

Liquidity saving mechanisms and bank behaviour

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Interbank payment systems

Real Time Gross Settlement (RTGS) mode

- Incentives to queue
- ‘Games’ being played on a liquidity/delay tradeoff

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Liquidity Saving Mechanisms (LSMs)

Aims

1. Model a system with internal queues (LMM)
2. Look at how much liquidity/delay a LSM reduces in theory
3. Look at how banks would use a LSM
 - An 'agent-based' model

Model of a payment system

- N banks
- A ‘day’ of several ‘seconds’
- Random payment *orders*
 - random pairs ‘payer&payee’
 - for each payment a ‘urgency’ parameter $u \sim U[0,1]$
- Each bank sends payment orders in either of two ‘pipes’ (streams): RTGS or Queue

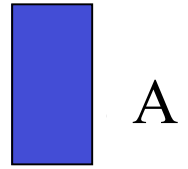
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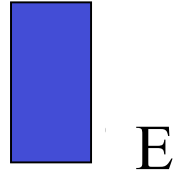
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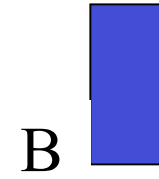
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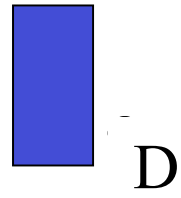
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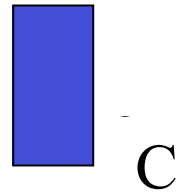
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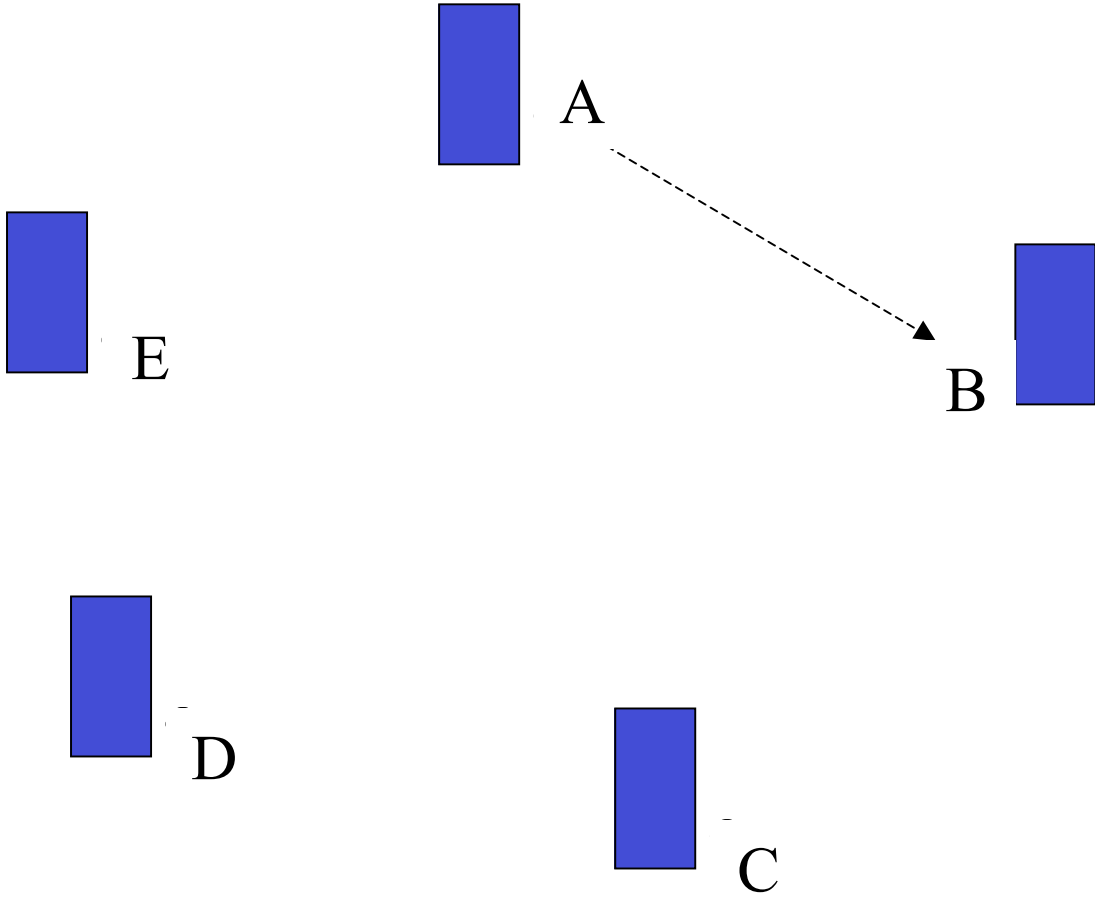
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D



C



Low urgency? RTGS



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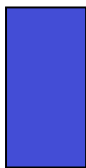
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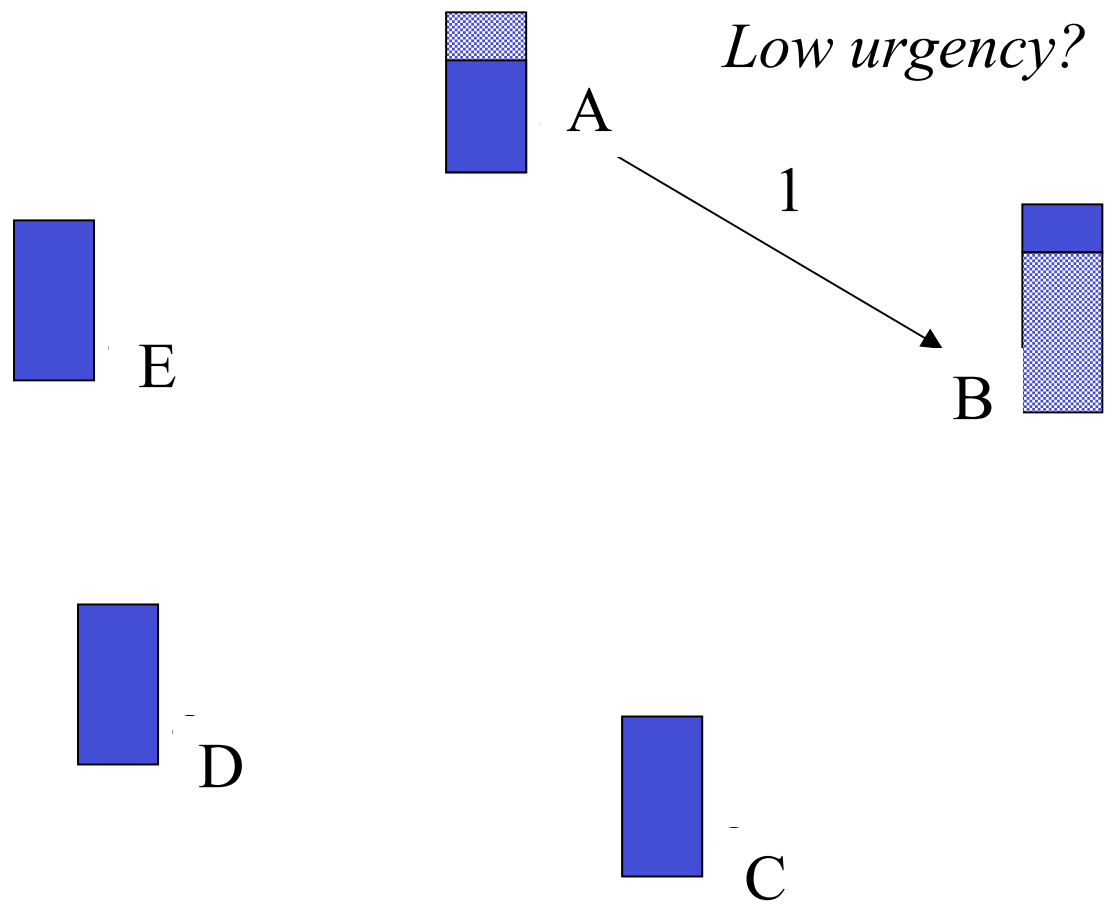


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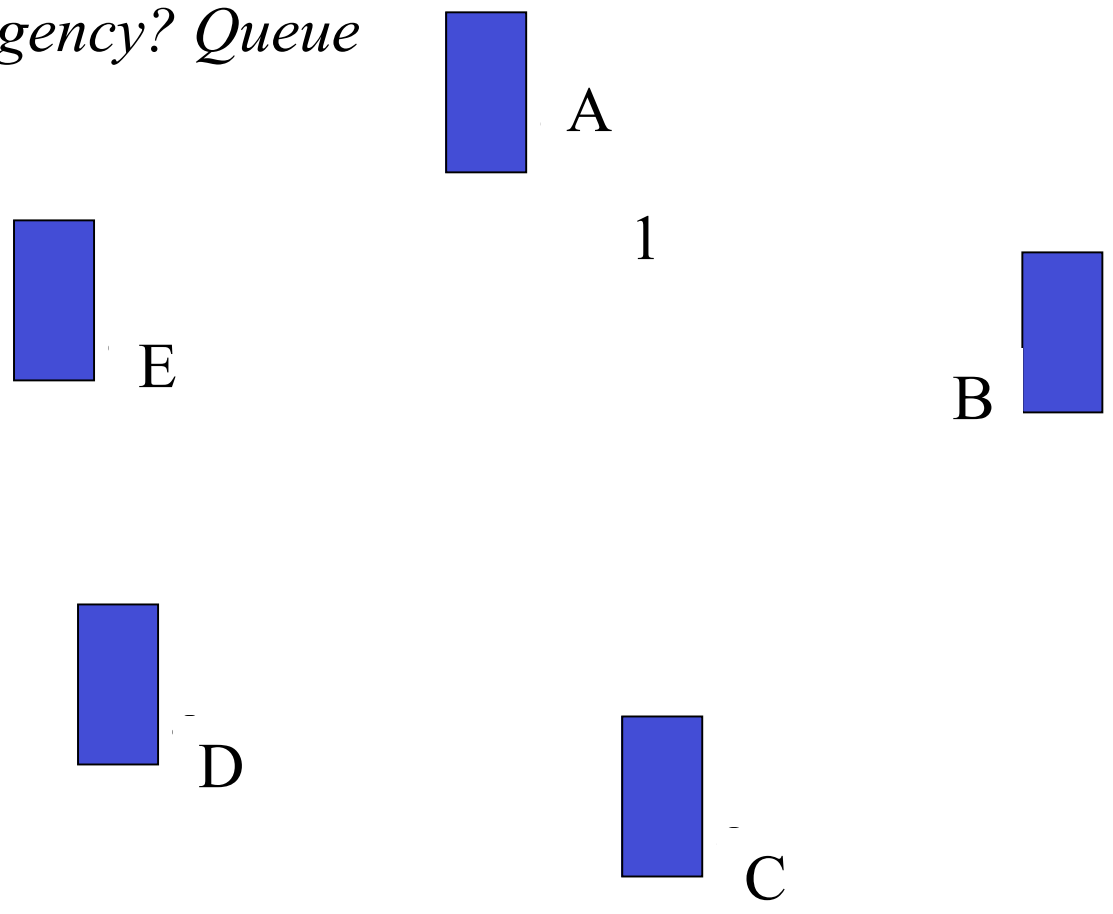


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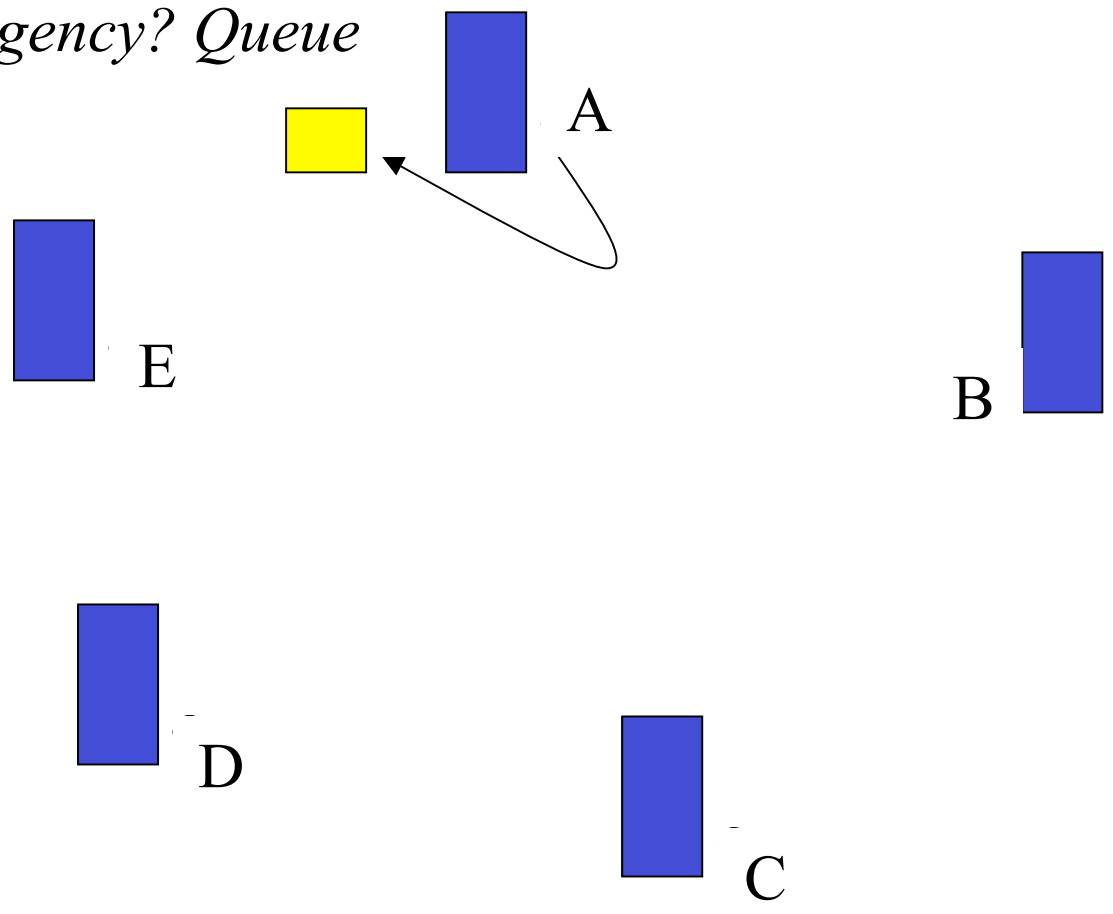
Low urgency? RTGS

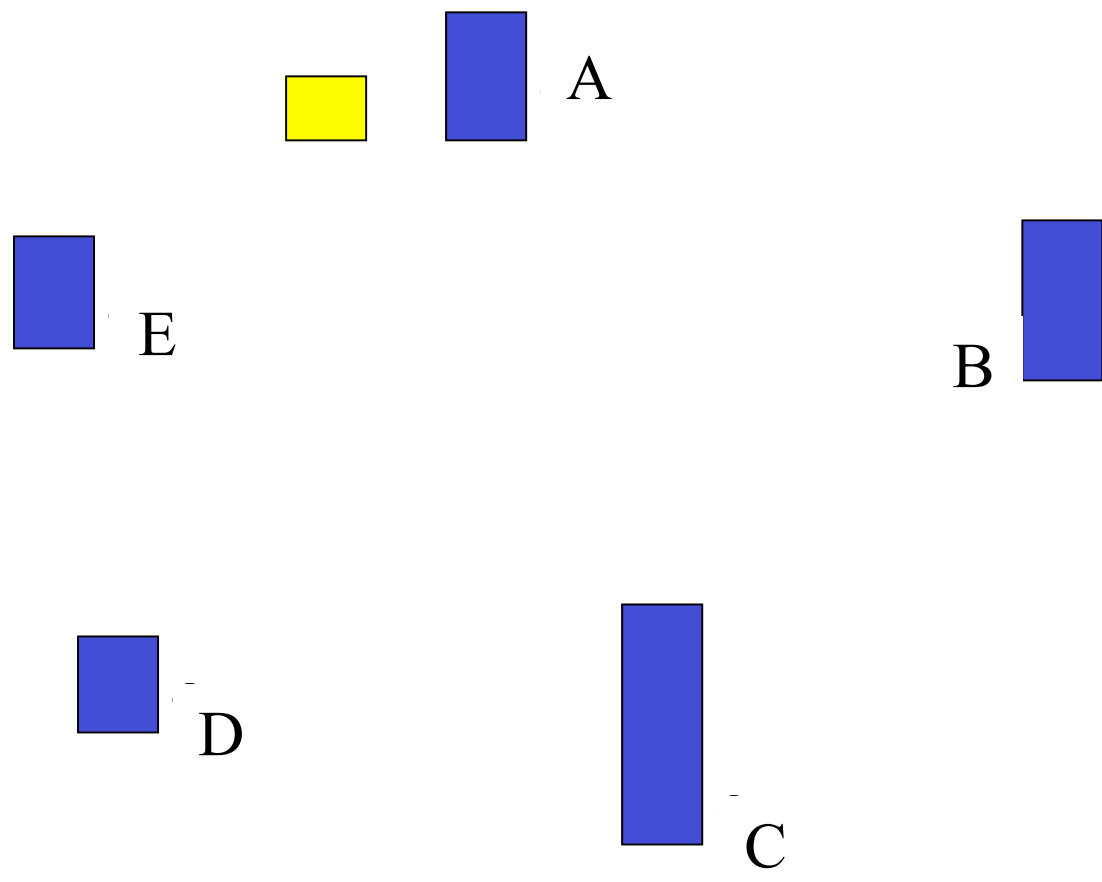


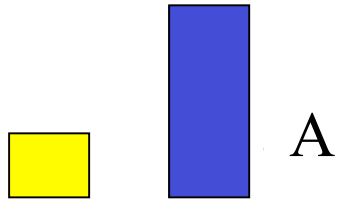
High urgency? Queue



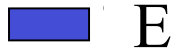
High urgency? Queue



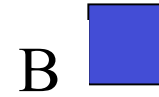




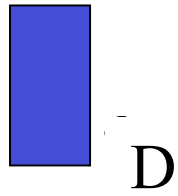
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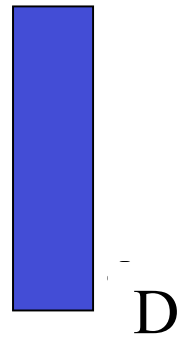
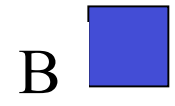
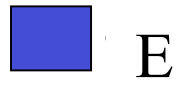
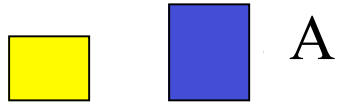
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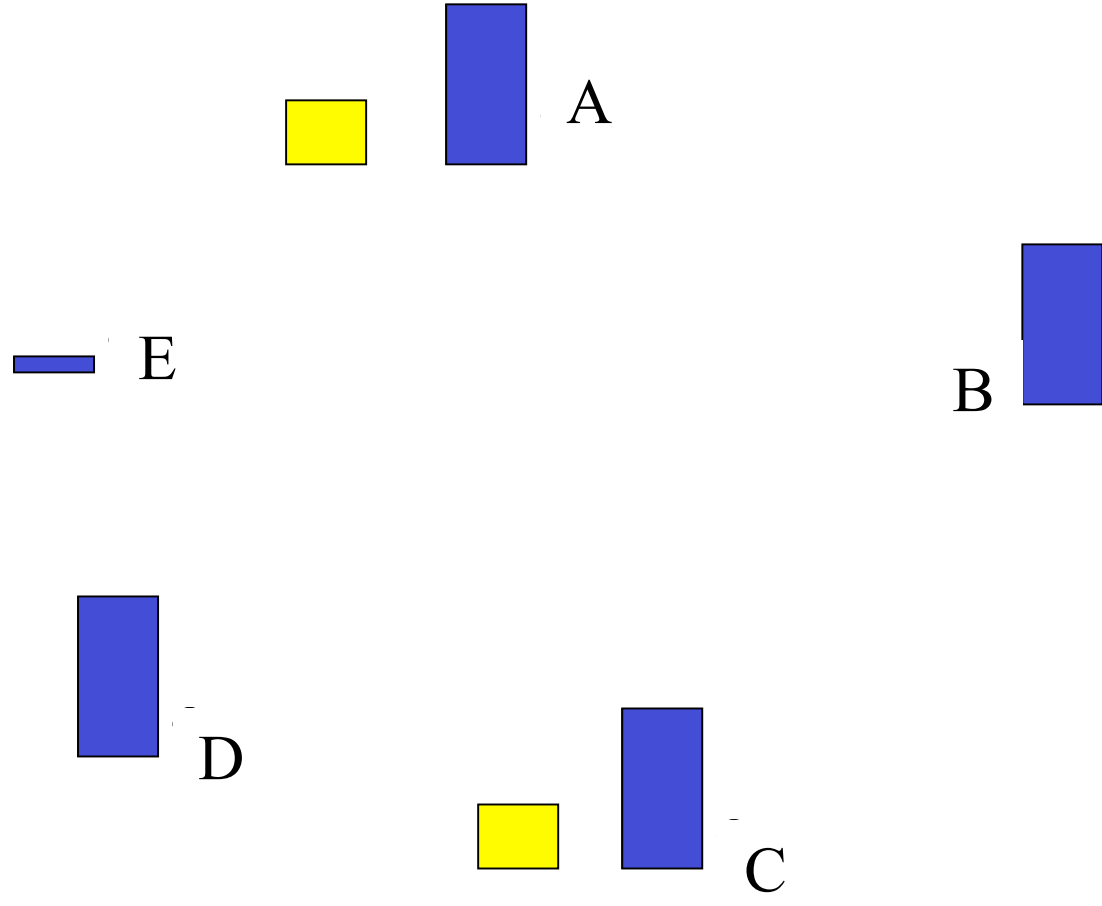


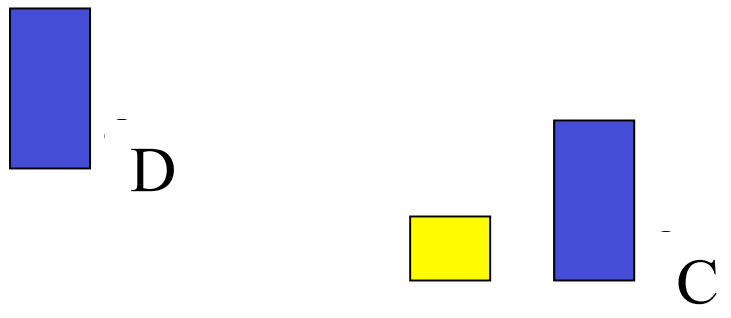
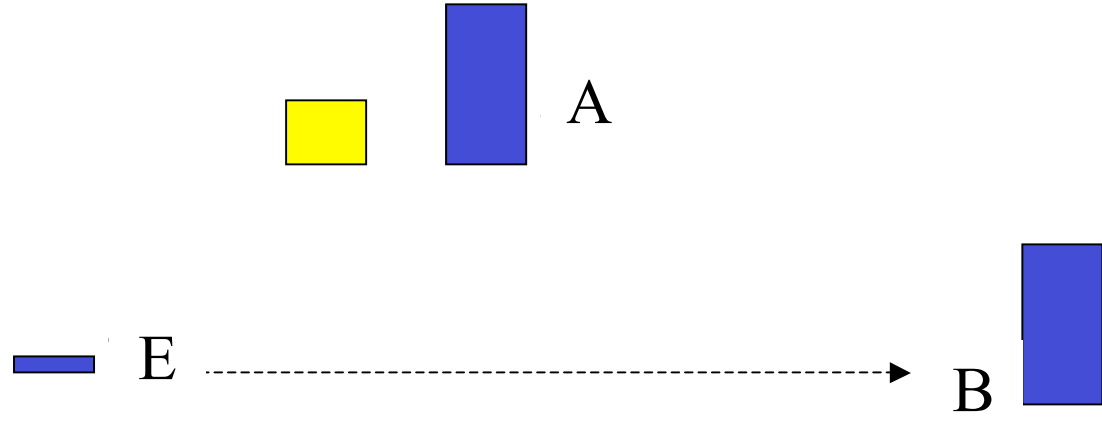
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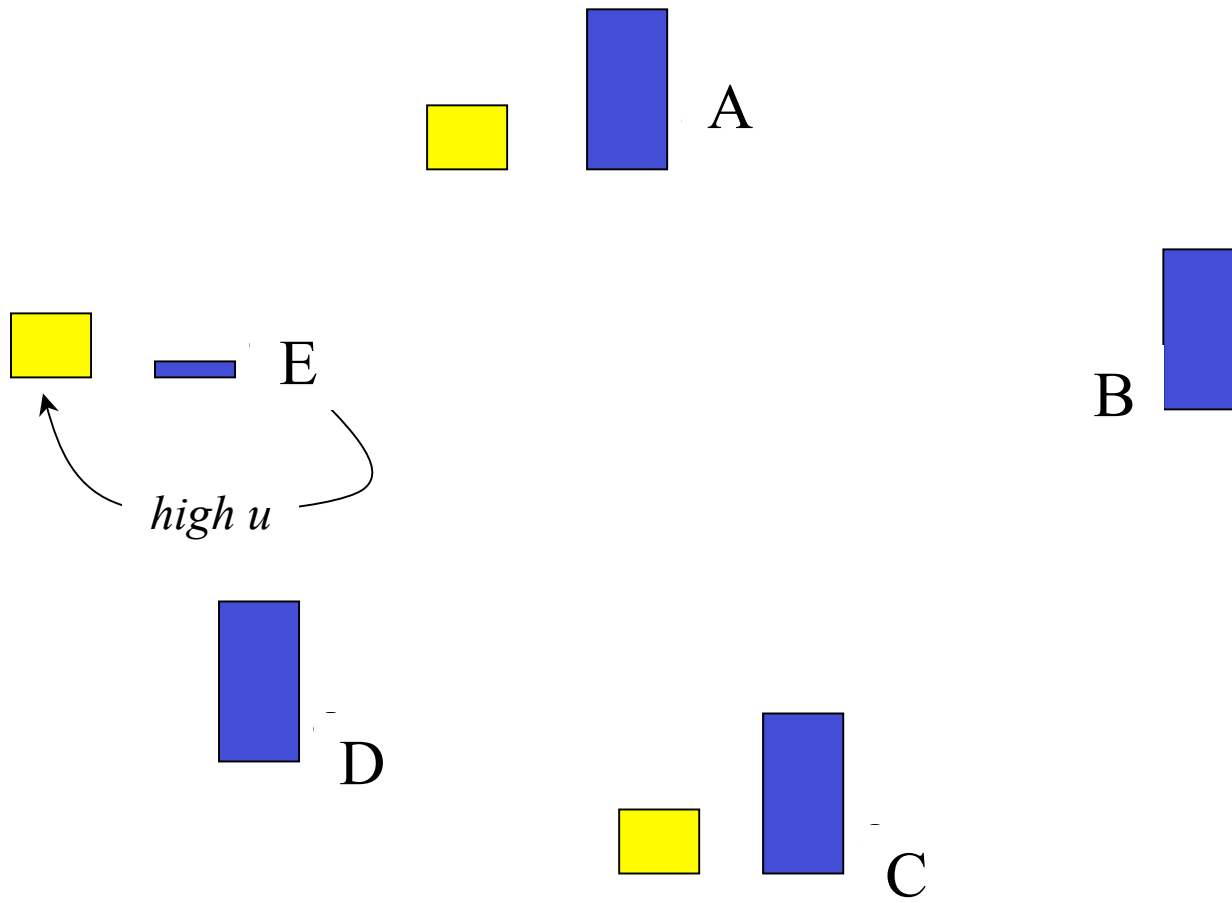


