  $d$  denotes the percentage of change in mid-price that we allow before we clear.
  - ▶ We set up seemingly large thresholds  $d$  in  $\{0.1, 0.2, 0.3\}$  since the price grid is sparse.
- Figure 2 shows that the market is able to maintain a high efficiency by controlling the stability level  $d$ .

## Exploration of Combined Termination Rules

- ▶ We take a first exploration of combined termination rules and examine the performance of RCMs with Extreme-Volume termination rule (RCM+EVACM). The experiment results are shown in Figure 2.

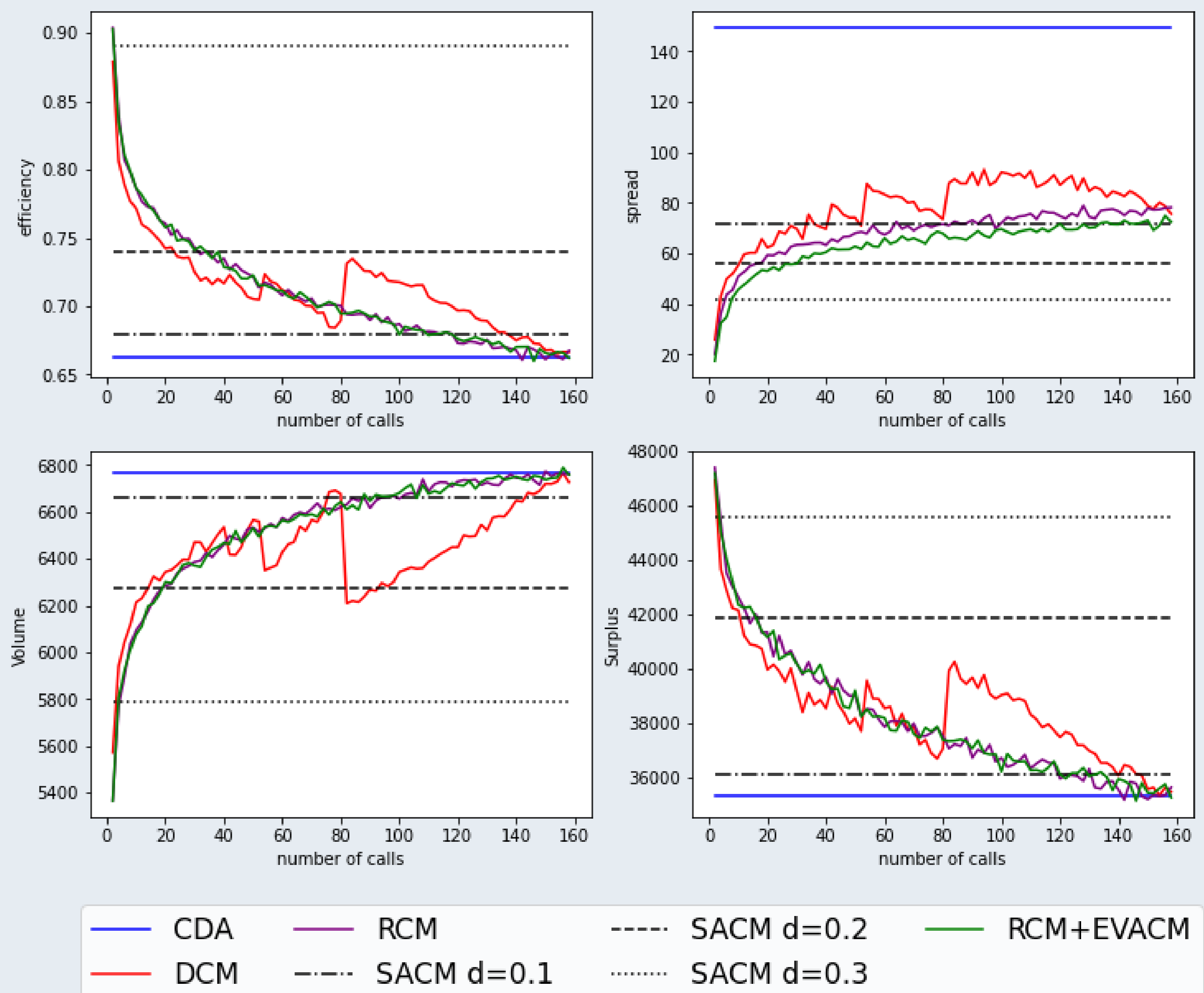


Figure 2: Market Measures: SACMs vs others

- ▶ We conclude that in most markets measures, RCM+EVACM performs similarly to RCM. However, in the aspect of market spread, there is a constant decrease from RCMs to RCM+EVACMs, showing that the additional EVACM helps to narrow down the spread.

## Conclusion

- ▶ ACMs with adaptive termination rules provide a balance between good market performance and acceptable price stability, and reduce the risk of sharp price movements.
- ▶ Flexibility is the key advantage of ACMs over other markets. Studying combinations of clearing rules needs further research.