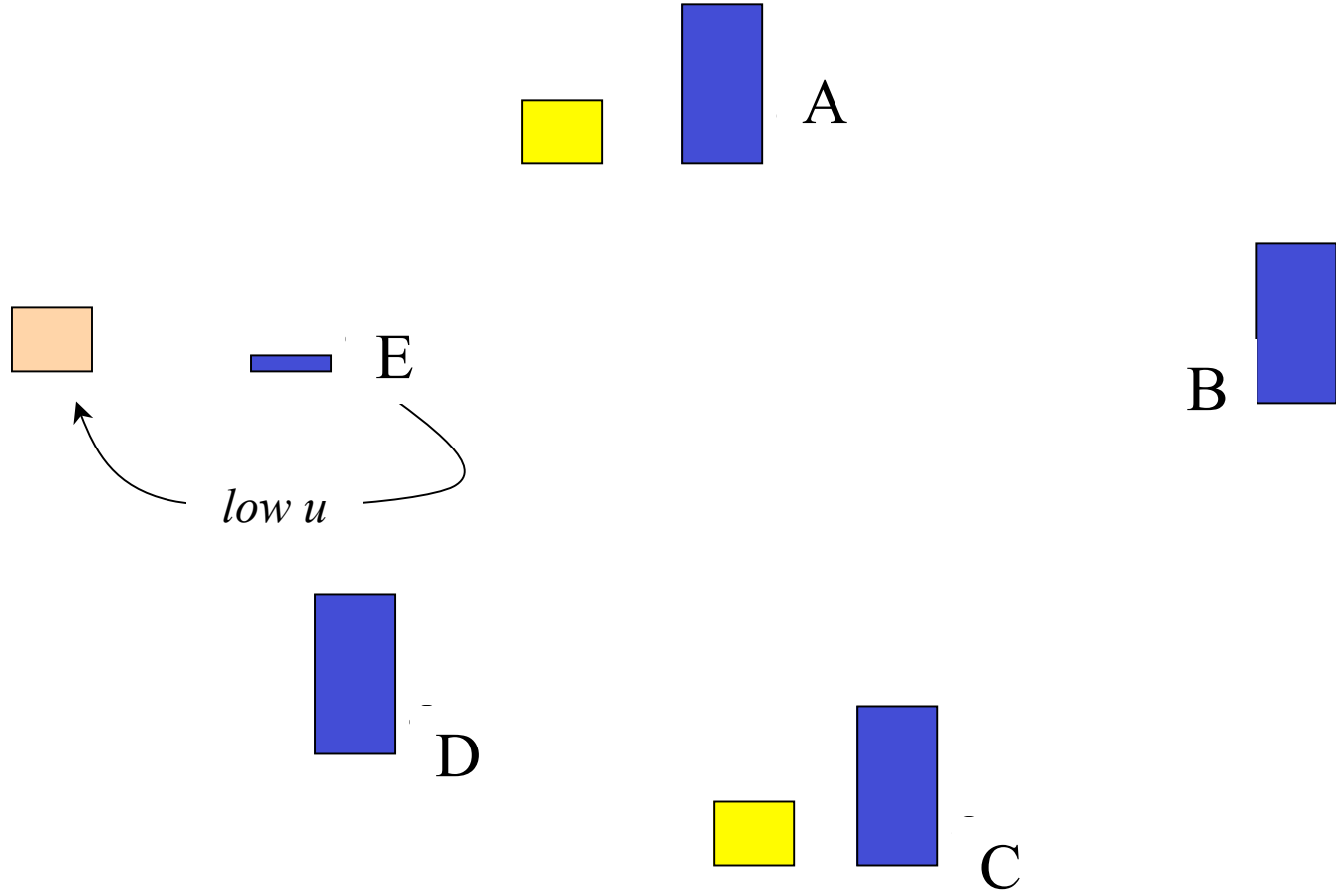
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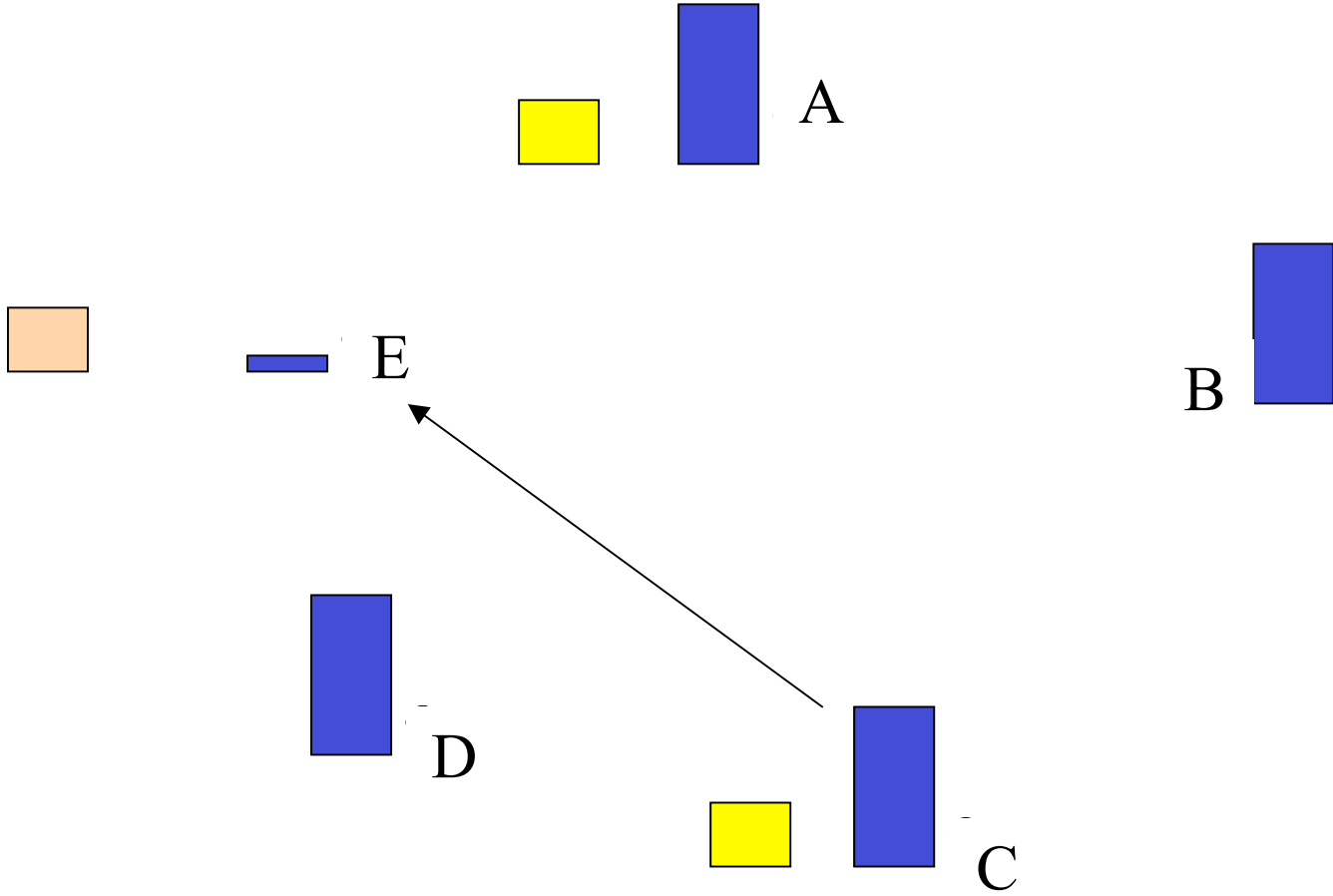


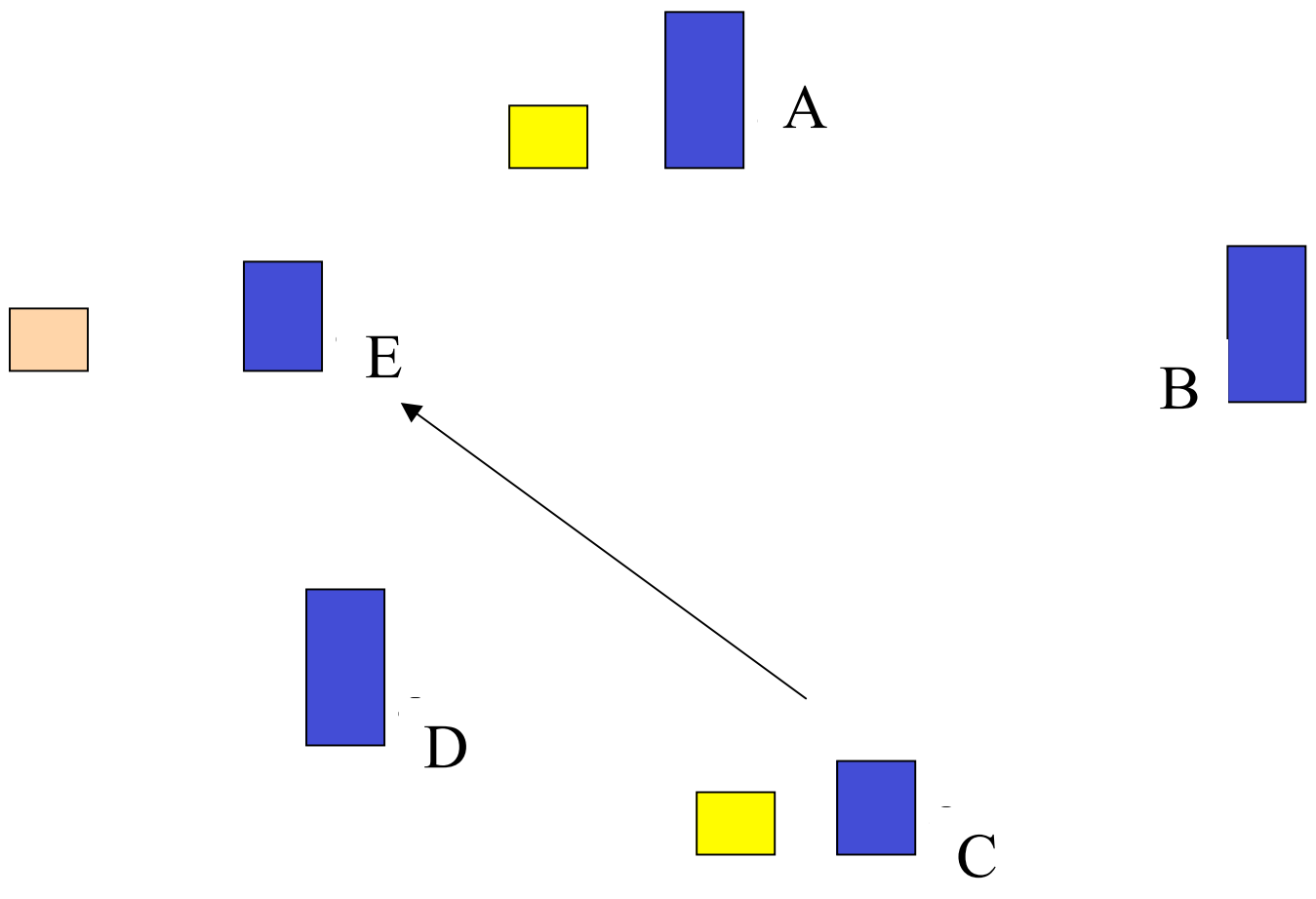


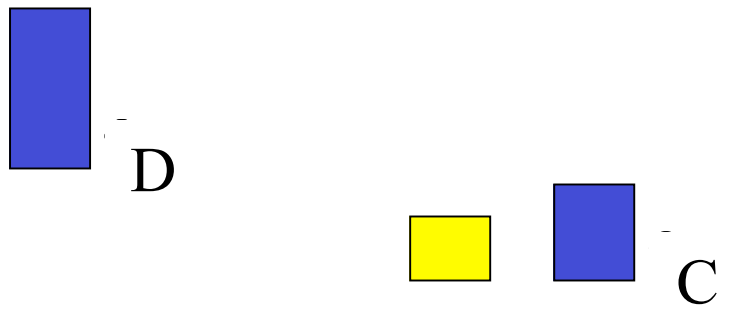
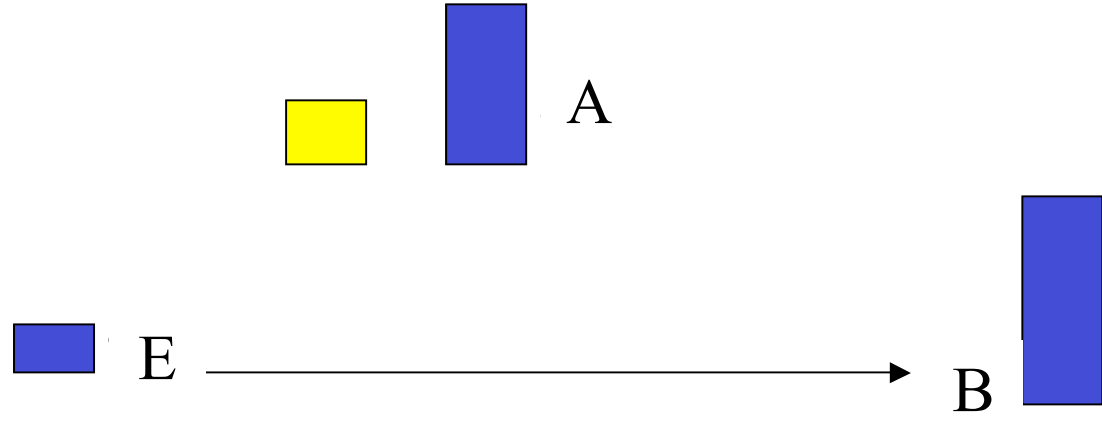


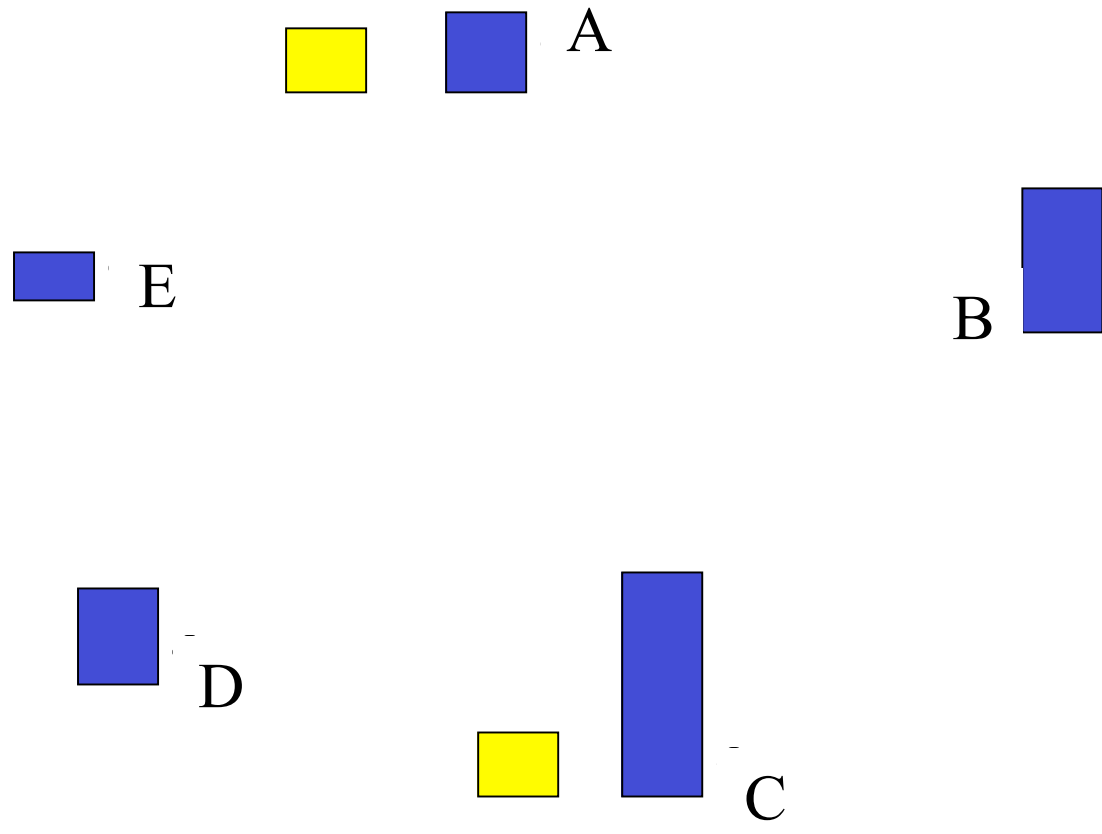


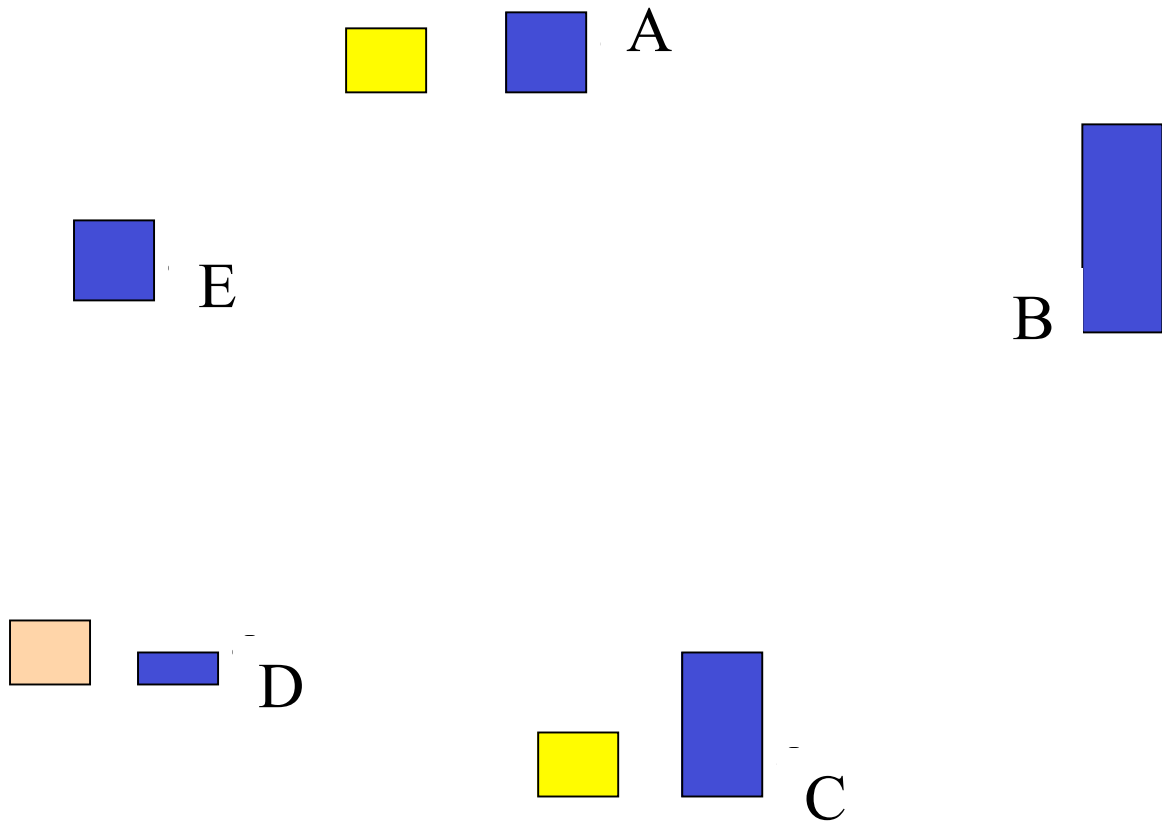


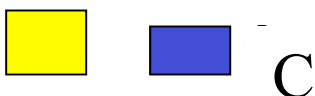
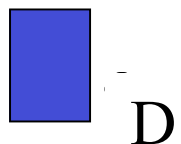
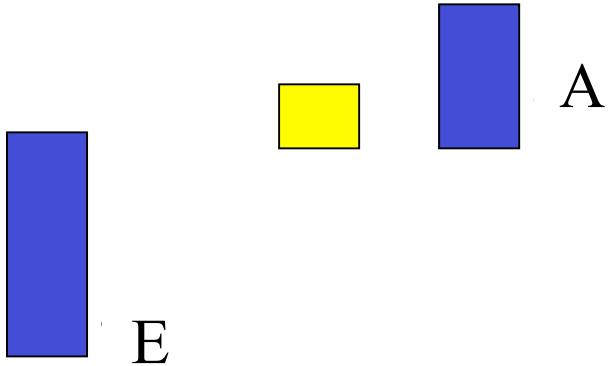


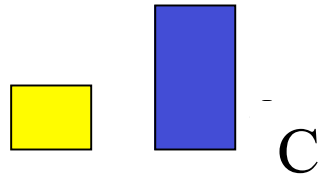
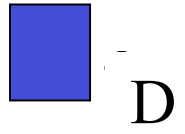
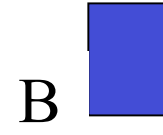
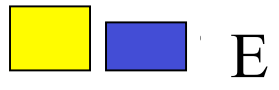
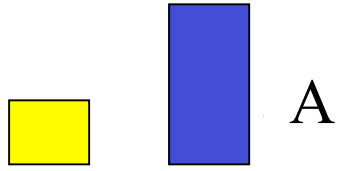


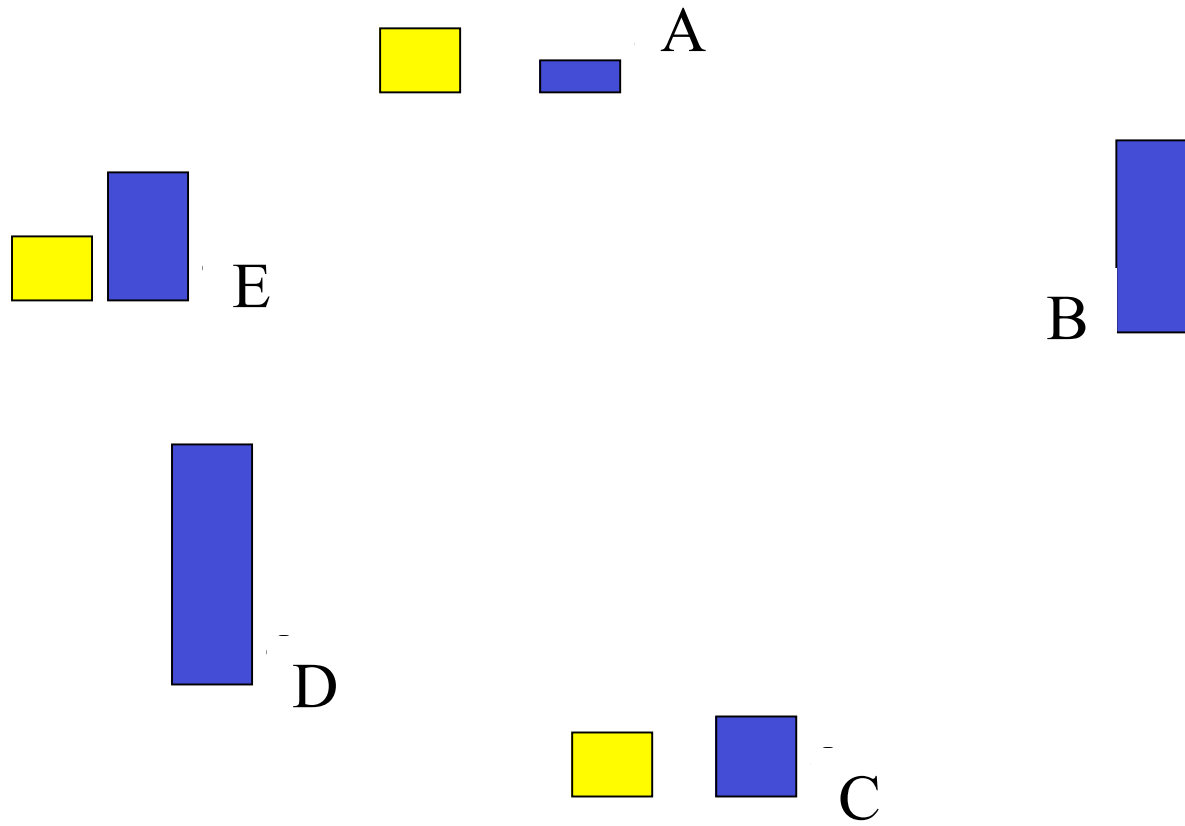


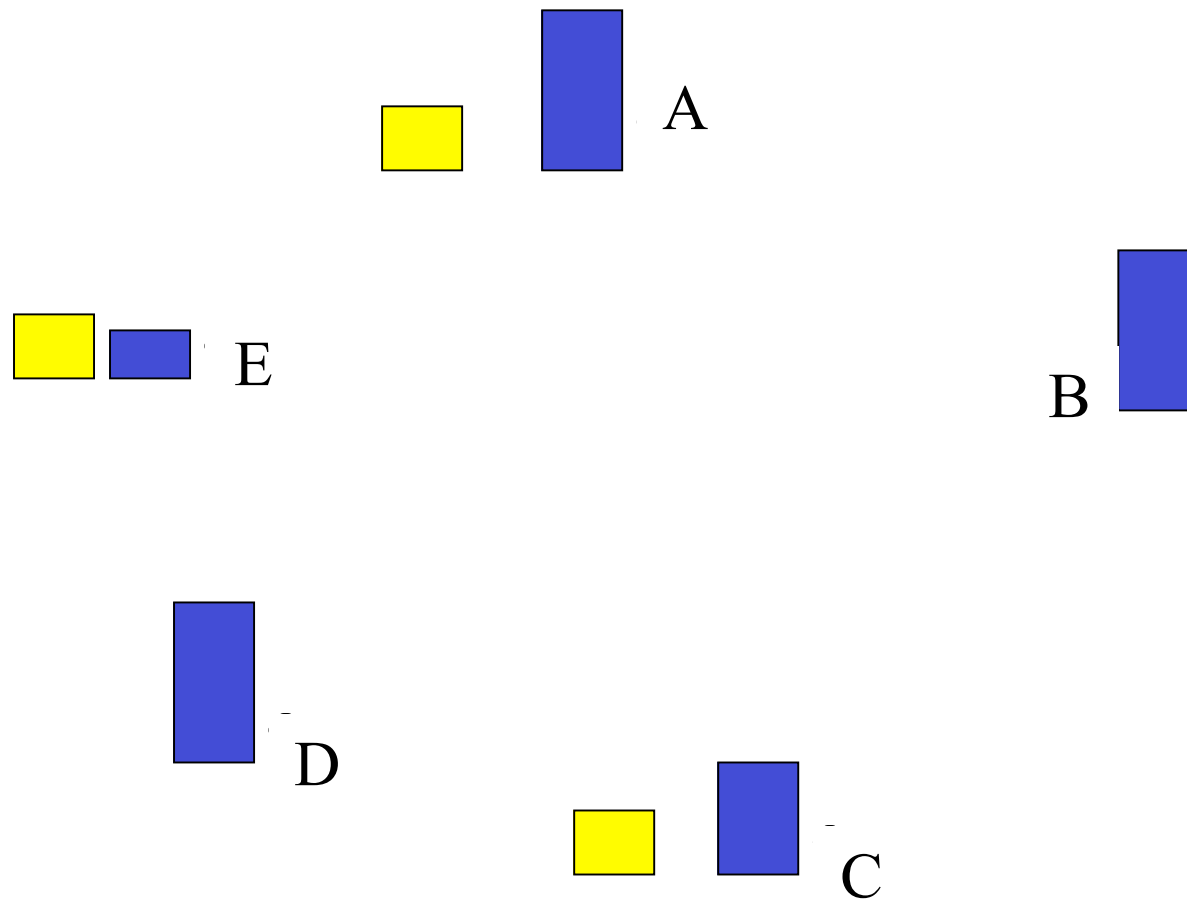












End of day

$$\begin{aligned}
 \text{Cost} &= \text{delay cost} + \text{liquidity costs} \\
 &= \frac{1}{2} u_k \cdot (t_k - t_k') + \frac{1}{2} \cdot a
 \end{aligned}$$

Illustration of costs

Very low liquidity

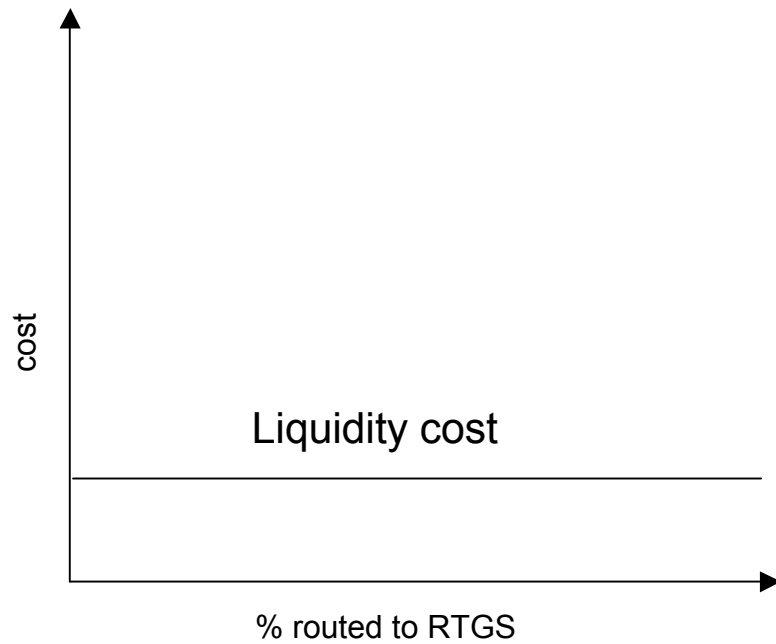


Illustration of costs

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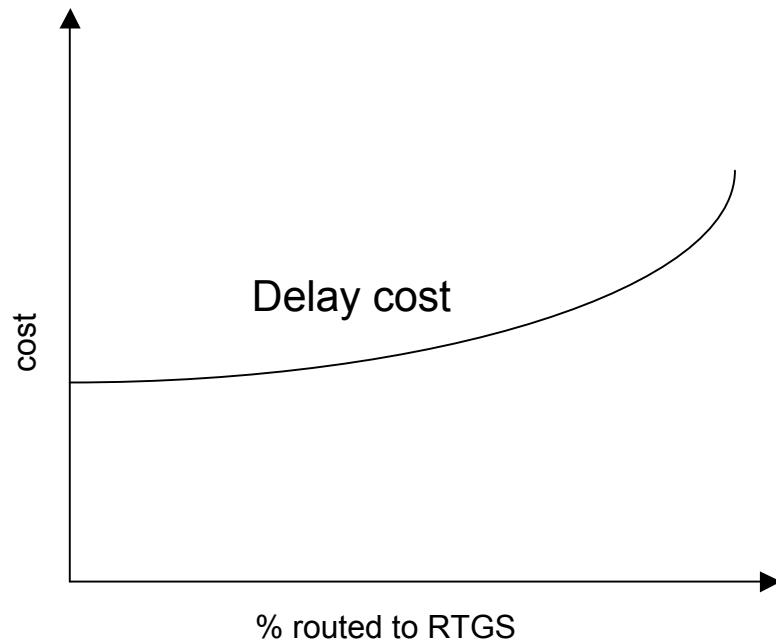


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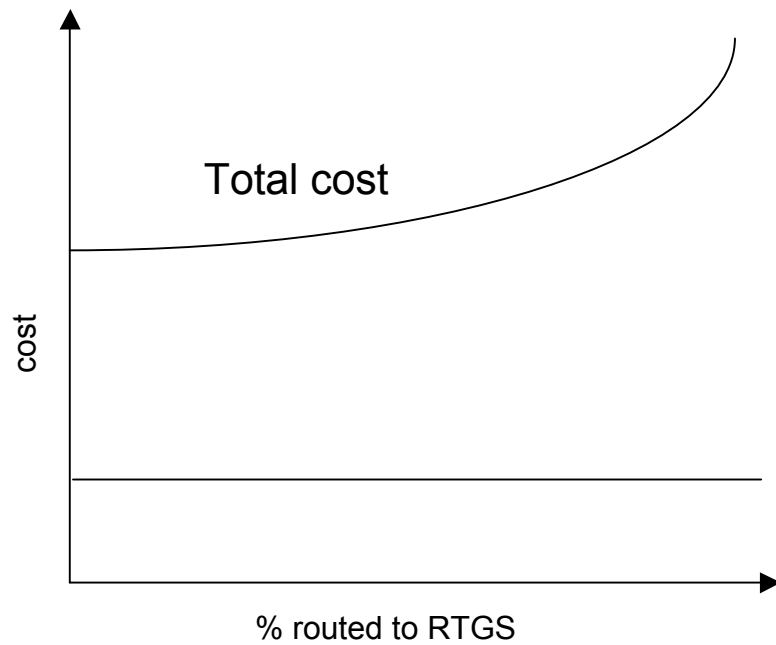
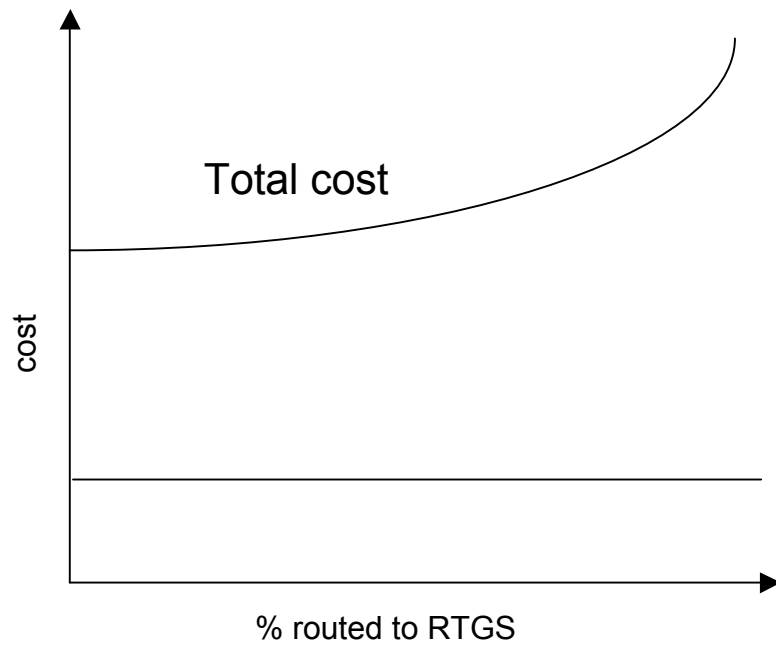
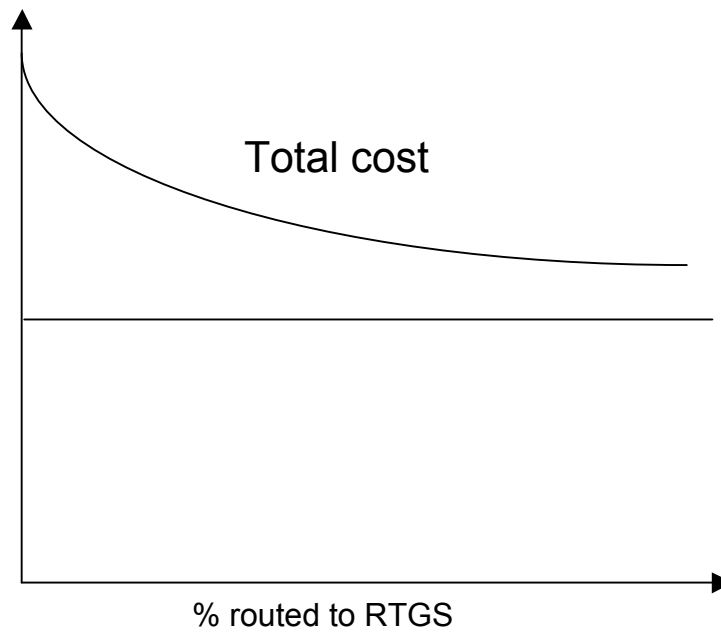


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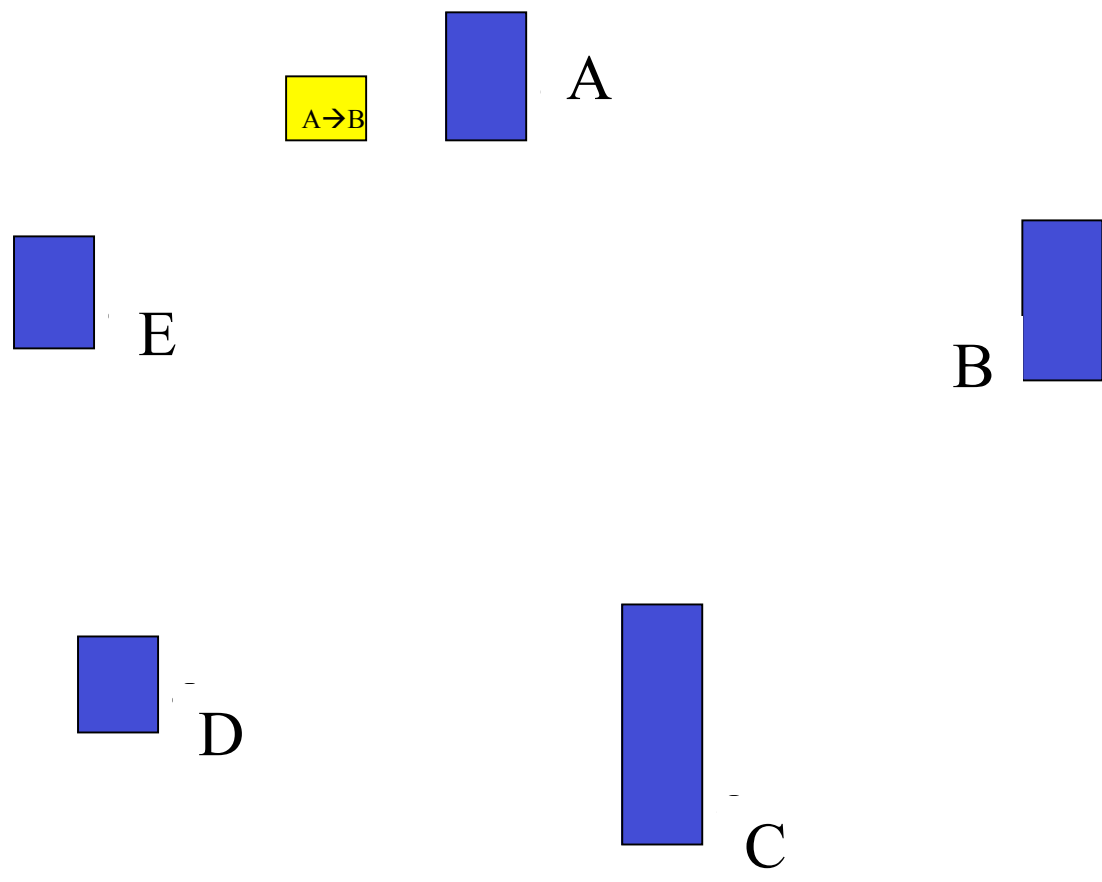


Very high liquidity



The game

- Banks choose
 - opening **liquidity** balance:
 - urgency **threshold** to queue:
- For each strategy profile $(\underline{c}_1, \underline{c}_1), (\underline{c}_2, \underline{c}_2), (\underline{c}_3, \underline{c}_3) \dots (\underline{c}_N, \underline{c}_N)$
a payoff (cost) function
- We look at Nash equilibrium for 2 cases:
 - ‘LMM’ - low urgency payments in *internal* queues
 - ‘LSM’ - low urgency payments in *central* queue



A → B



A



E



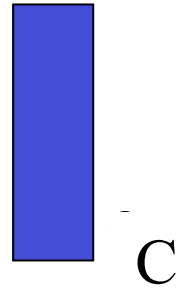
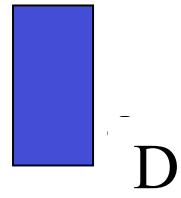
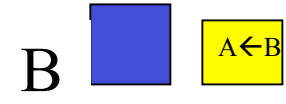
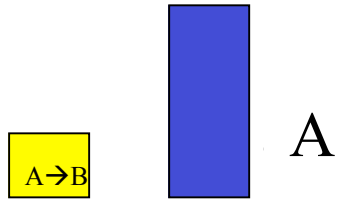
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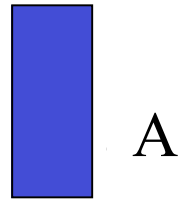


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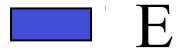


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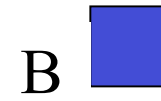




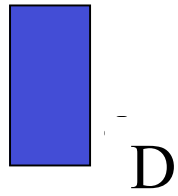
A



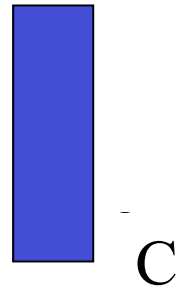
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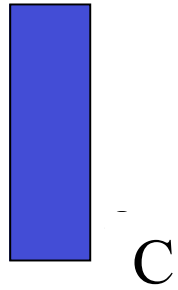
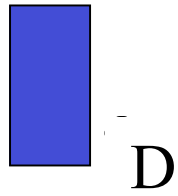
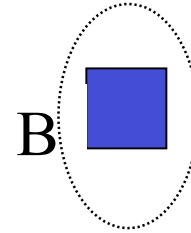
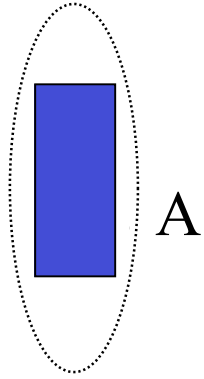
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D



C



Agent-based modelling

Liquidity flows very complex →

simulate the settlement process

to compute costs,

and hence equilibria

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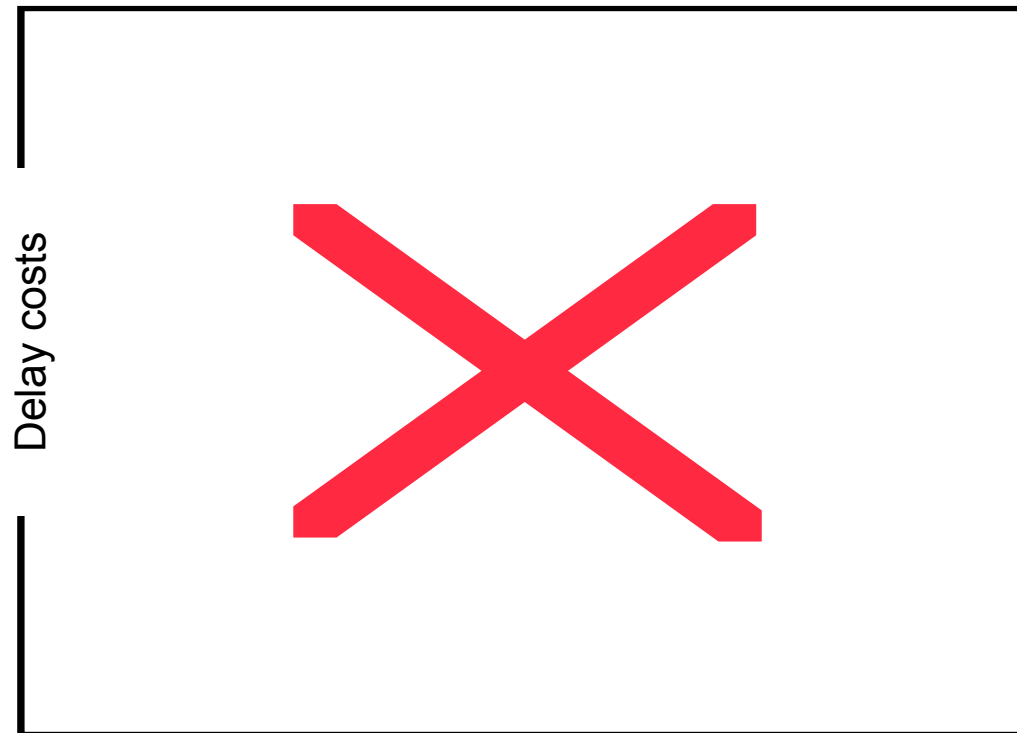
We look at symmetric equilibria:

$$\{(c_1, -1), (c_2, -2), (c_3, -3) \dots (c_N, -N)\} \quad : \quad (c_i, -i) = (c_j, -j) \text{ for each } i, j$$

1

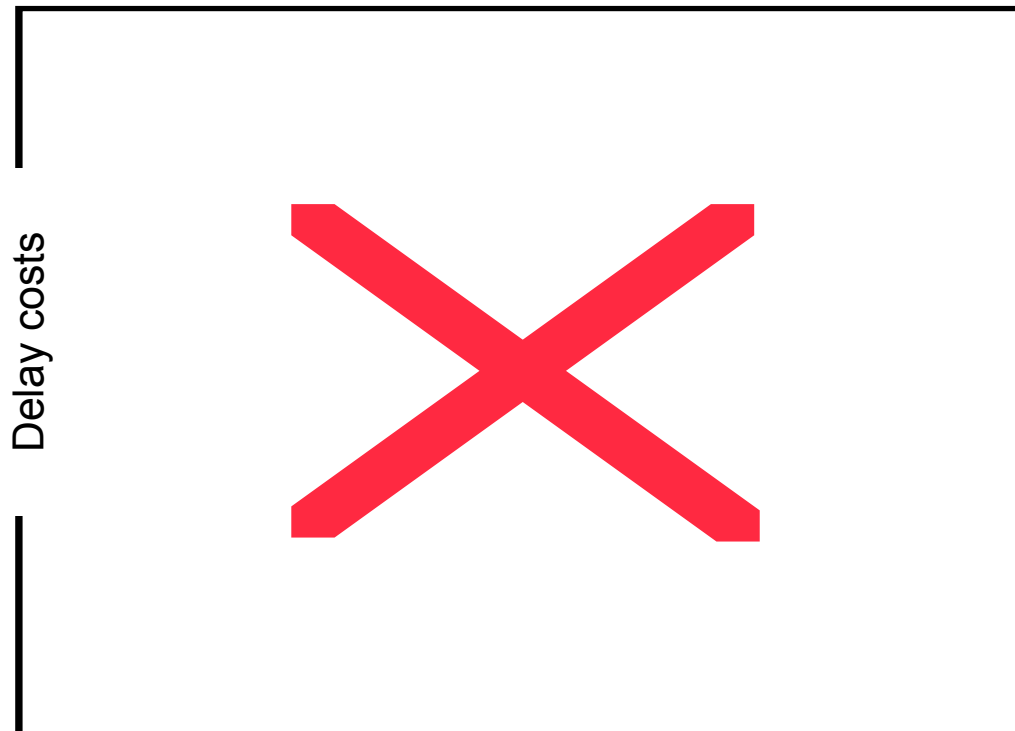
Model with internal queues
(LMM)

Delay costs with LMM



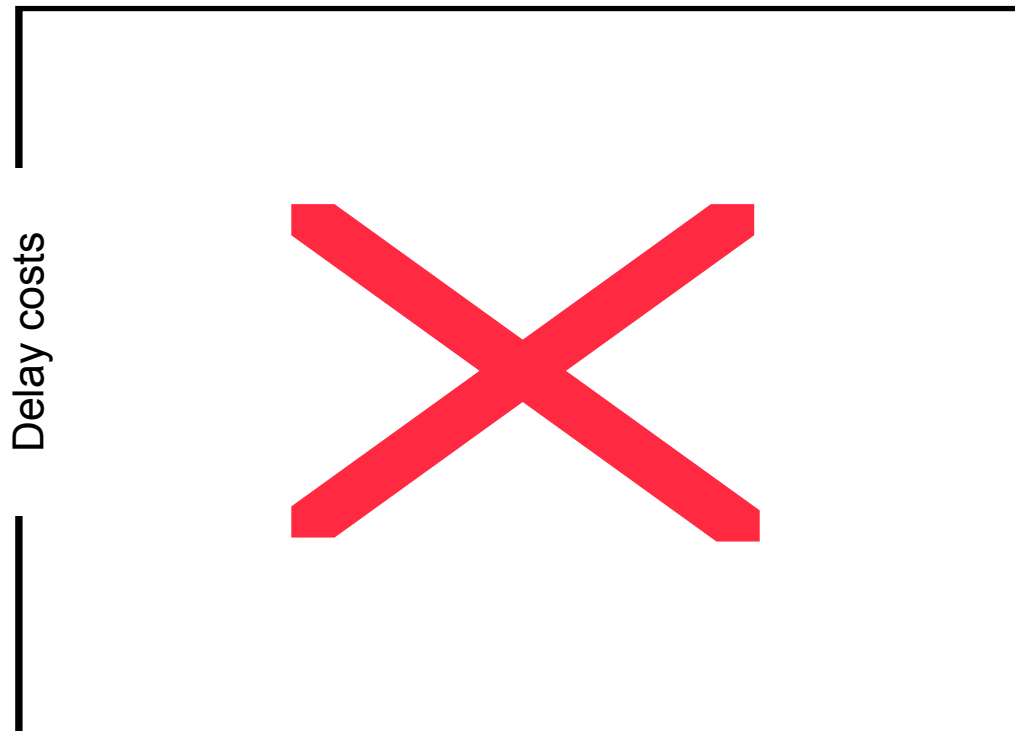
Delay costs with LMM

Increase “your” threshold



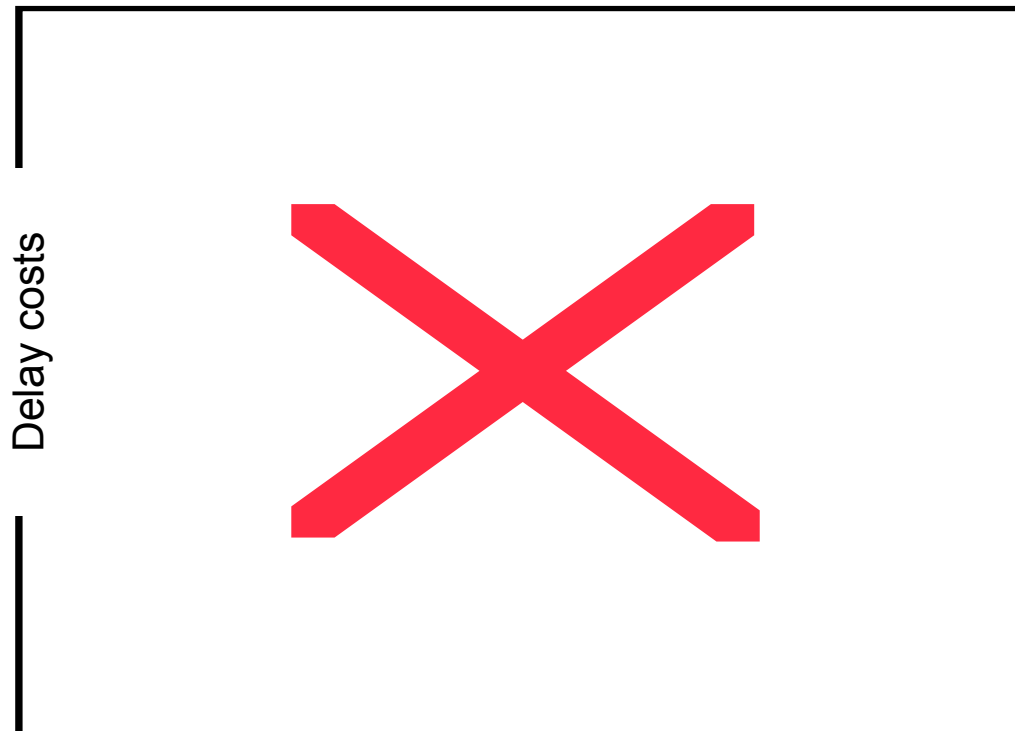
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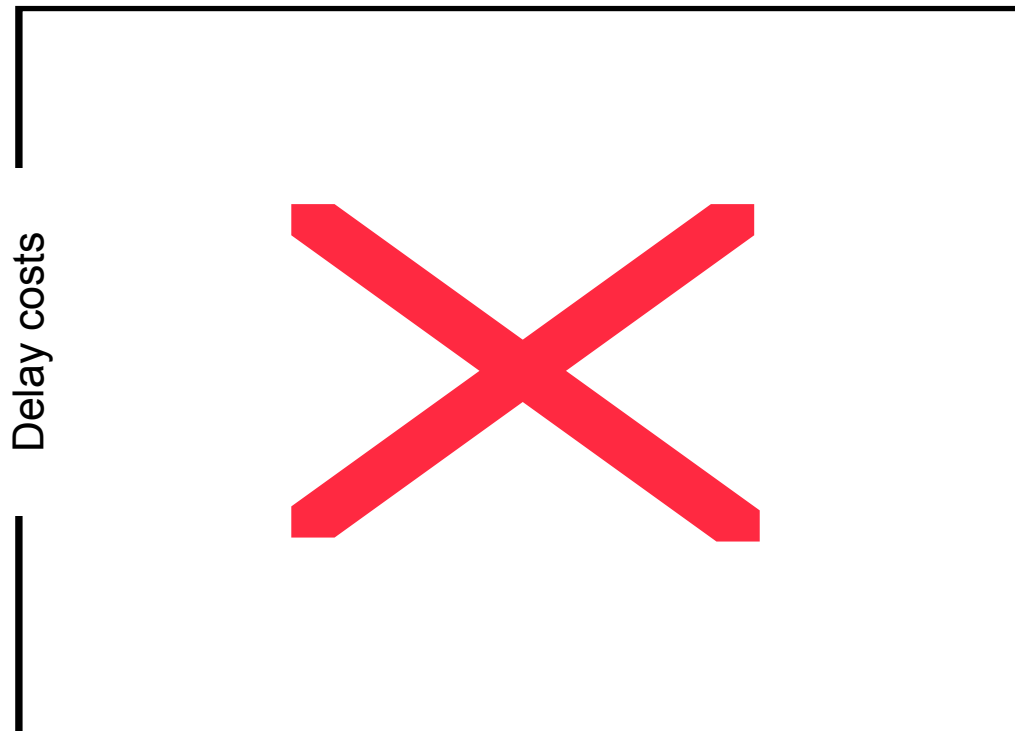
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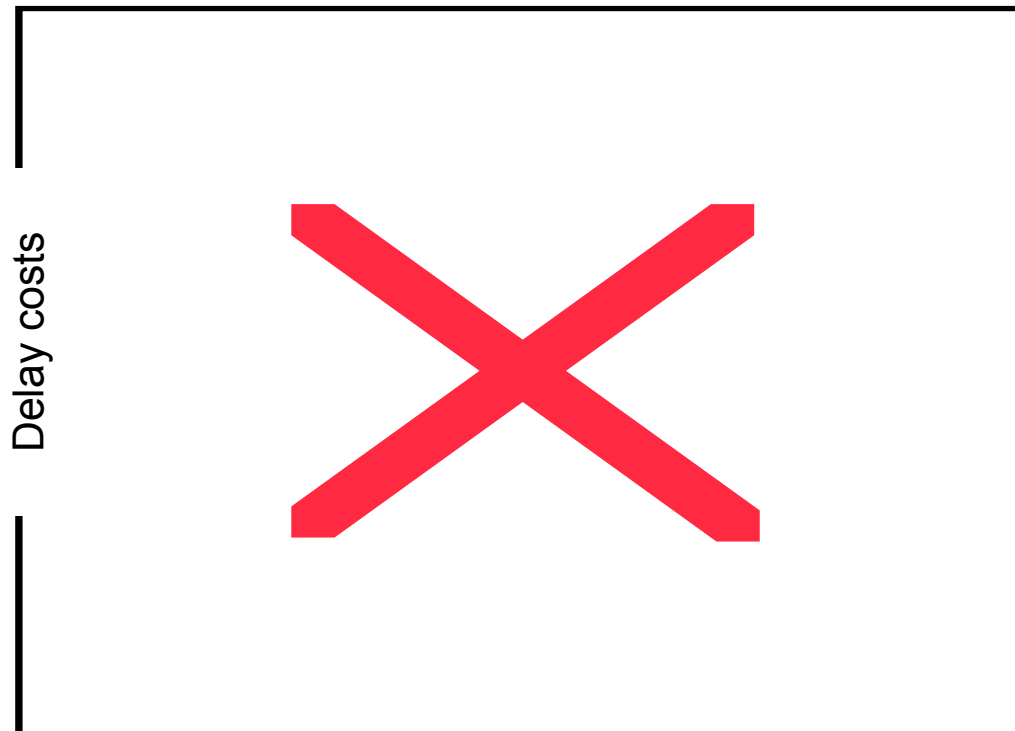
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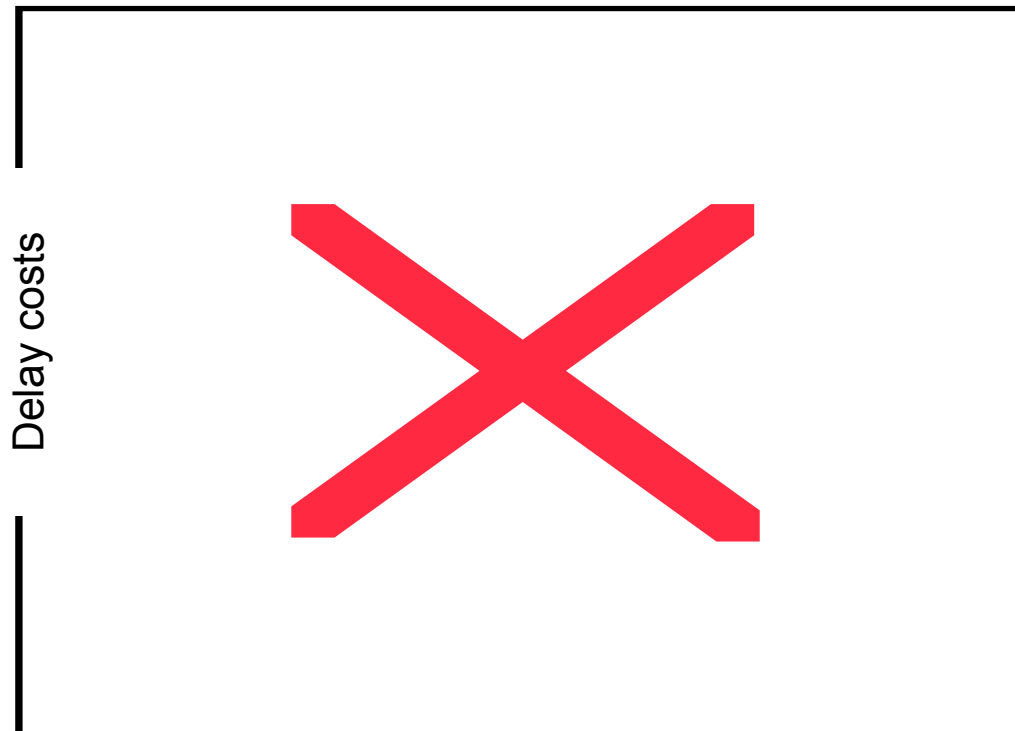
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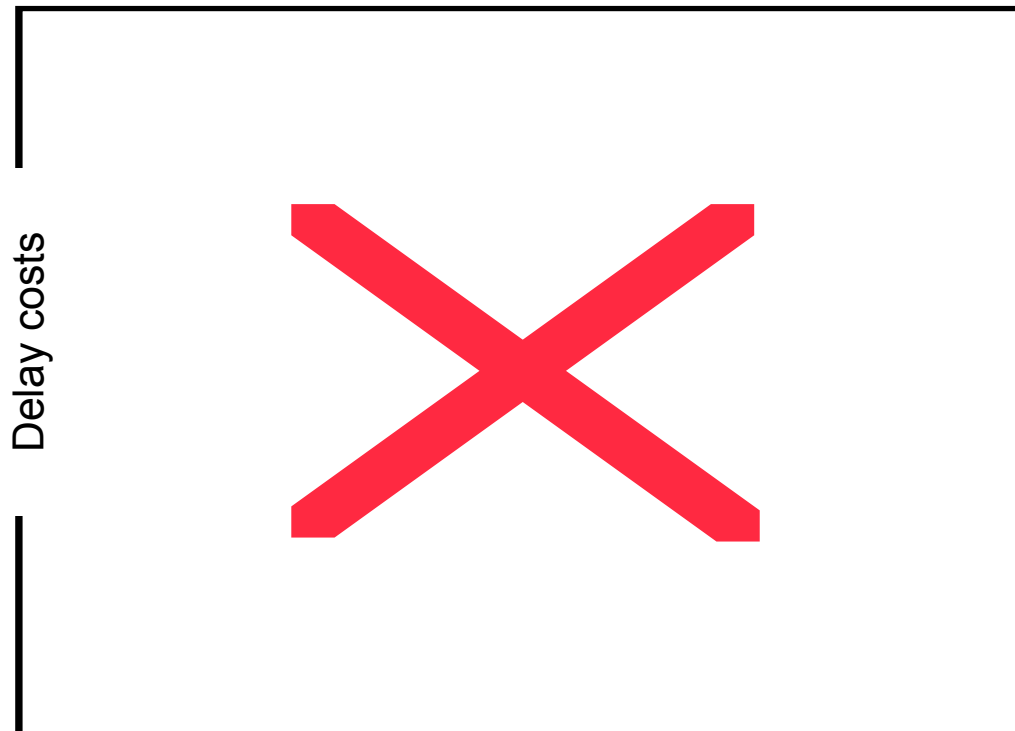
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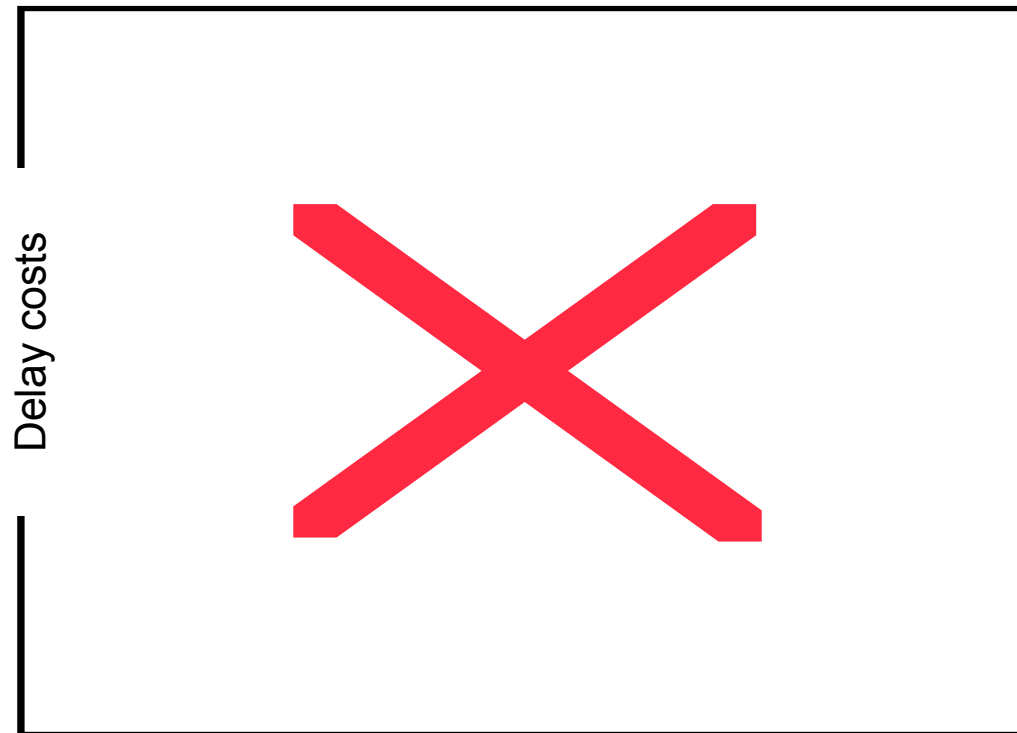
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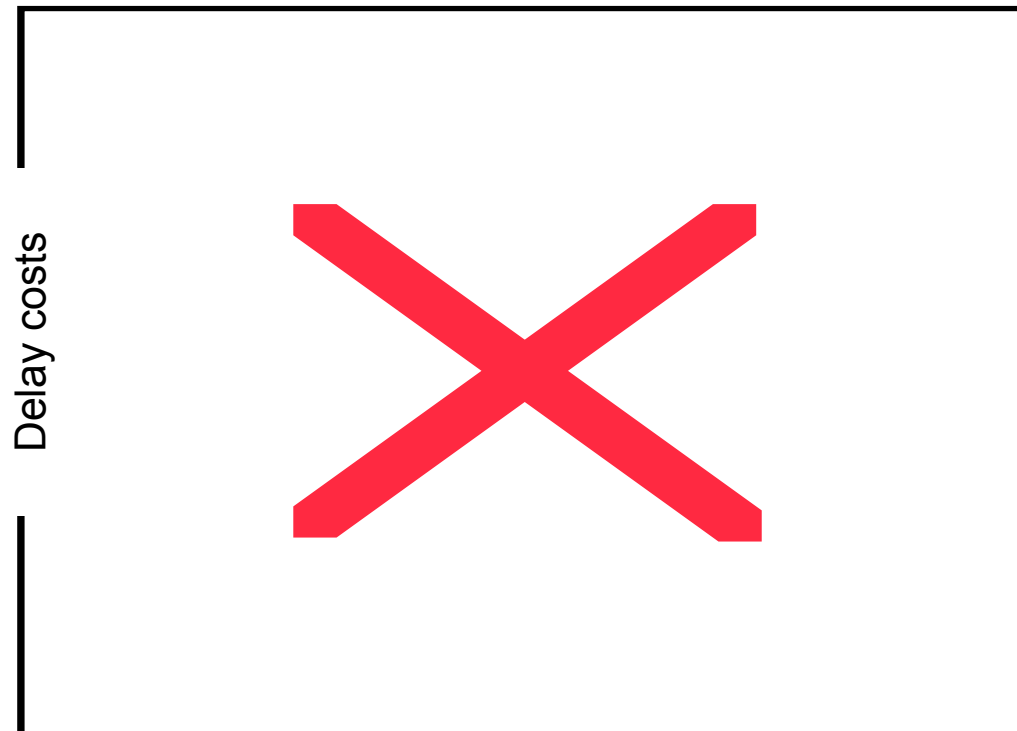
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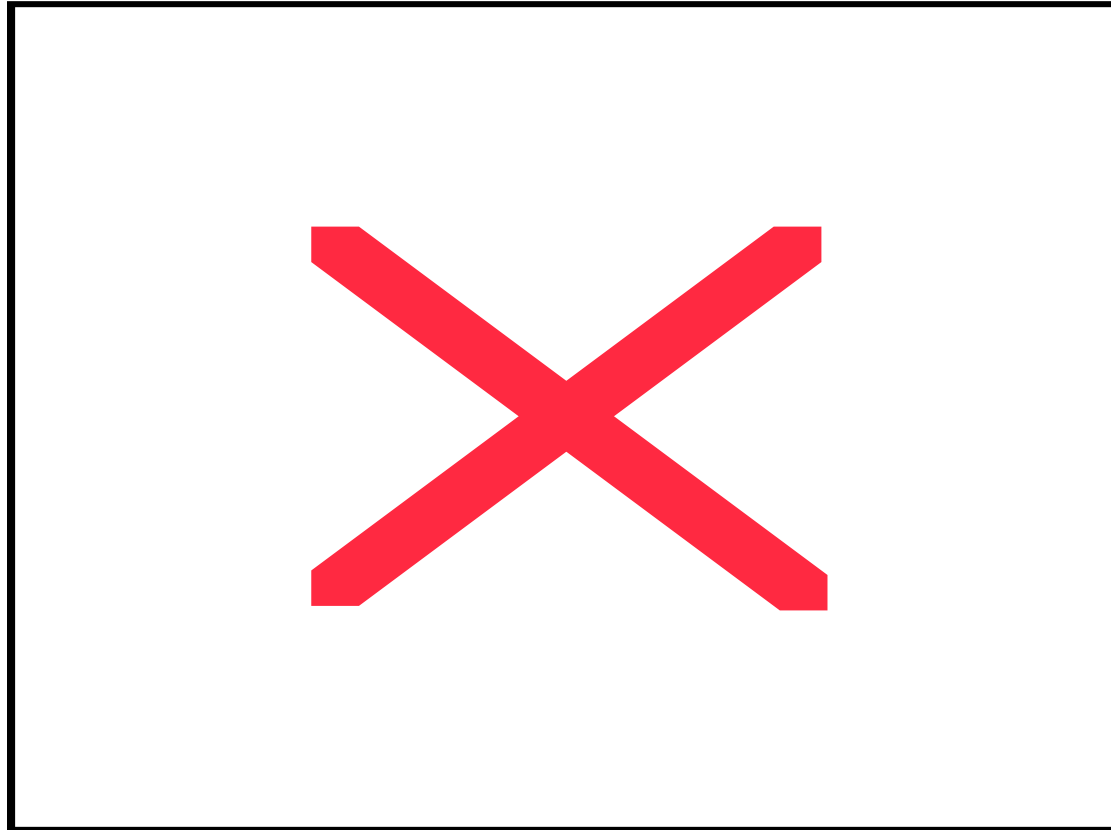
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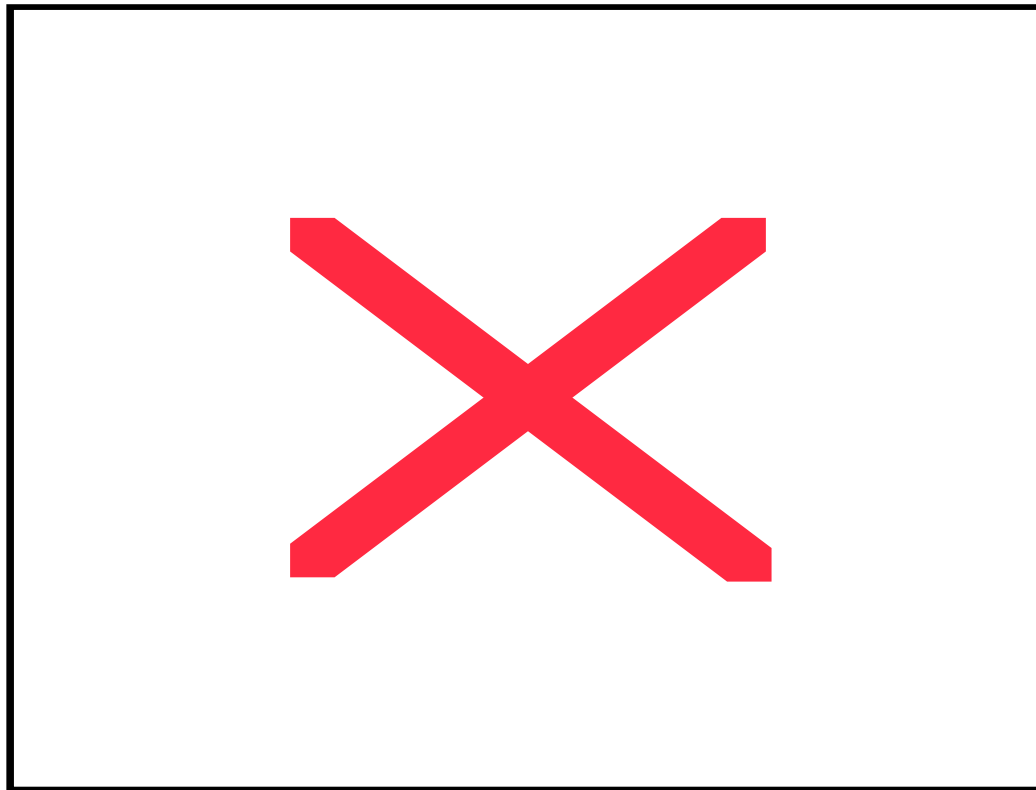


Delay costs with LMM

system level

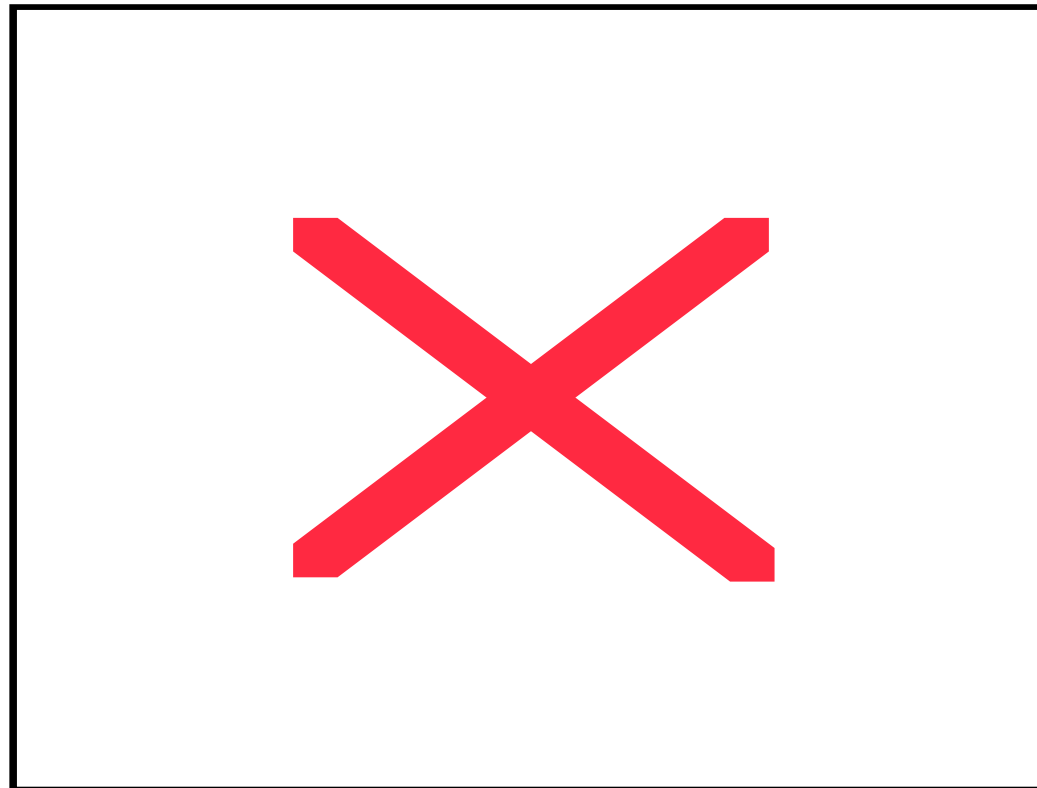


Equilibria - LMM



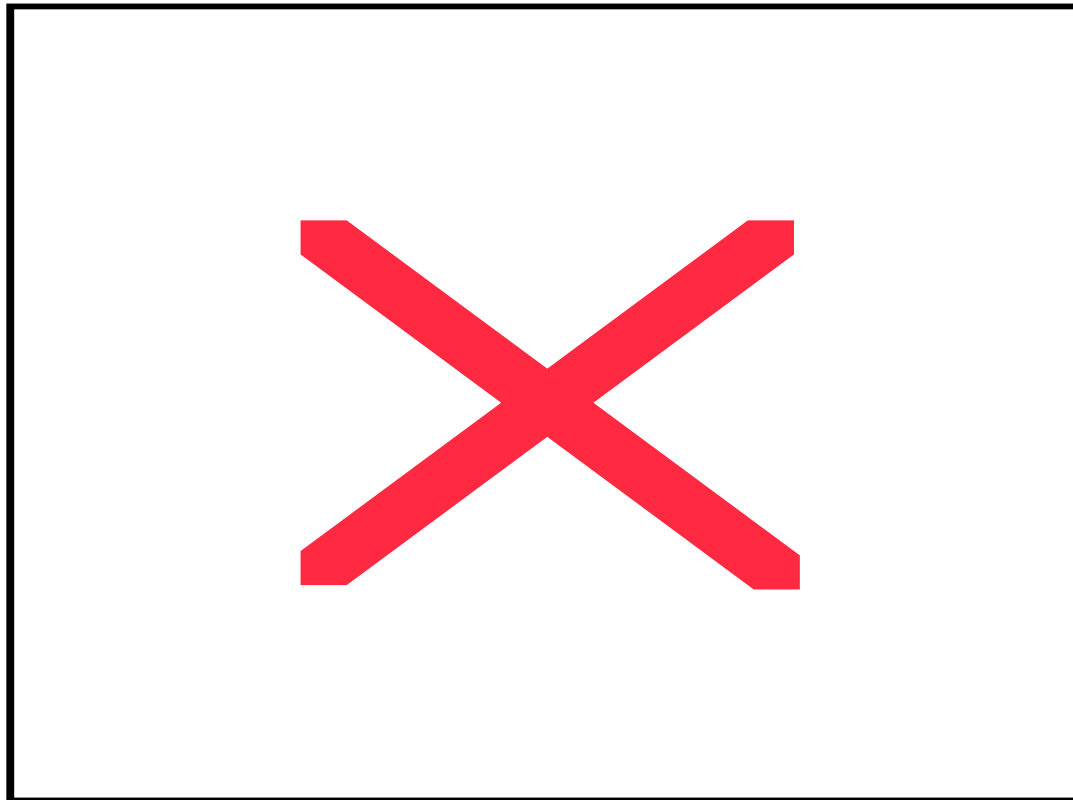
Equilibria - LMM

Increase liquidity price a



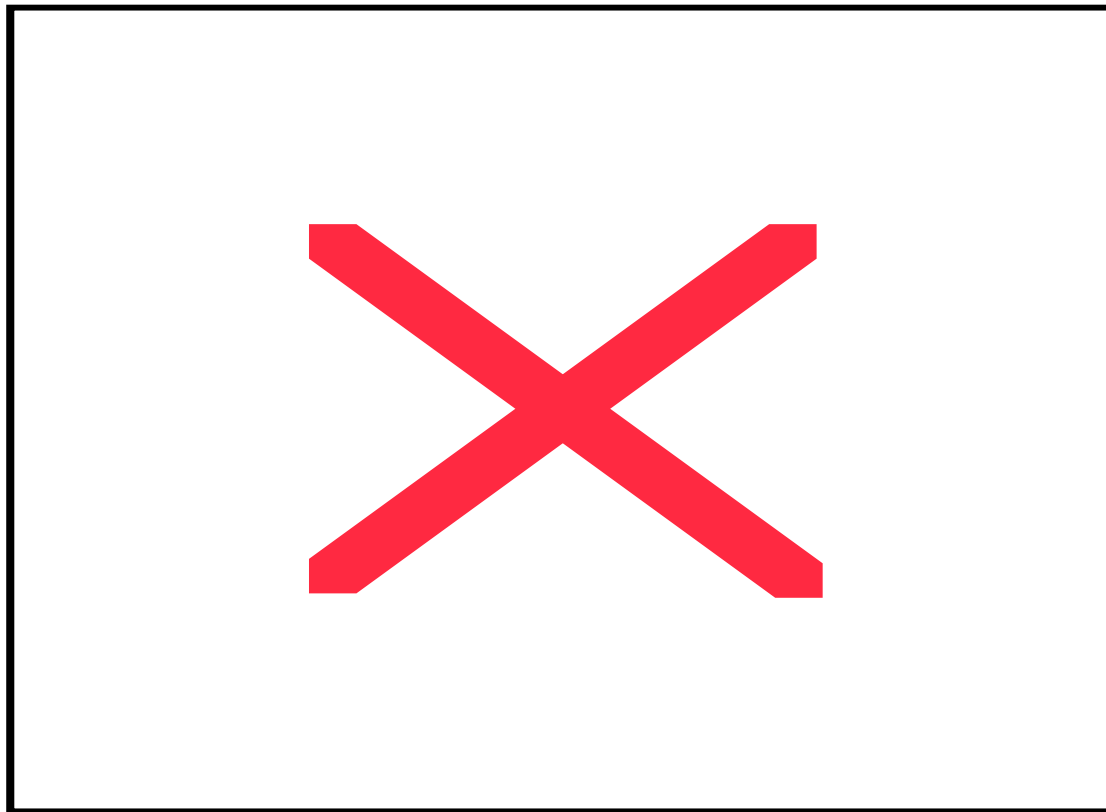
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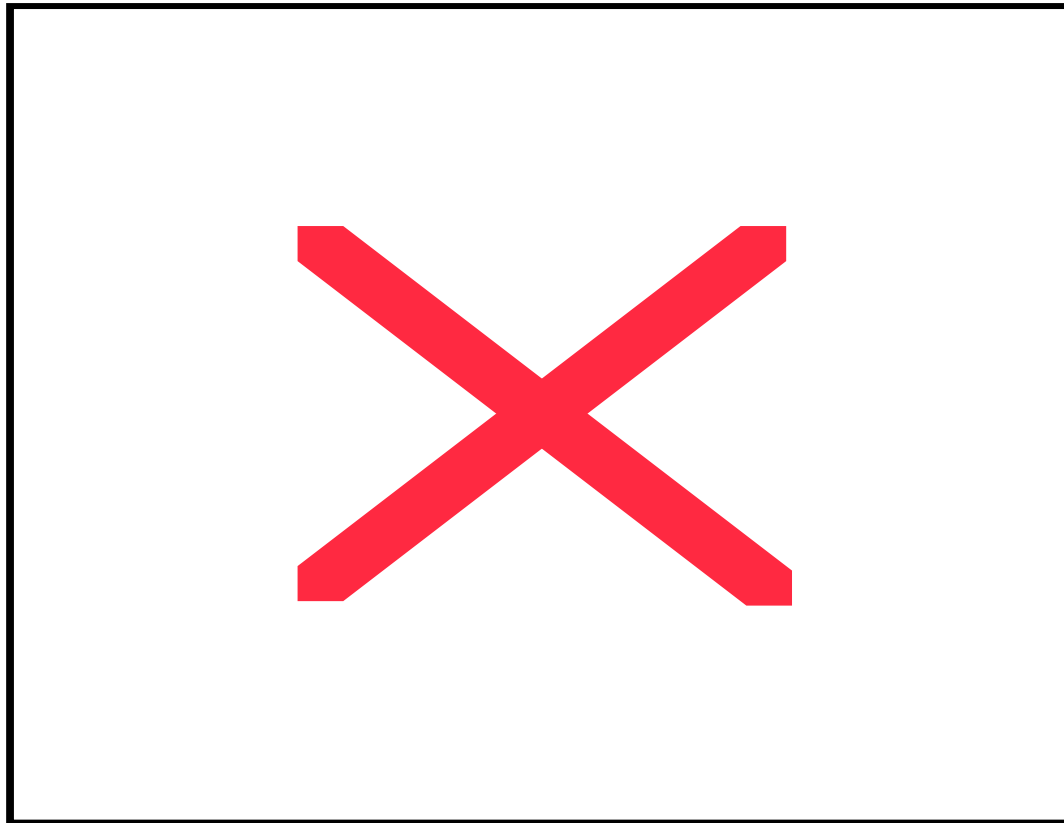
Equilibria - LMM

Increase liquidity price a



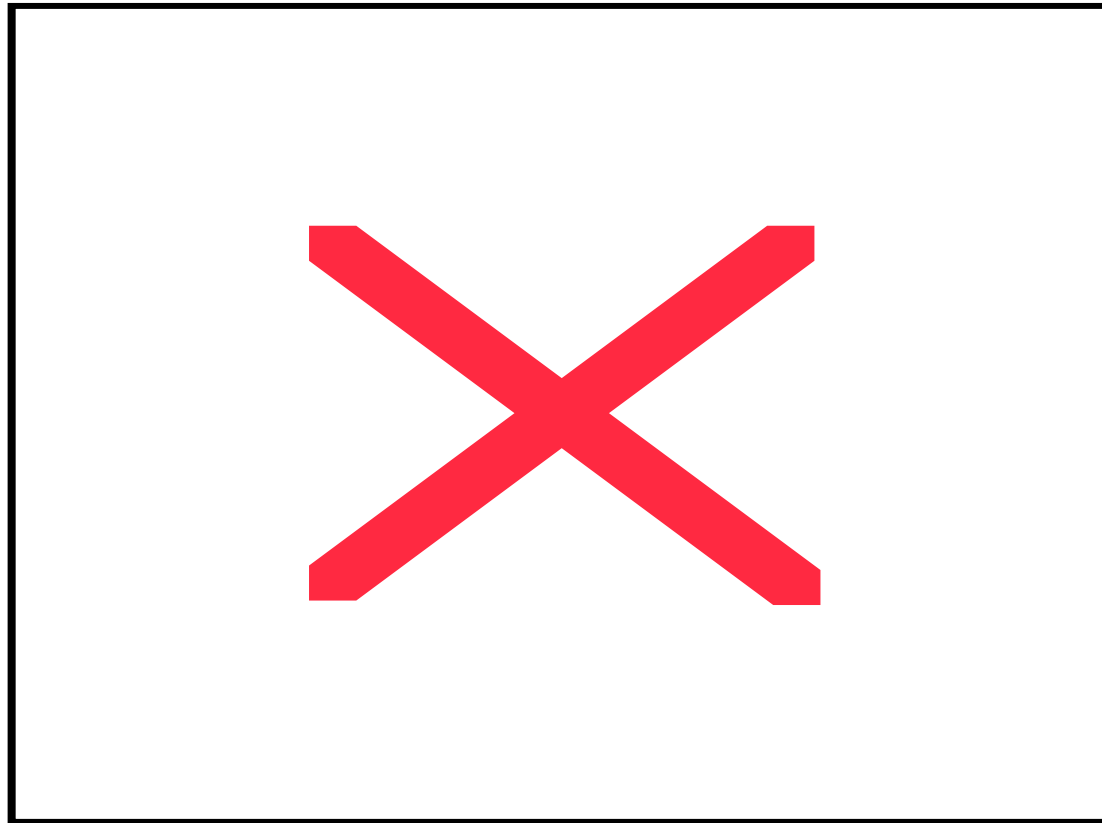
Equilibria - LMM

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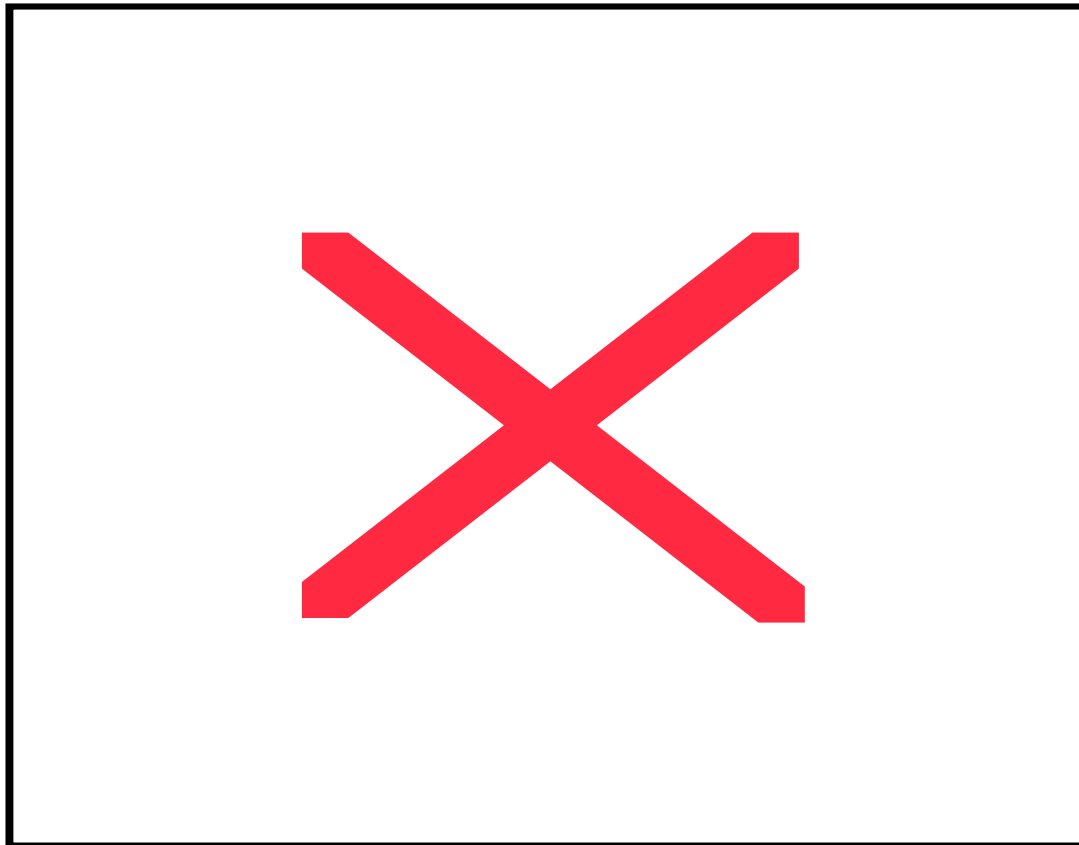
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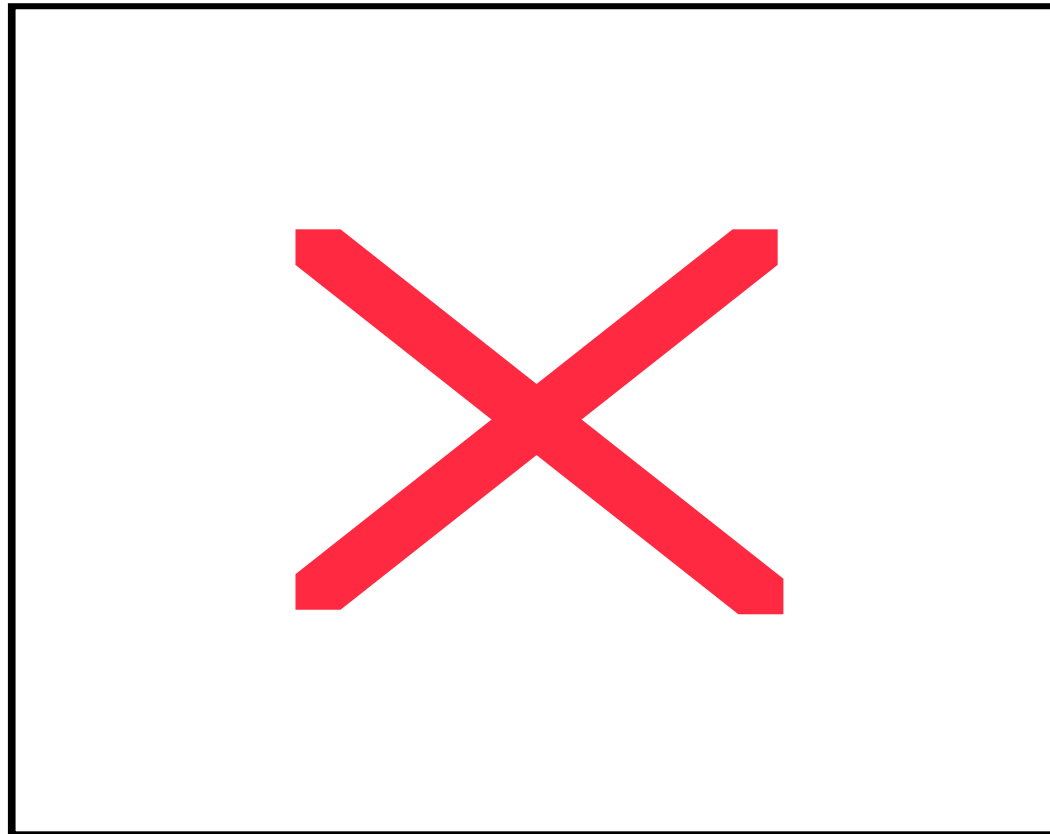
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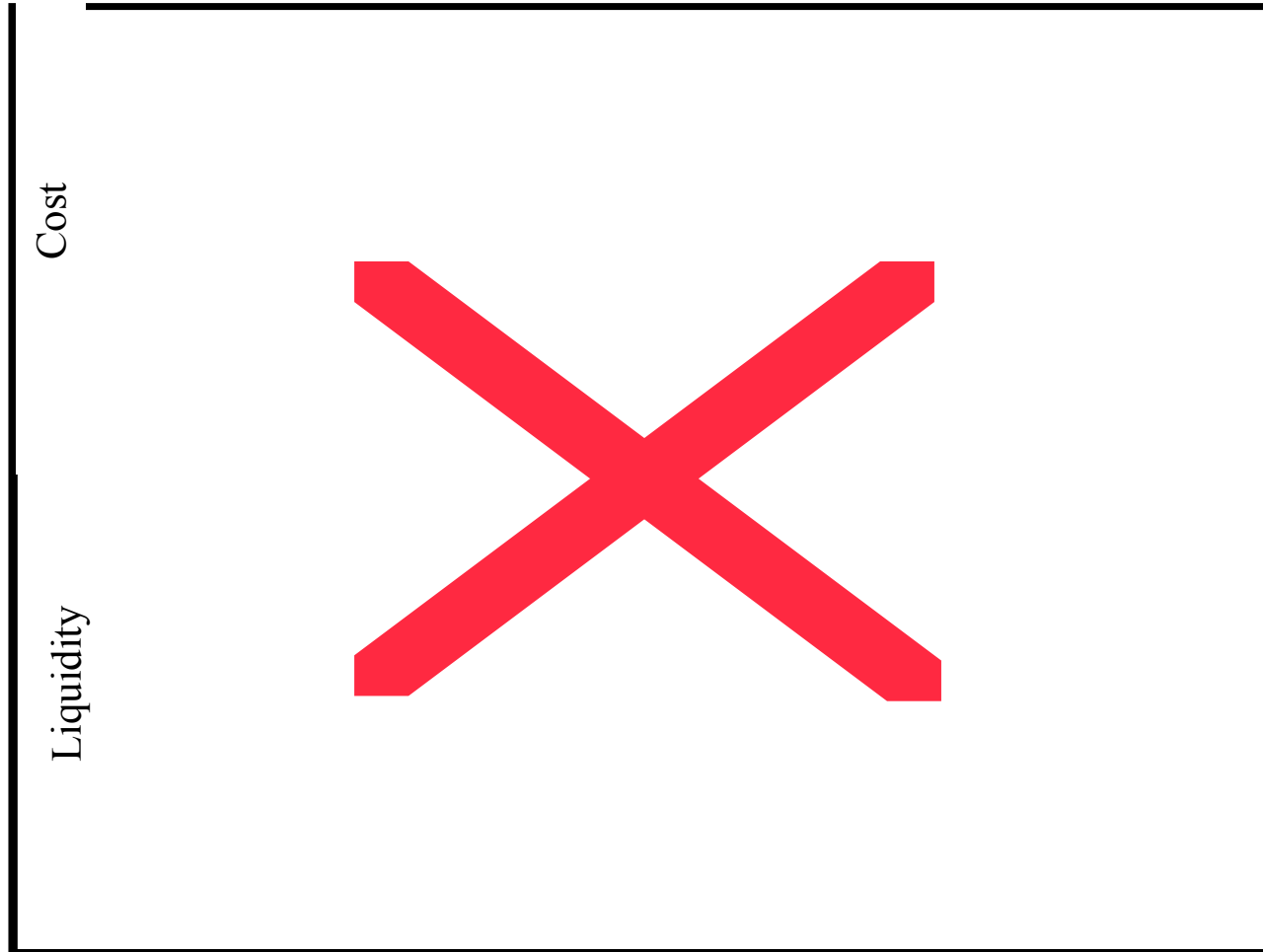


Equilibria - LMM

Increase liquidity price a



Equilibria - LMM



○ Equil.

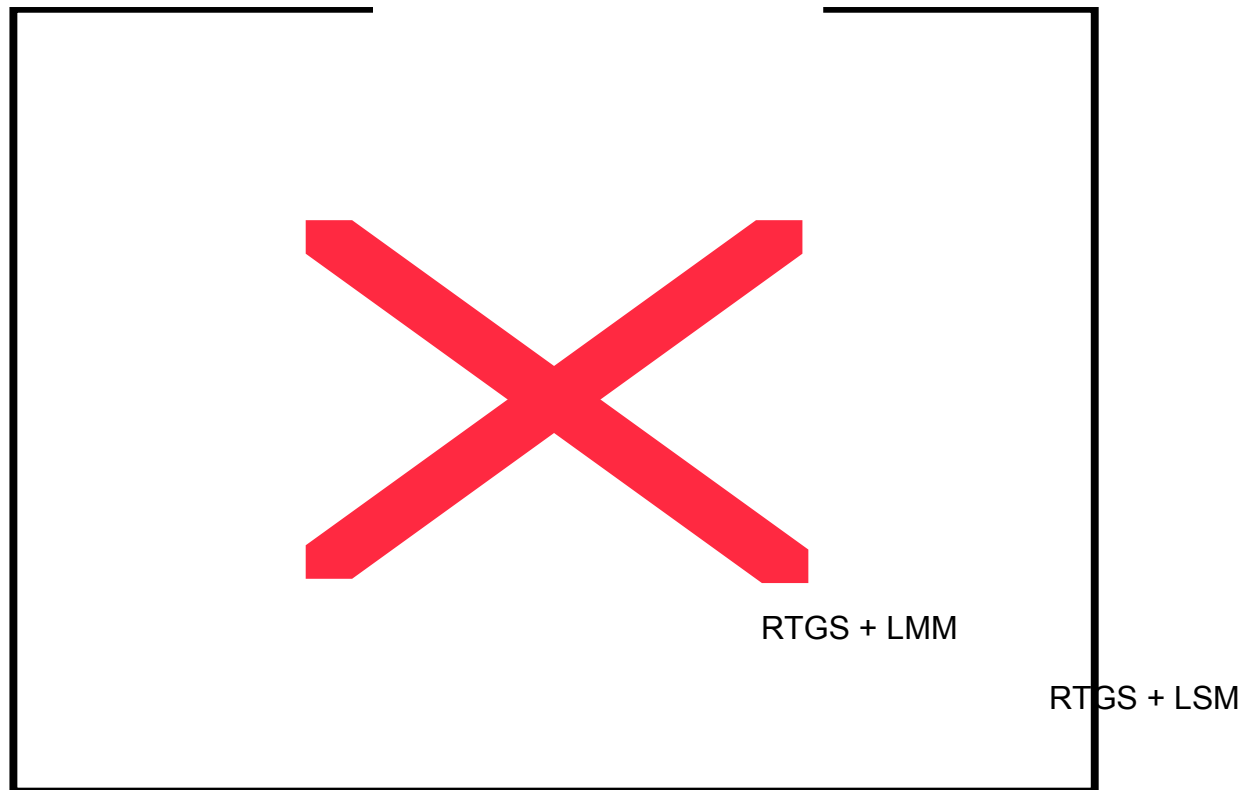
* Planner

Too little liquidity,
too much queueing

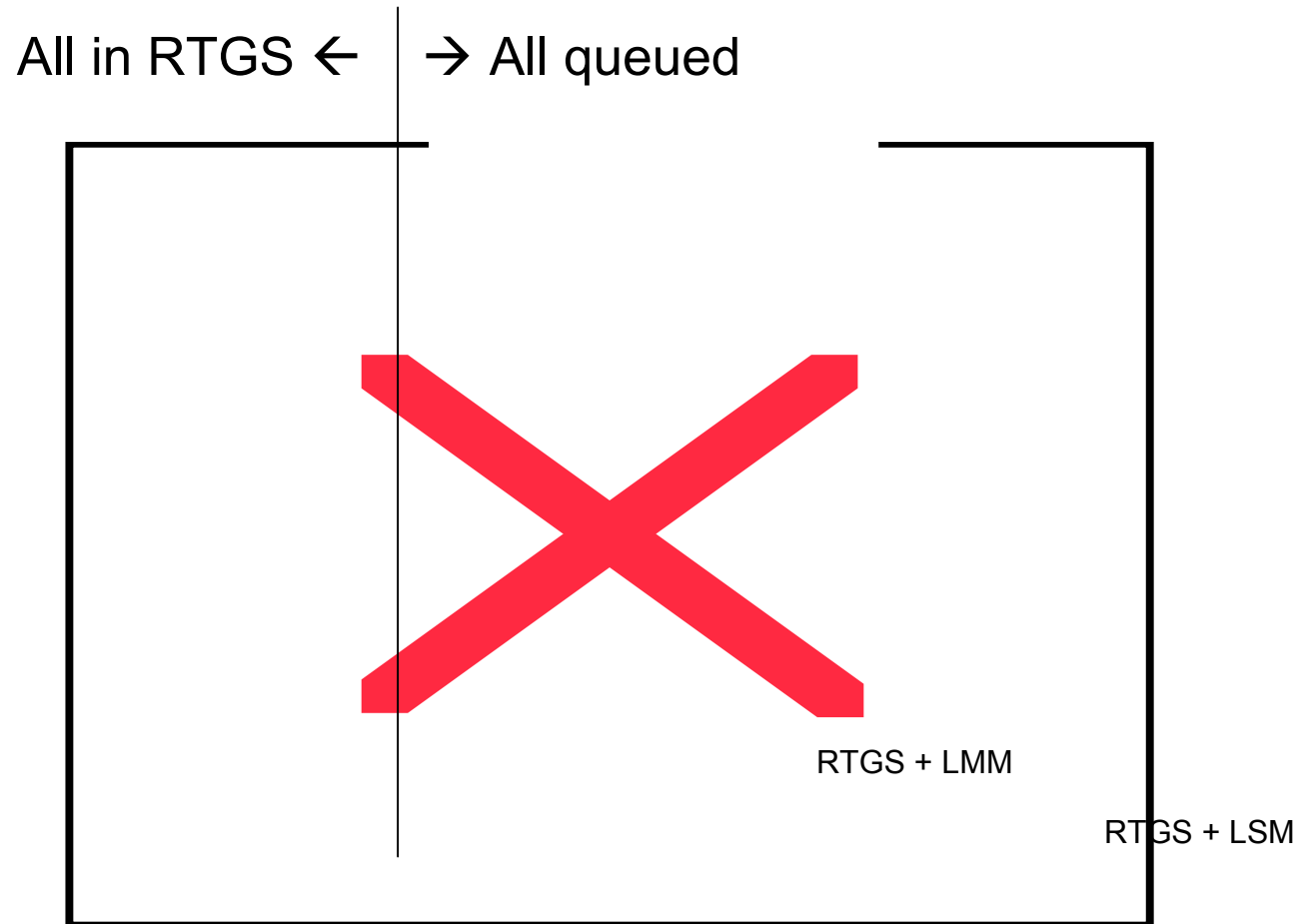
2

Potential savings from a LSM (‘LSM mechanics’)

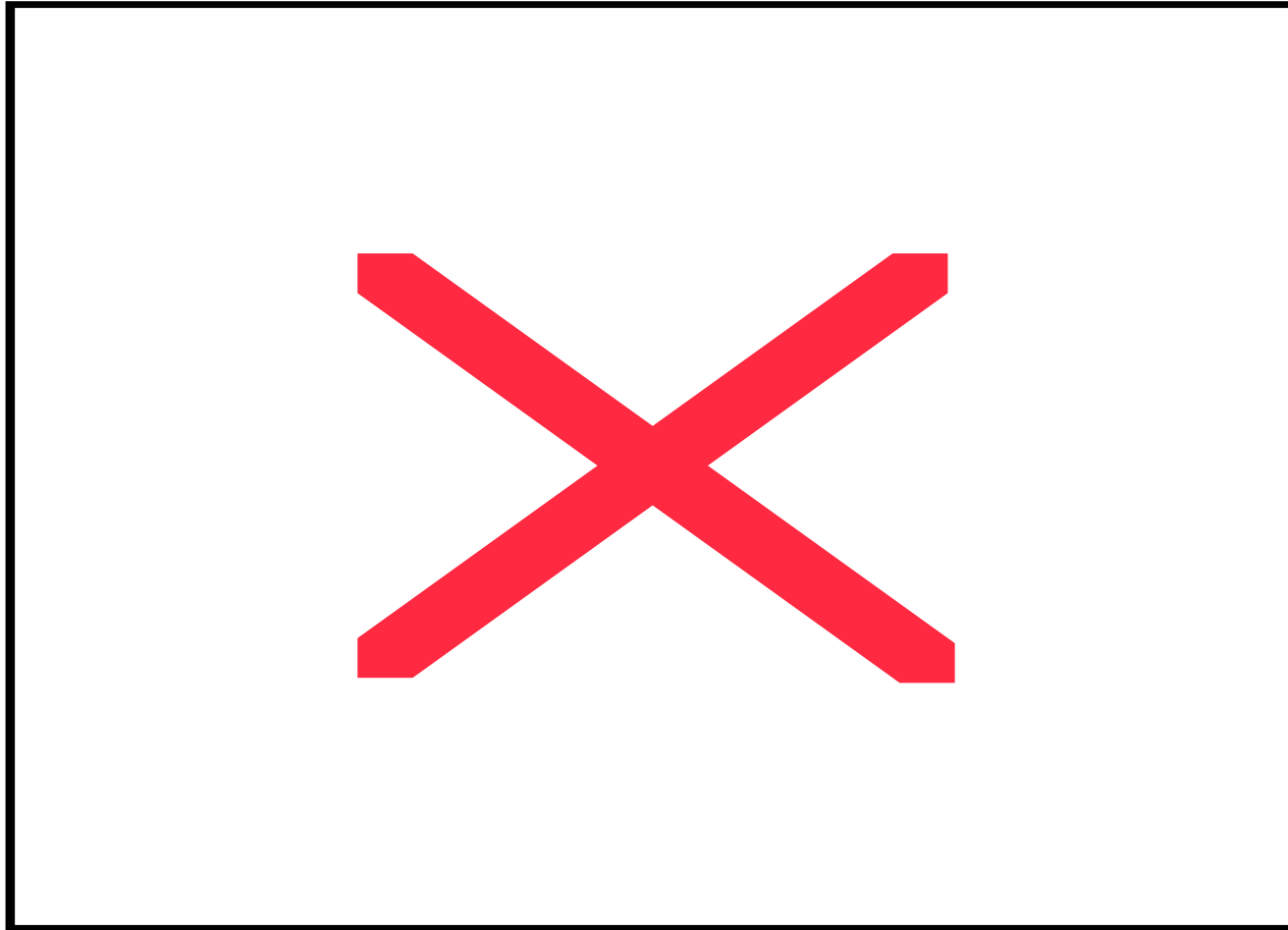
Savings in liquidity



Savings in liquidity



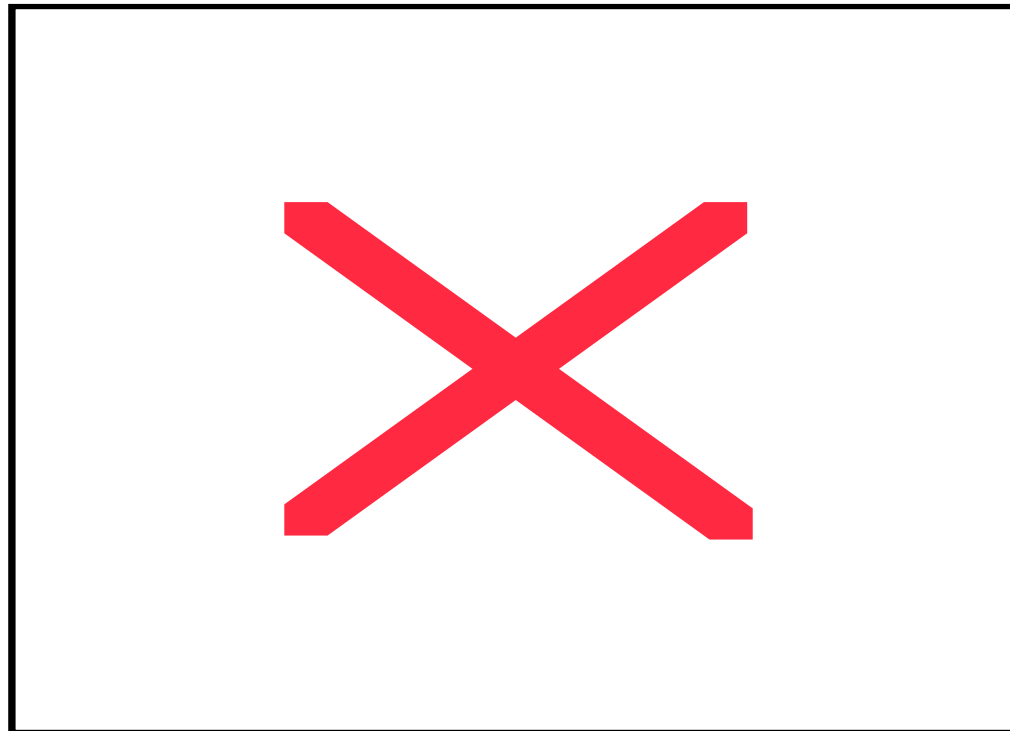
Savings in delay costs



3

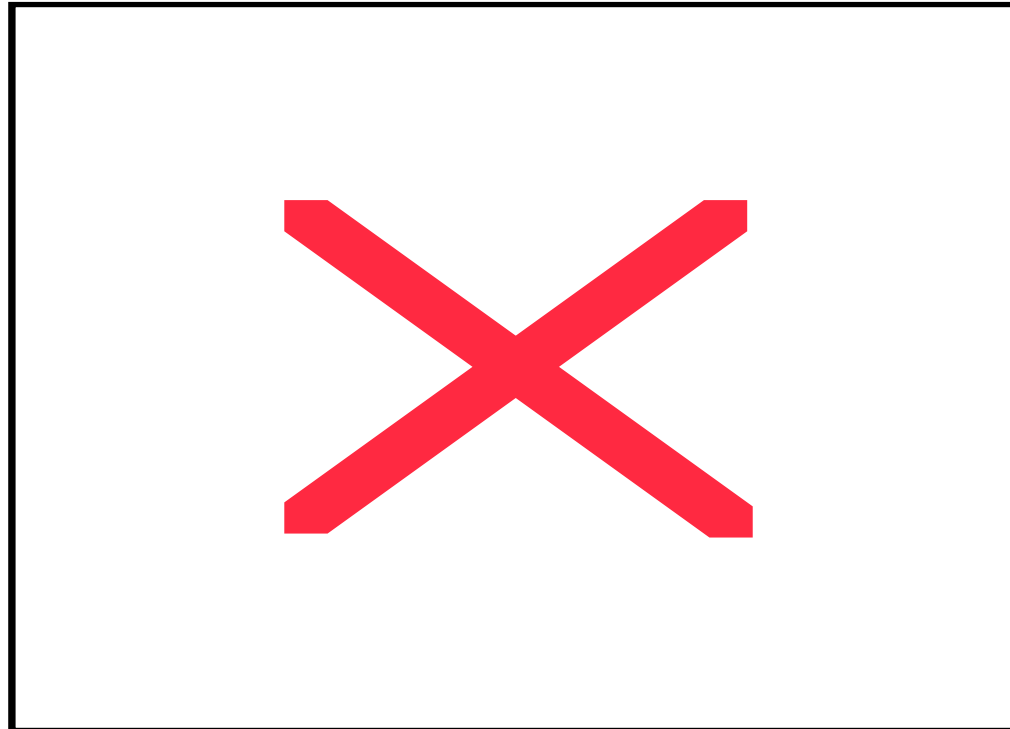
How would banks
use the LSM ?

Delay costs with LSM



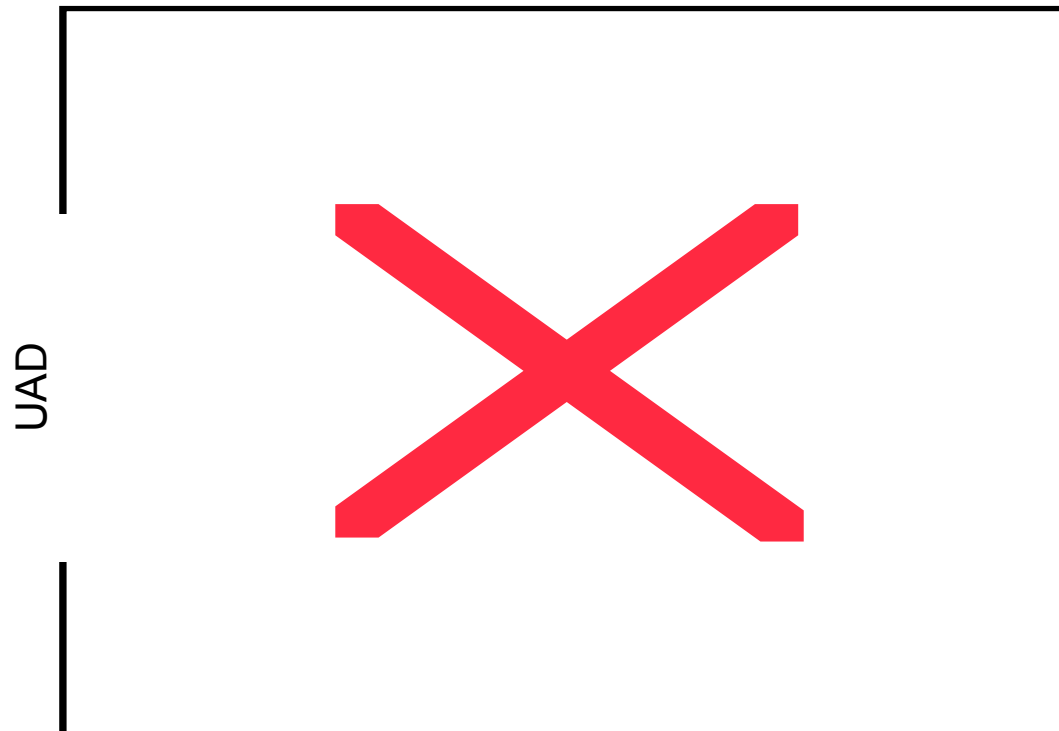
Delay costs with LSM

Increasing “your” threshold



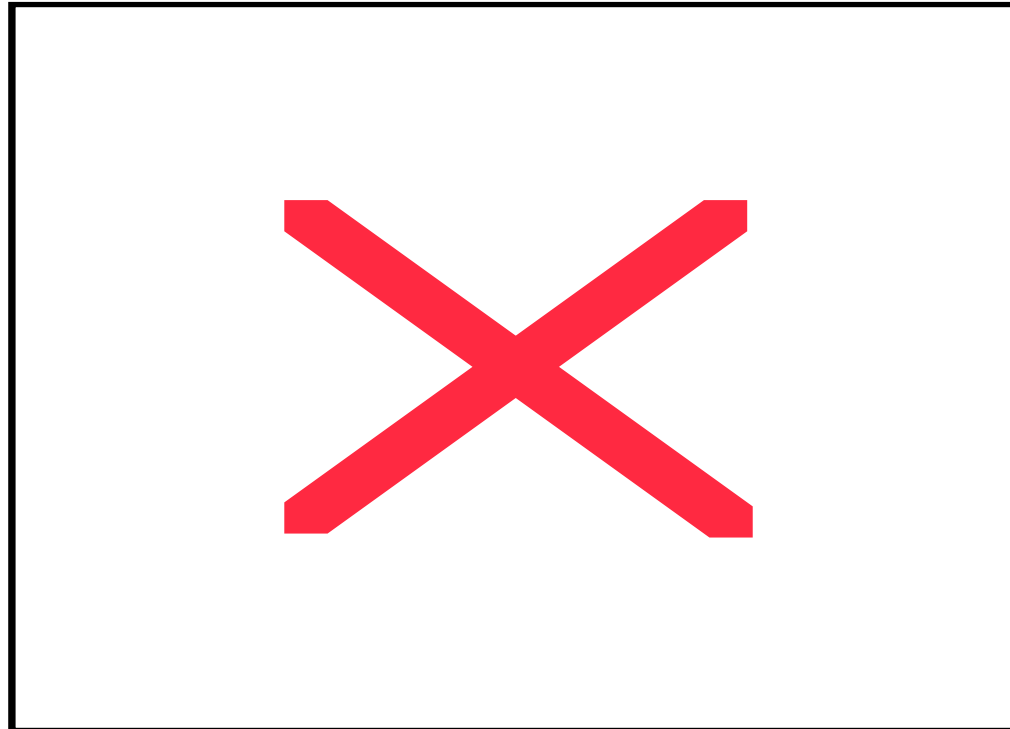
Delay costs with LSM

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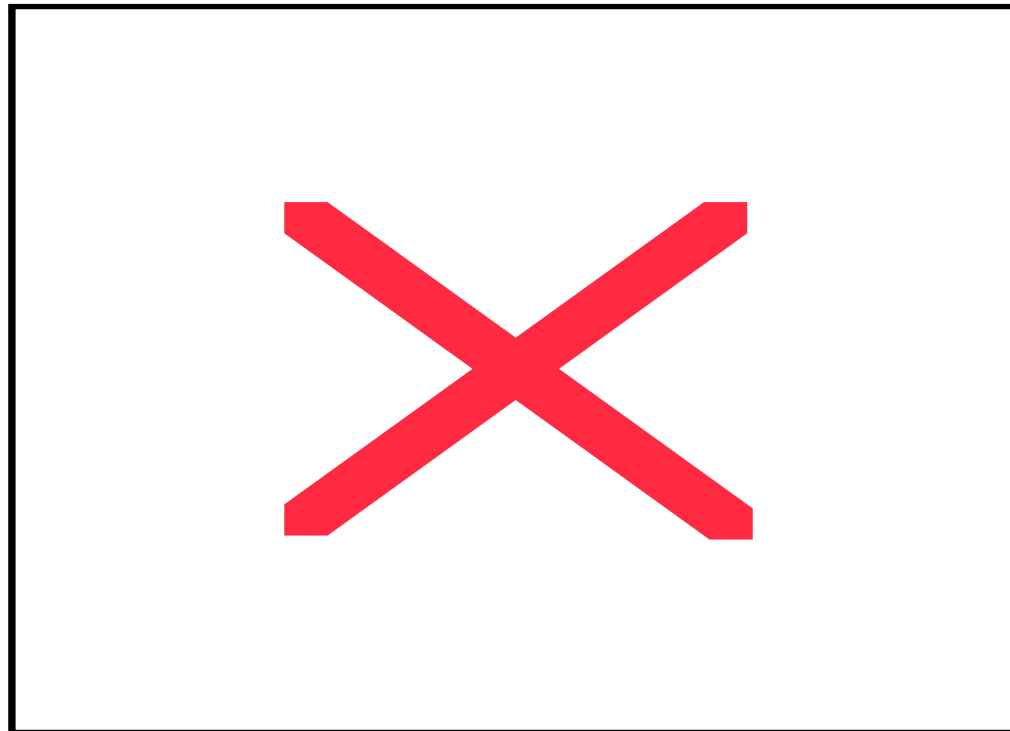
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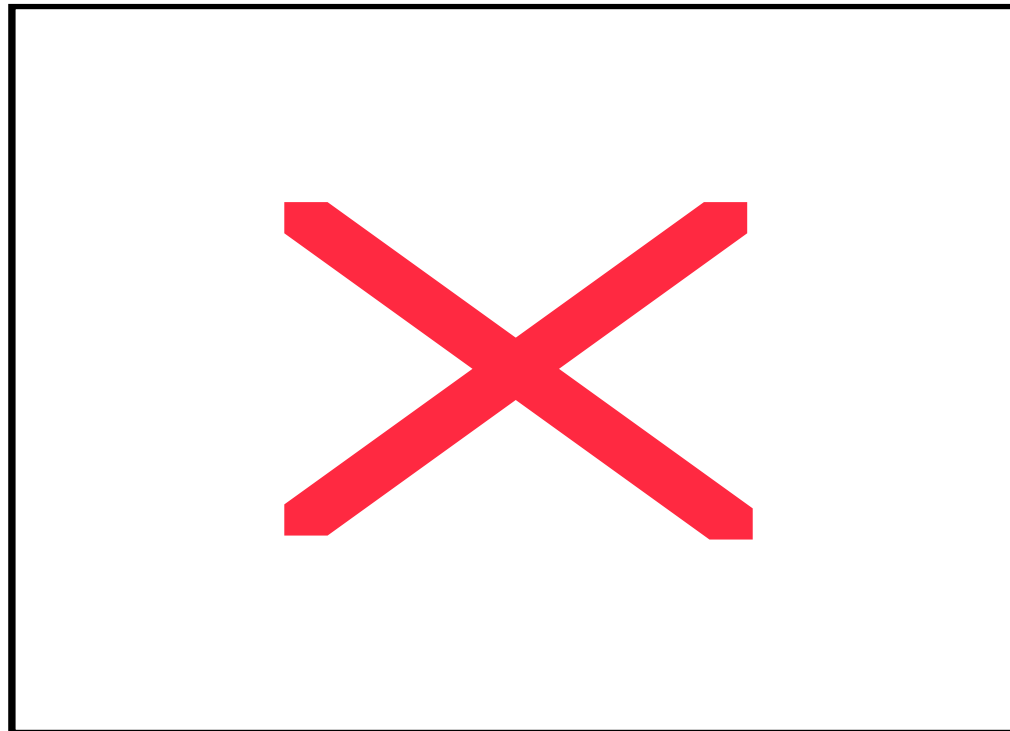
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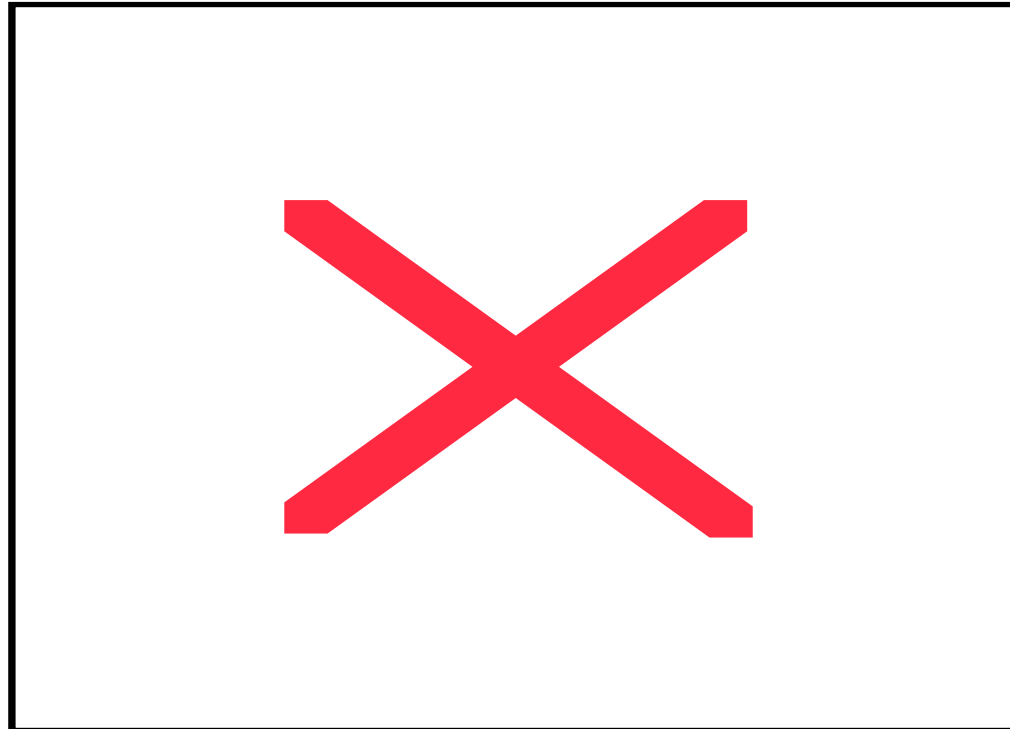
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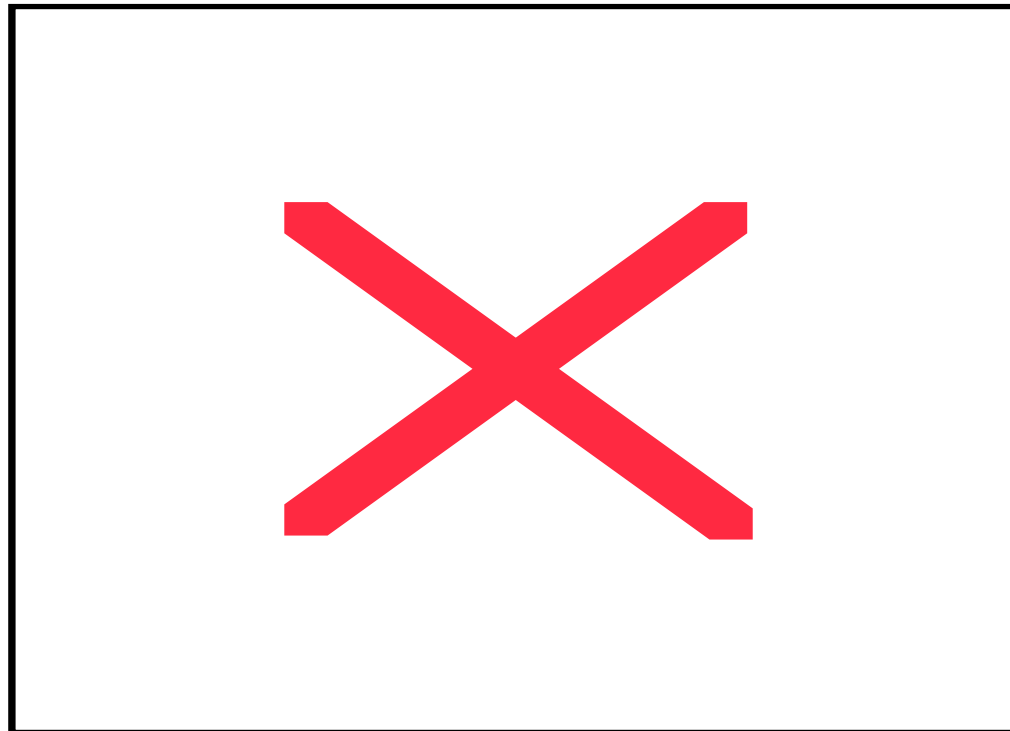
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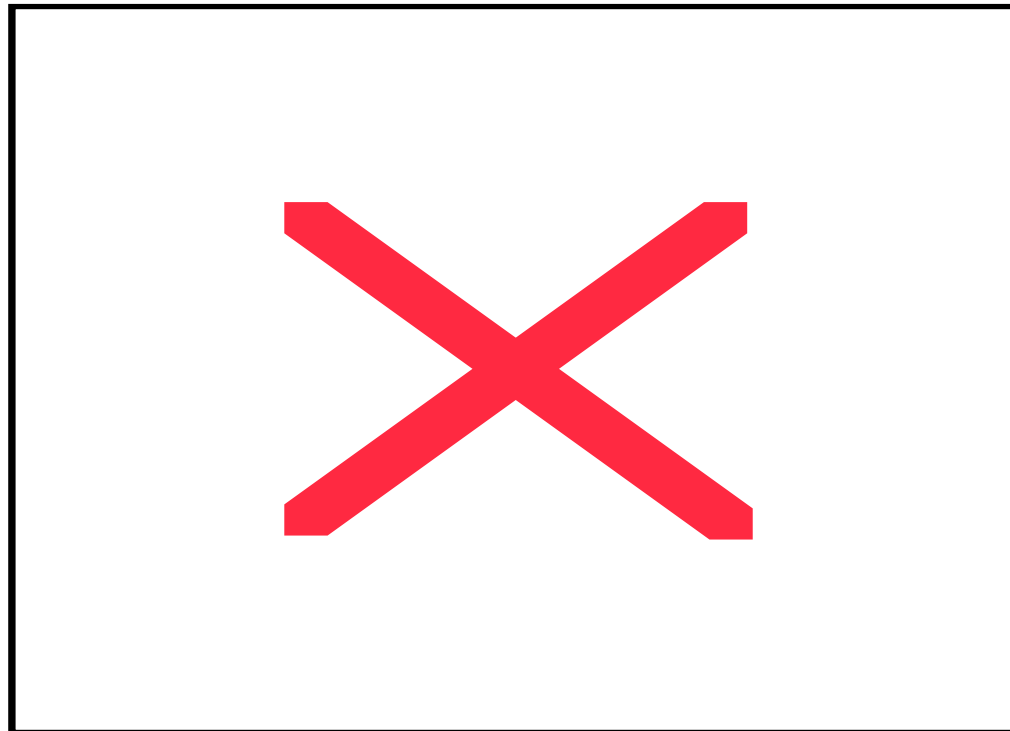
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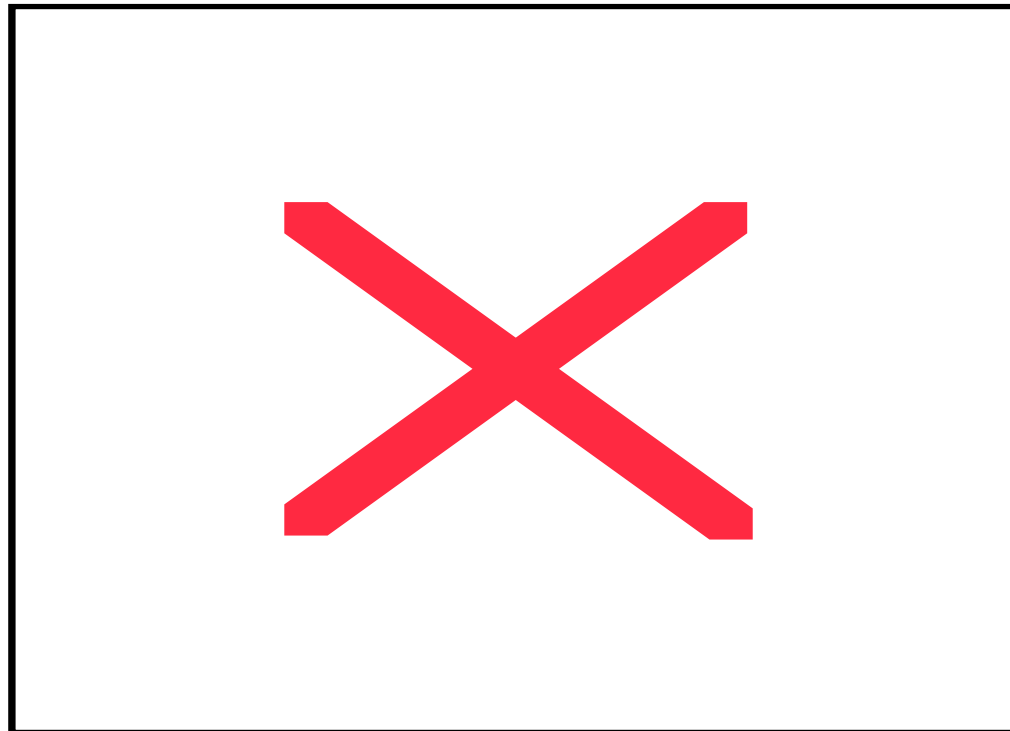
Delay costs with LSM

Increasing “your” threshold

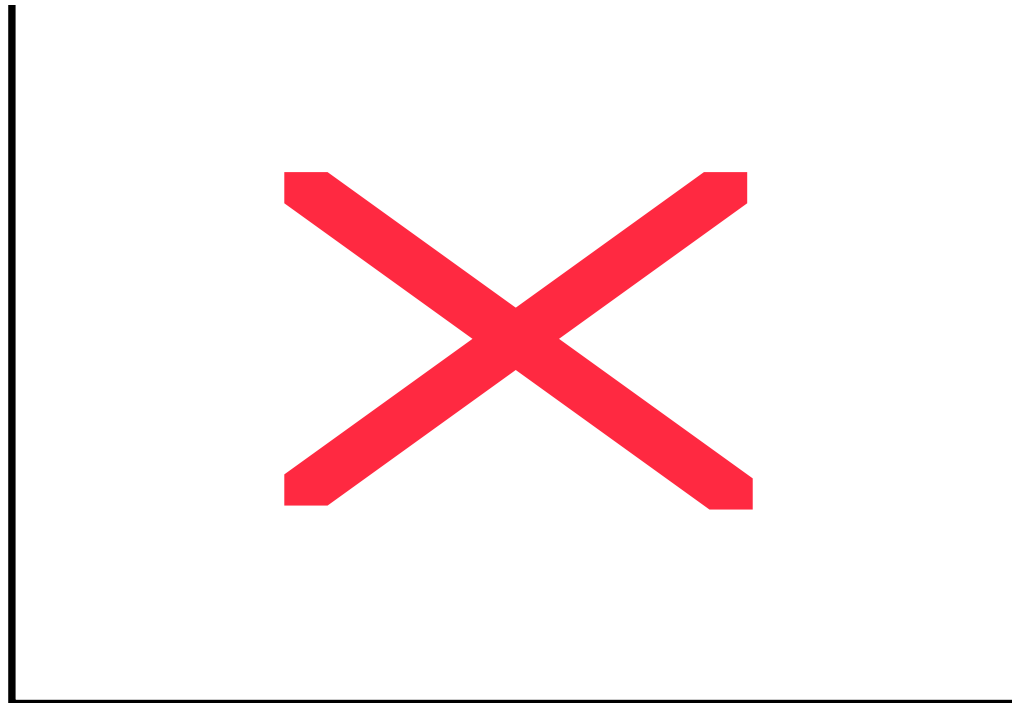


Delay costs with LSM

Increasing “your” threshold



_ - equilibria with LSM



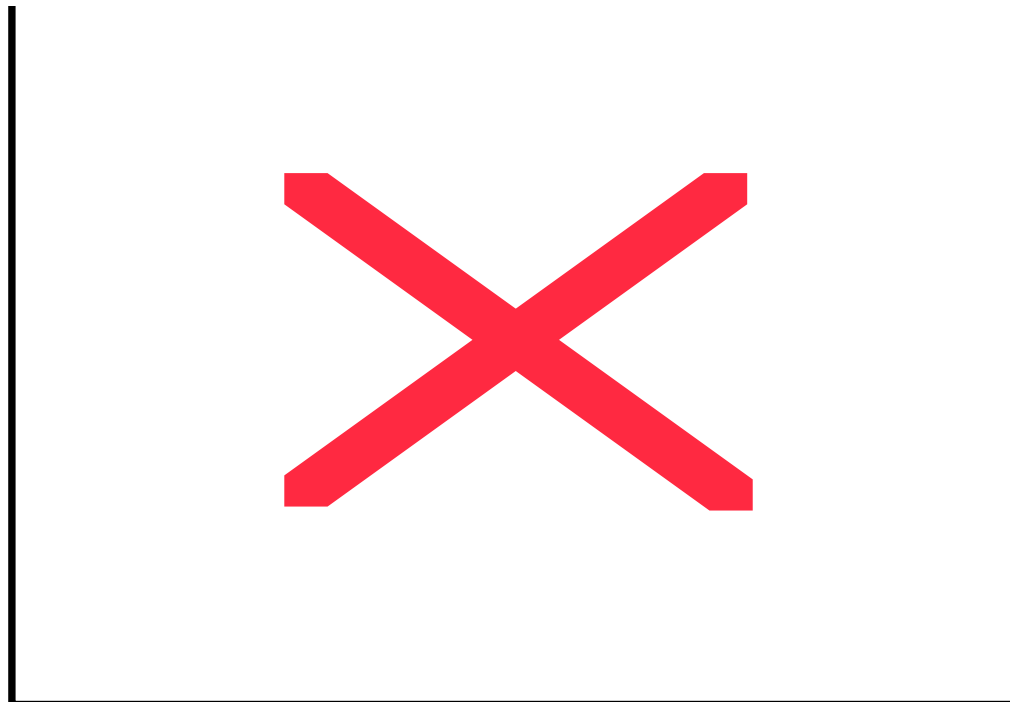
_ - equilibria with LSM

Increase liquidity price



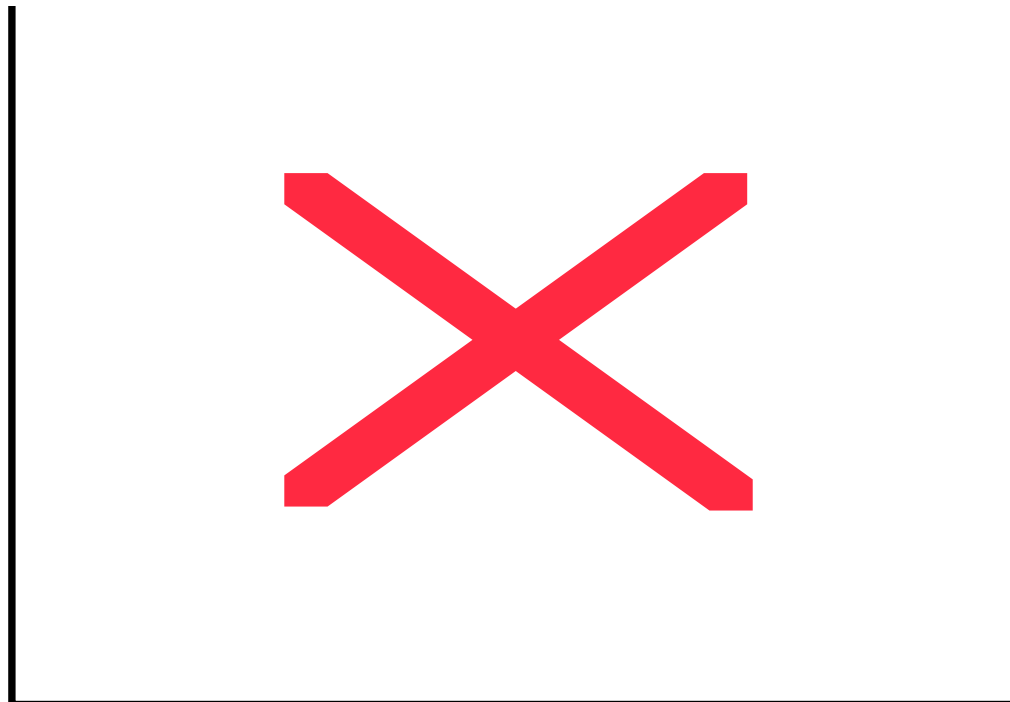
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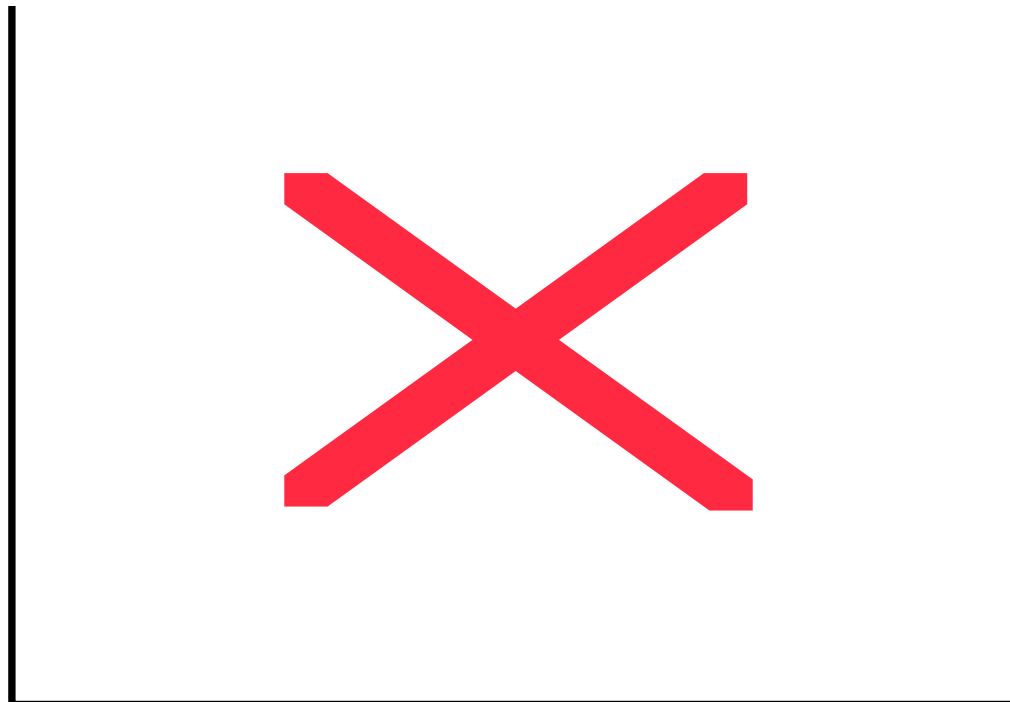
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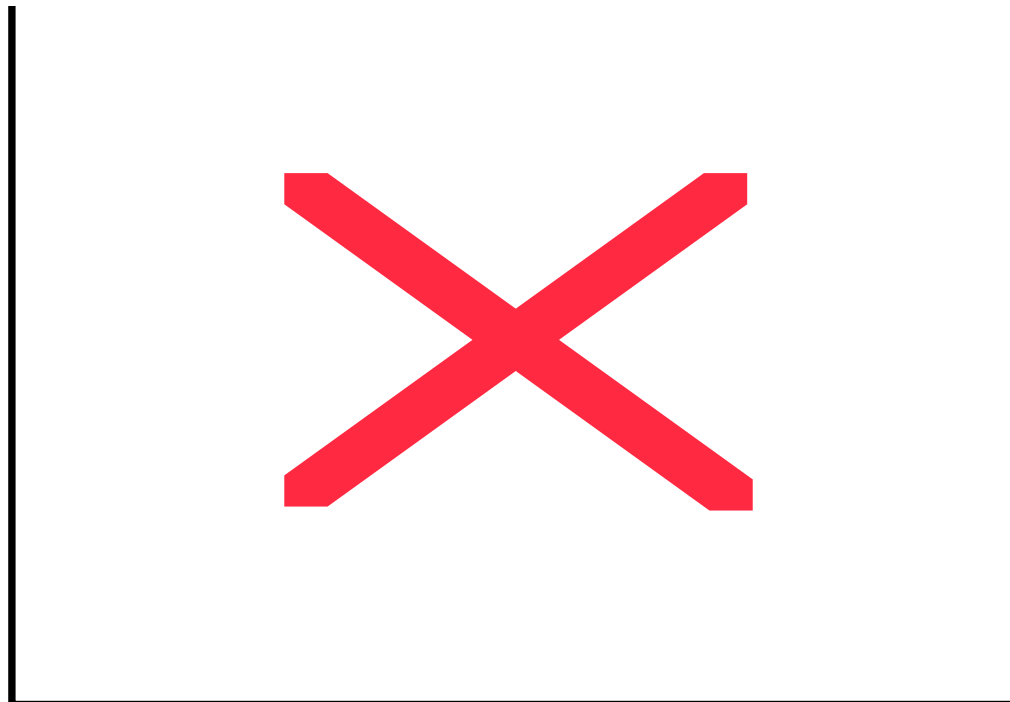
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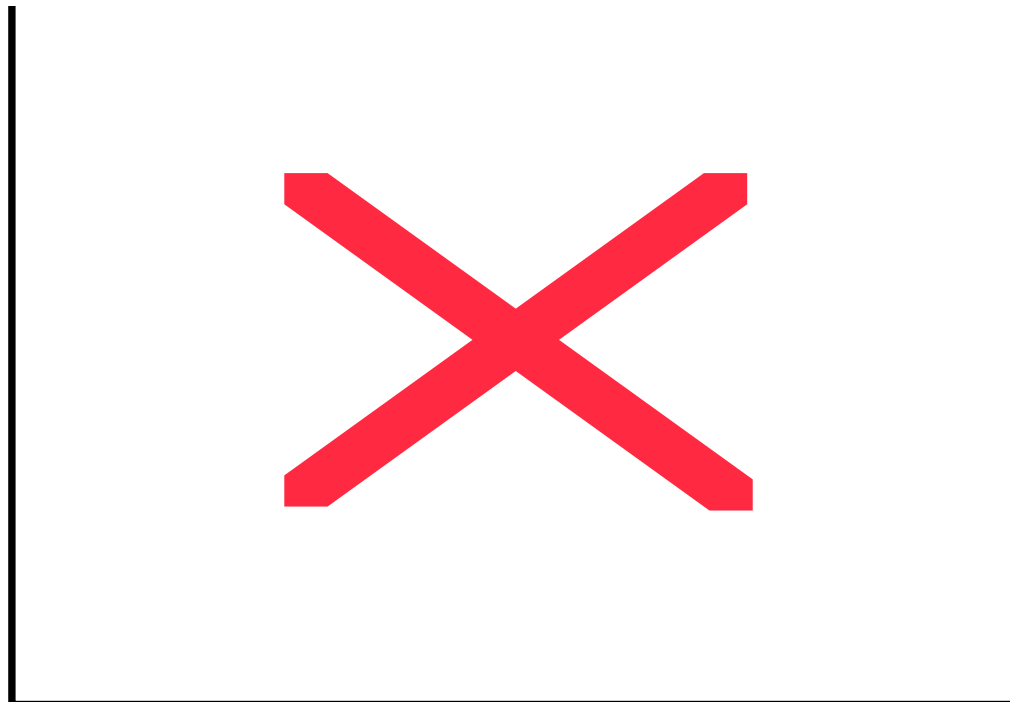
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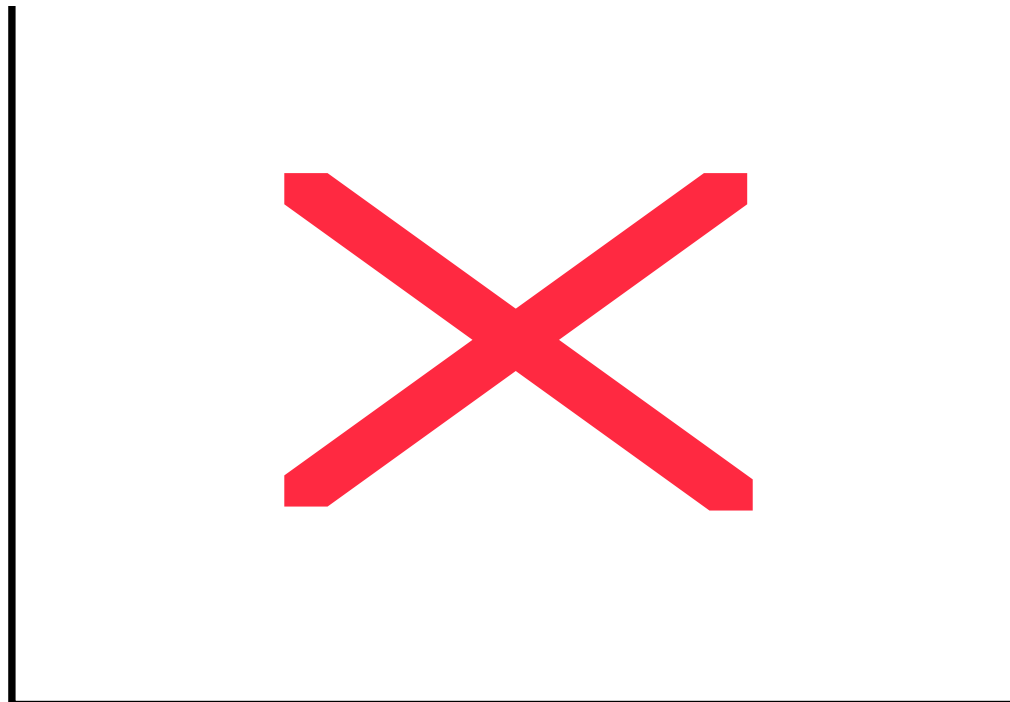
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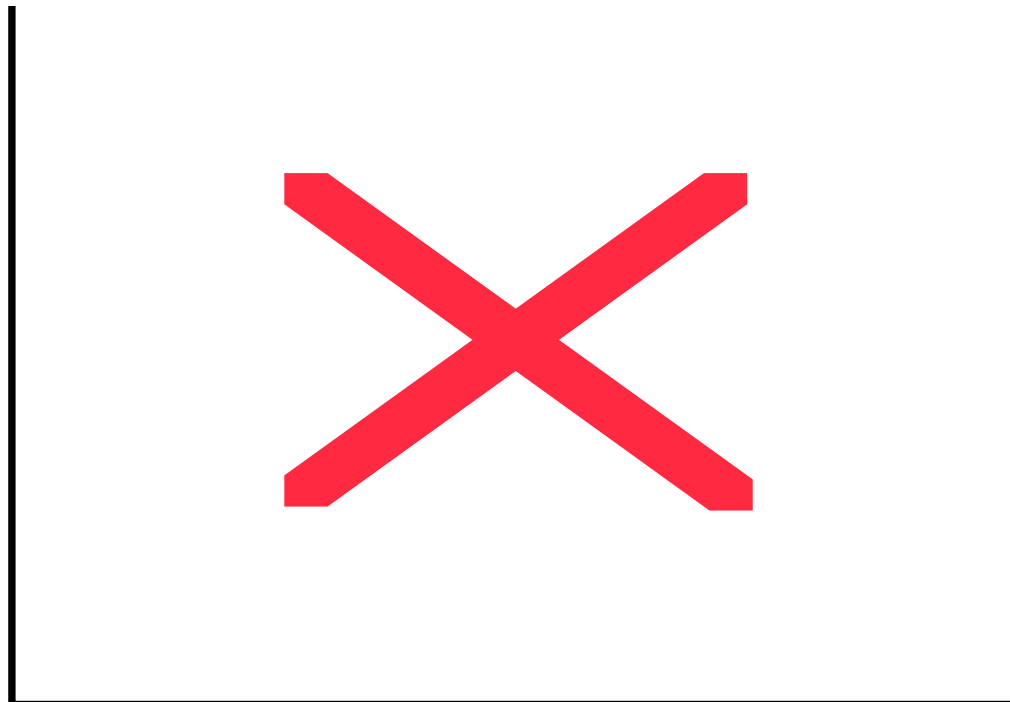
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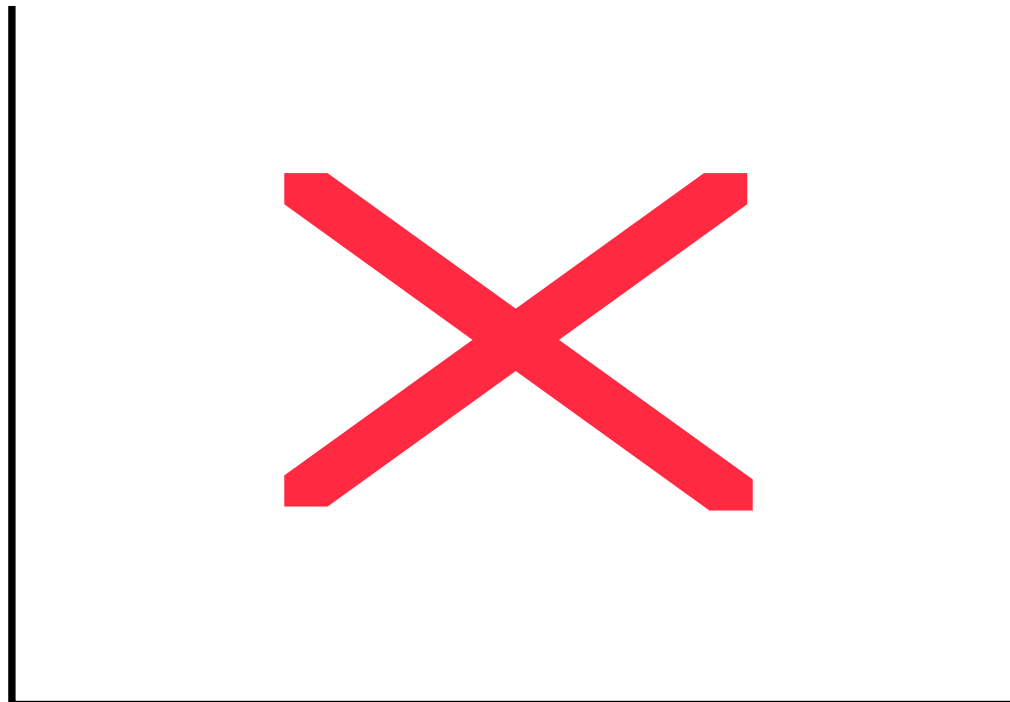
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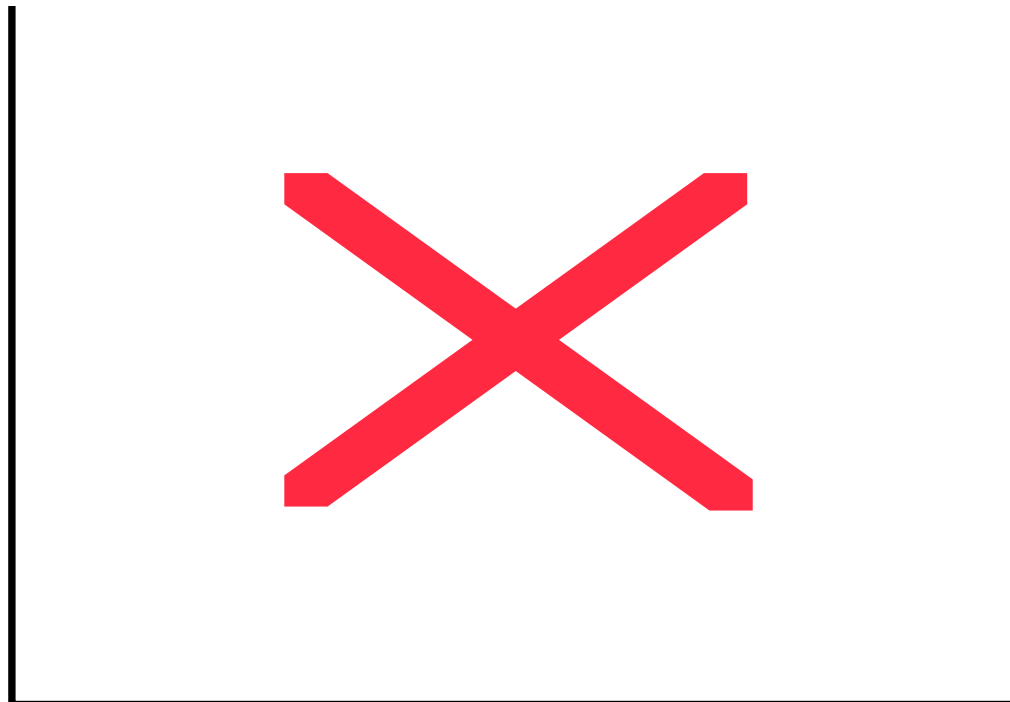
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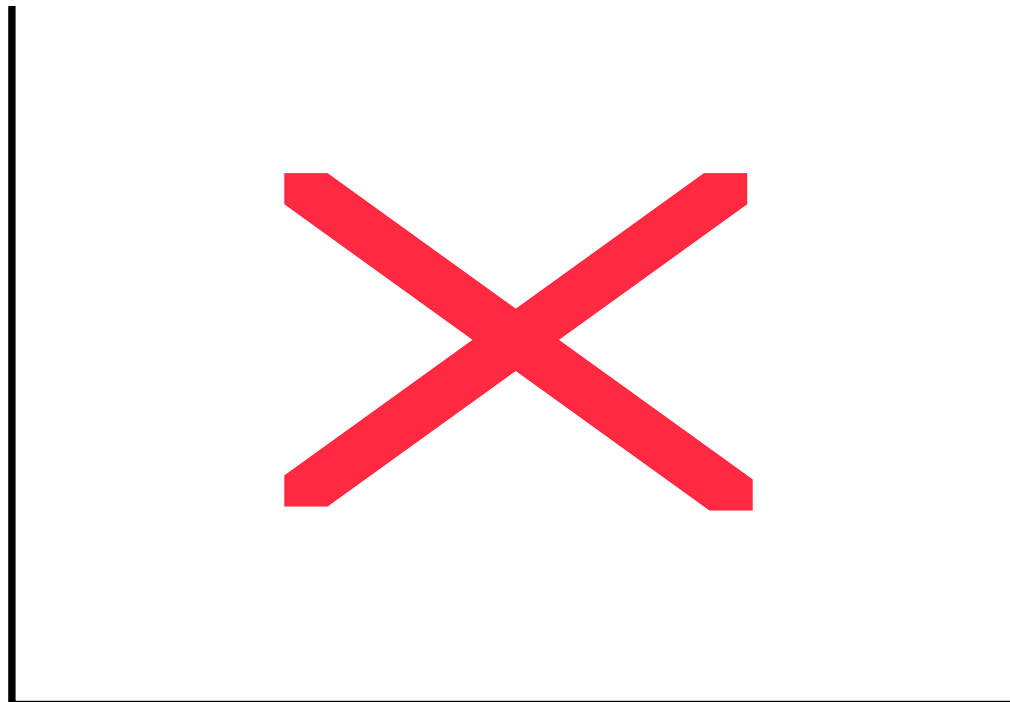
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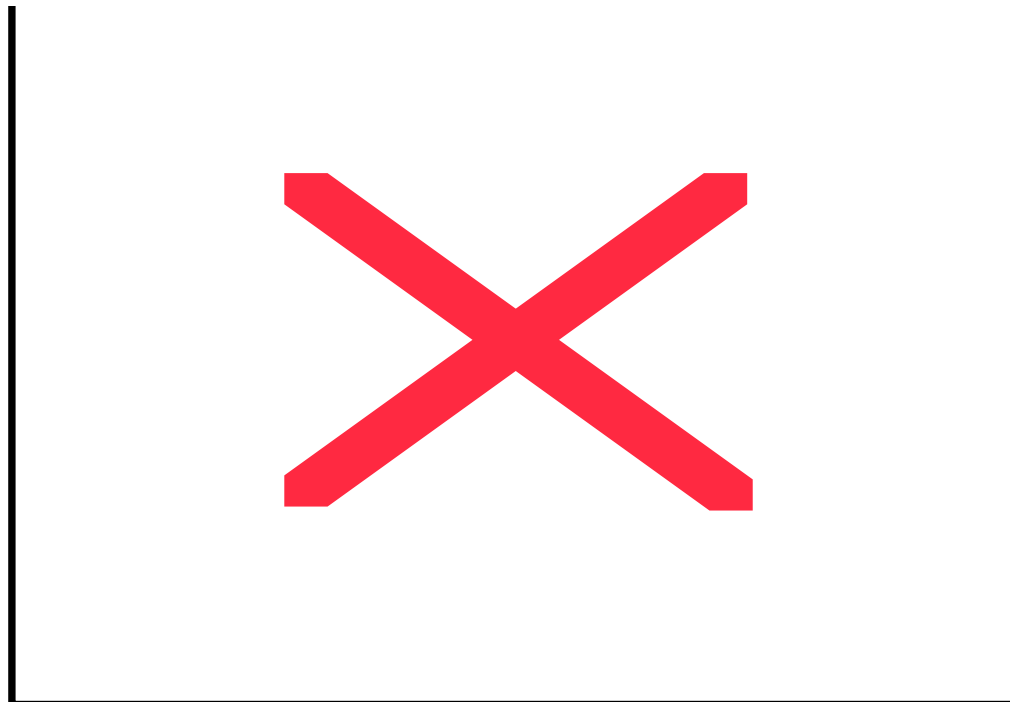
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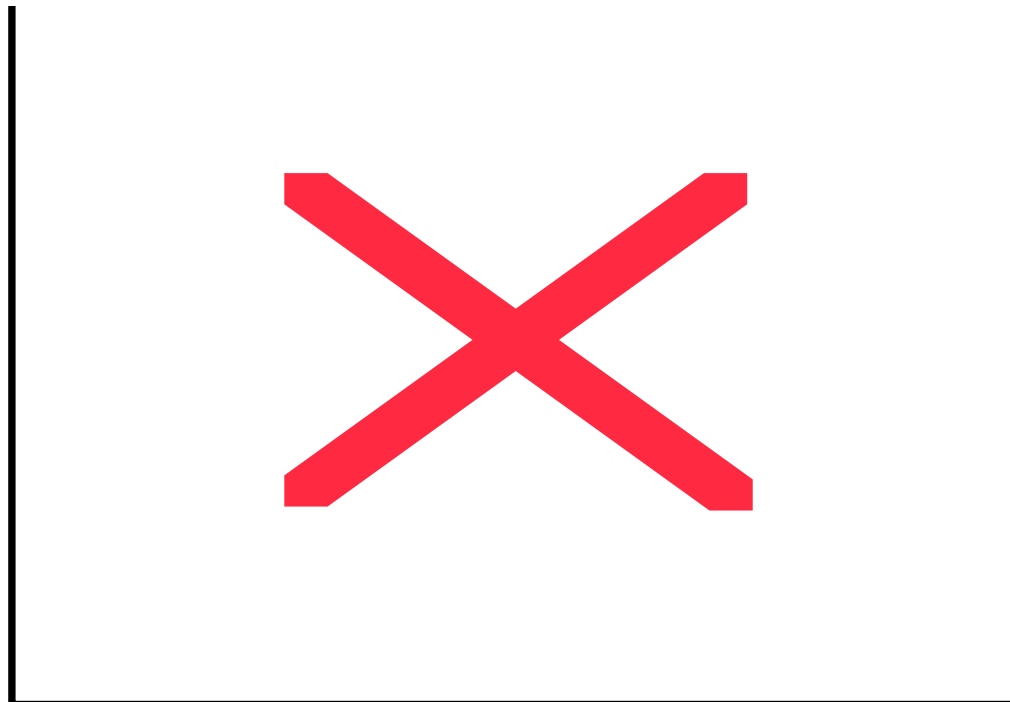
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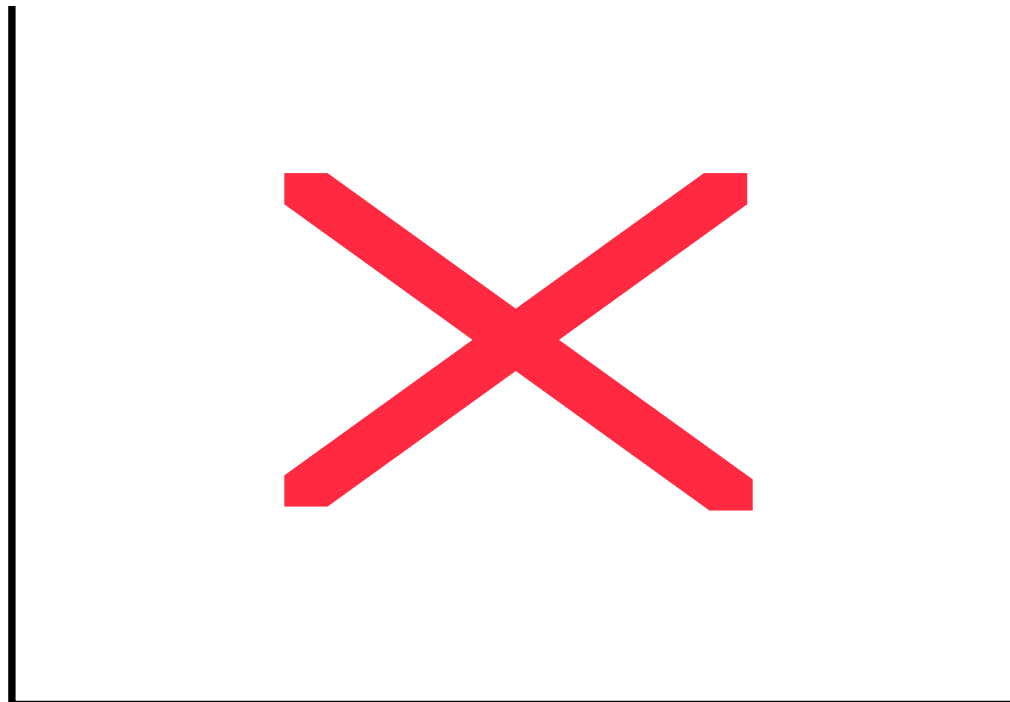
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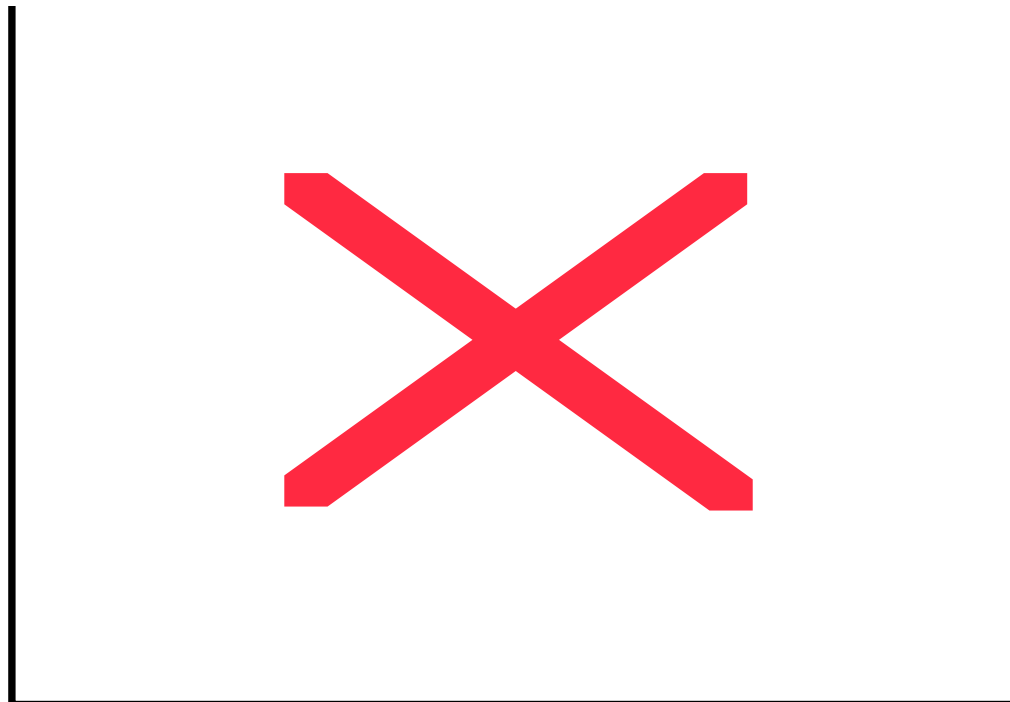
Increase liquidity price



At high liquidity cost
this is the only
equilibrium

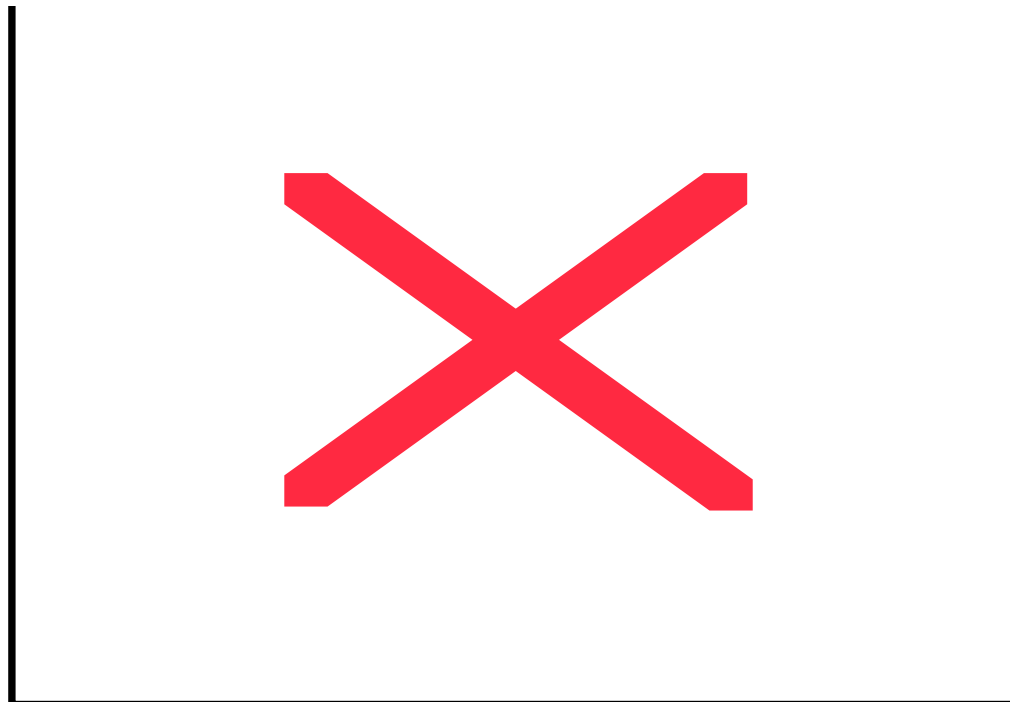
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Increase liquidity price



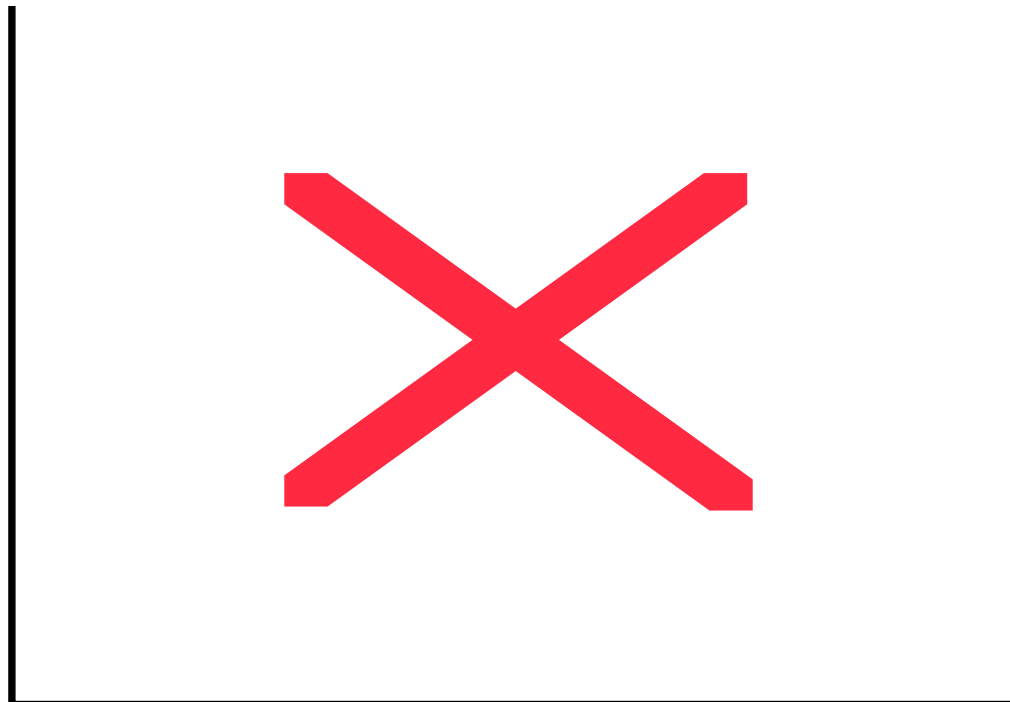
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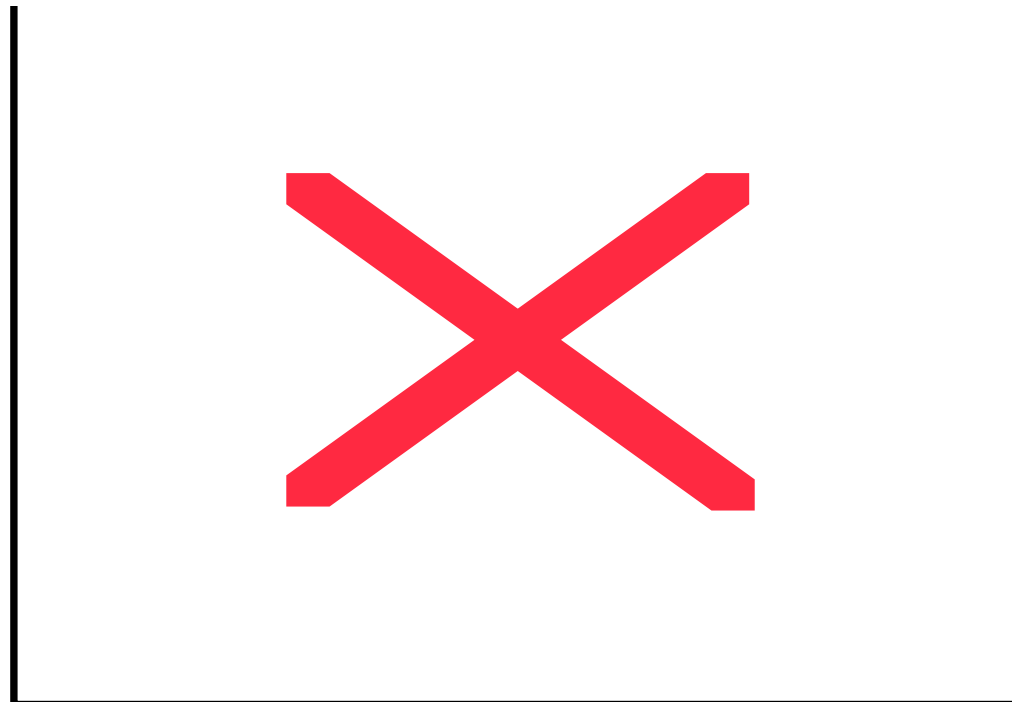
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Increase liquidity price



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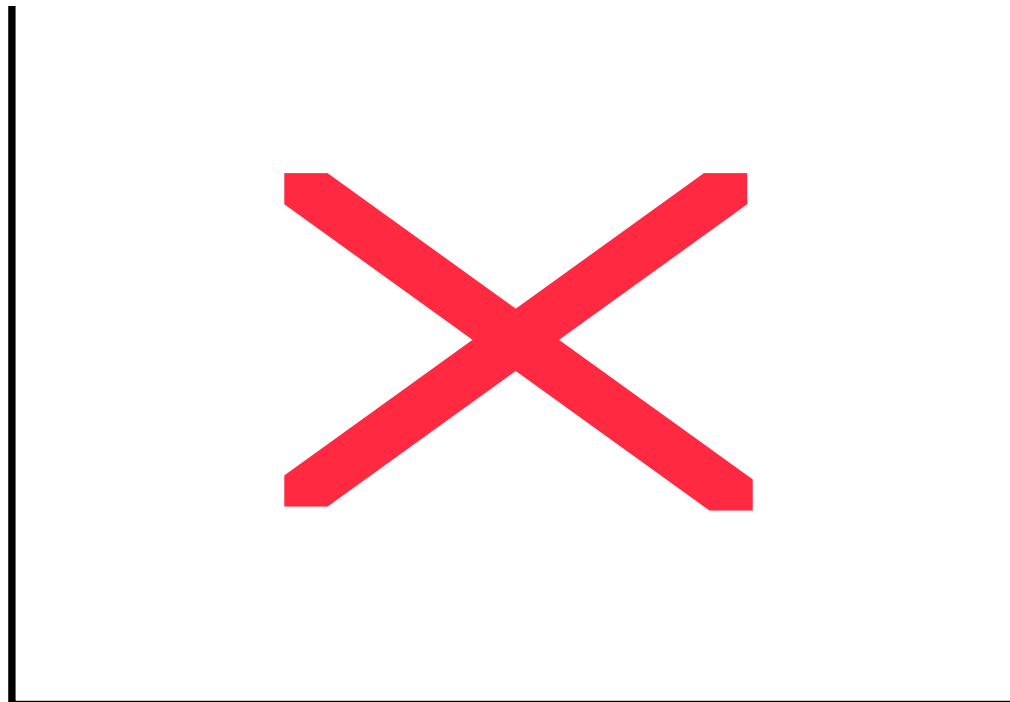
Increase liquidity price



At very high liquidity cost planner and banks choose the same

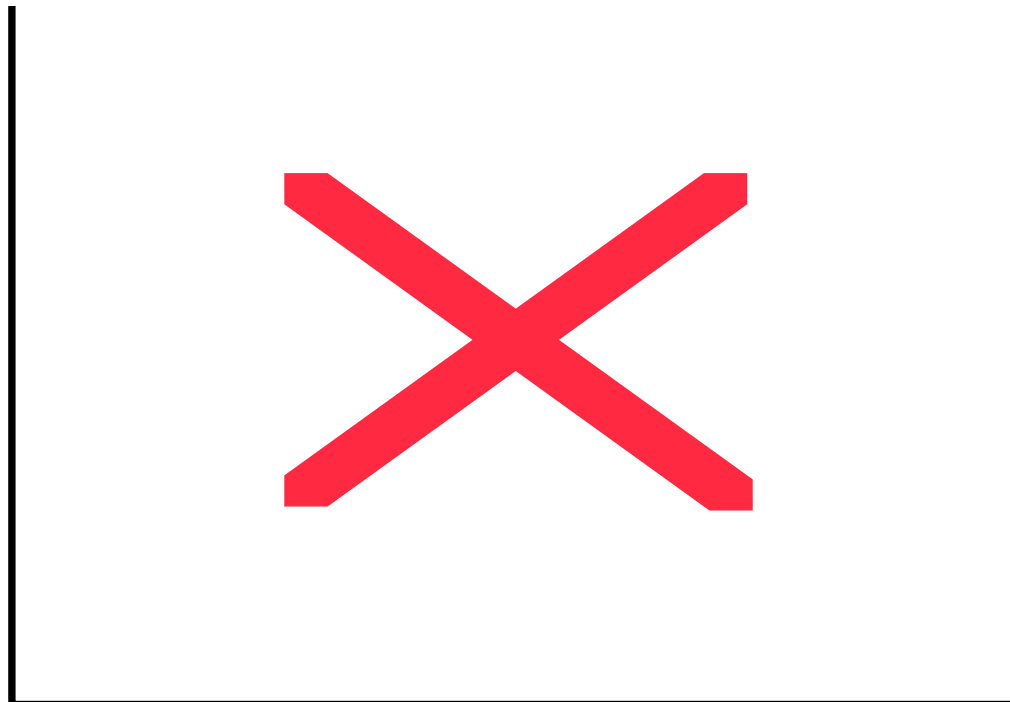
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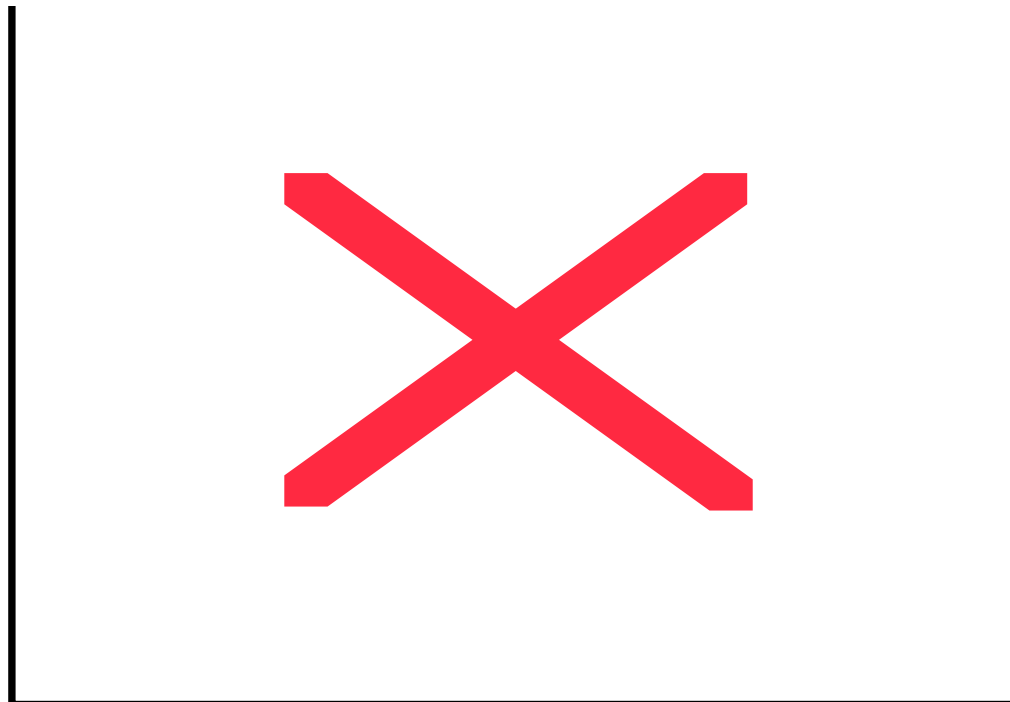
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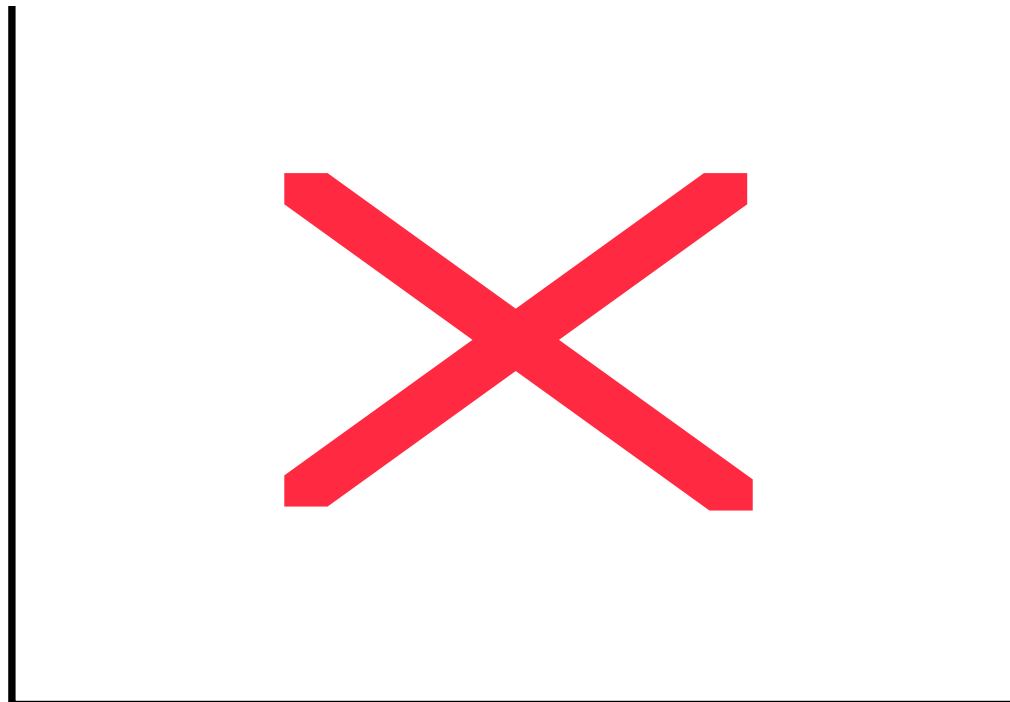
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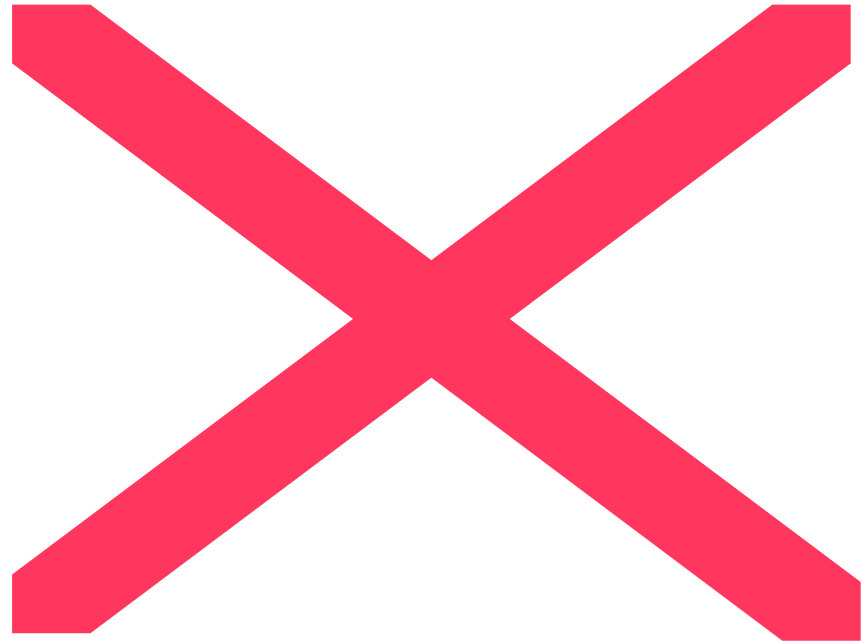
Increase liquidity price



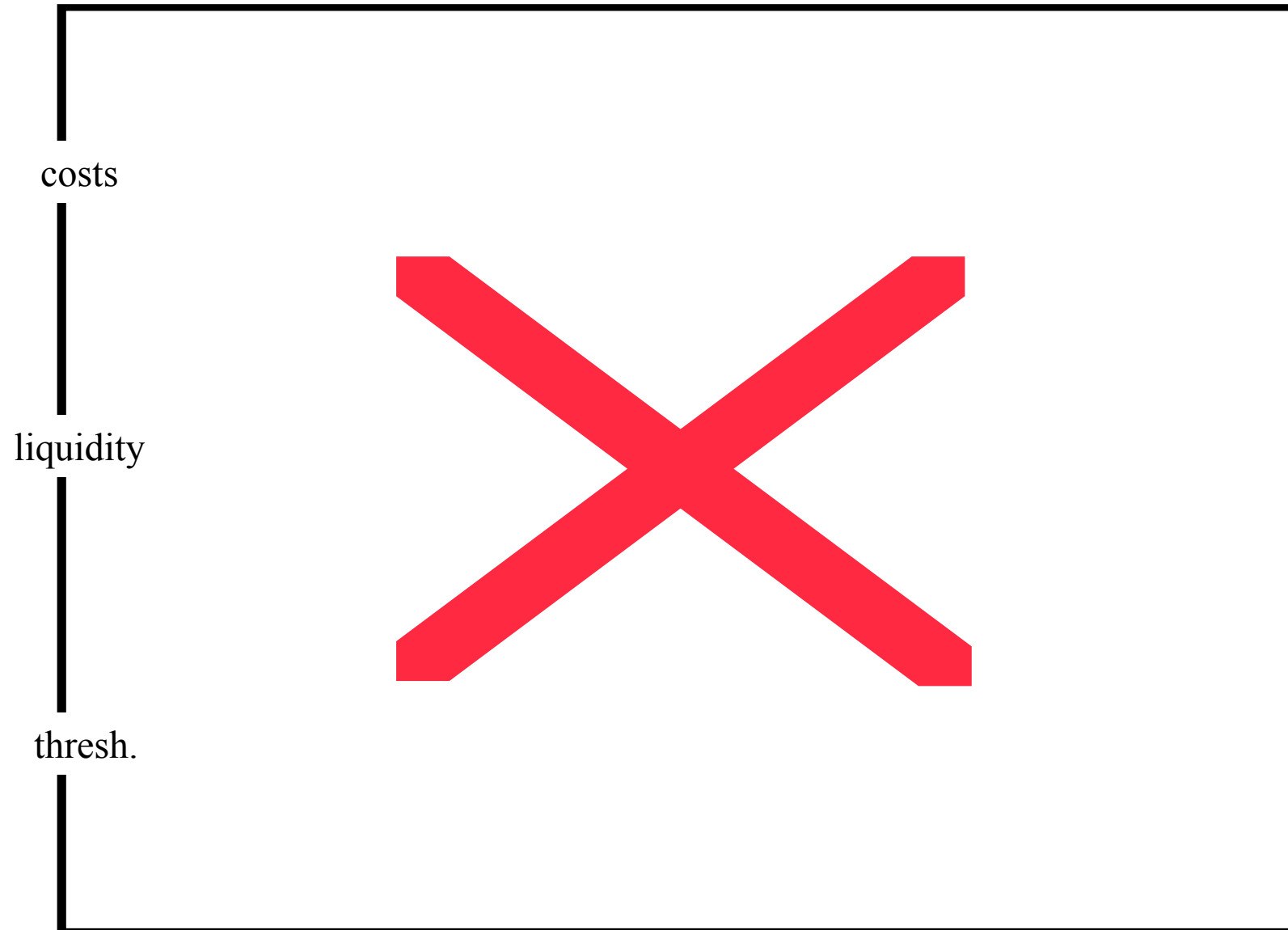
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Increase liquidity price

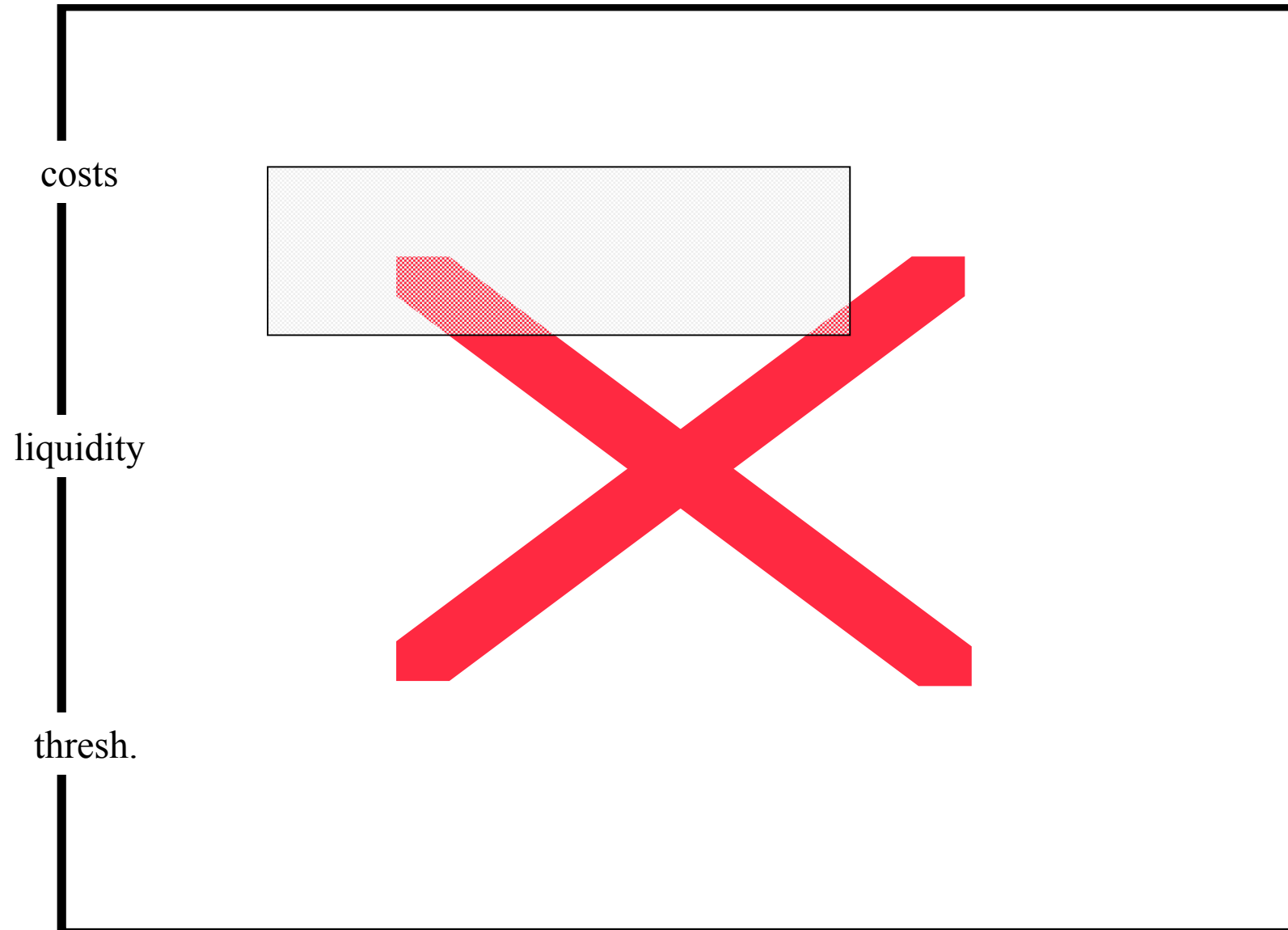




LMM vs LSM (good) equilibria



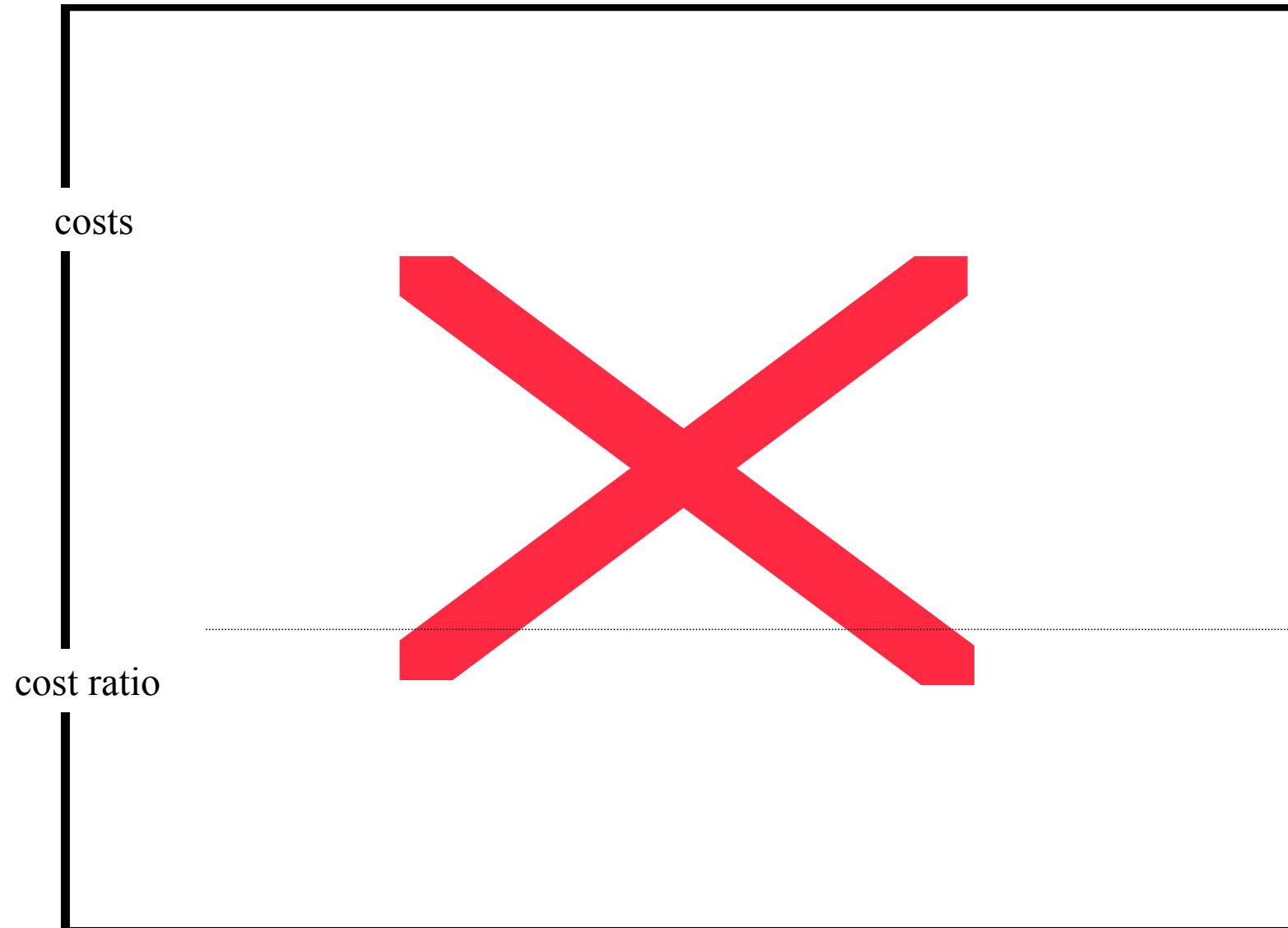
LMM vs LSM (good) equilibria



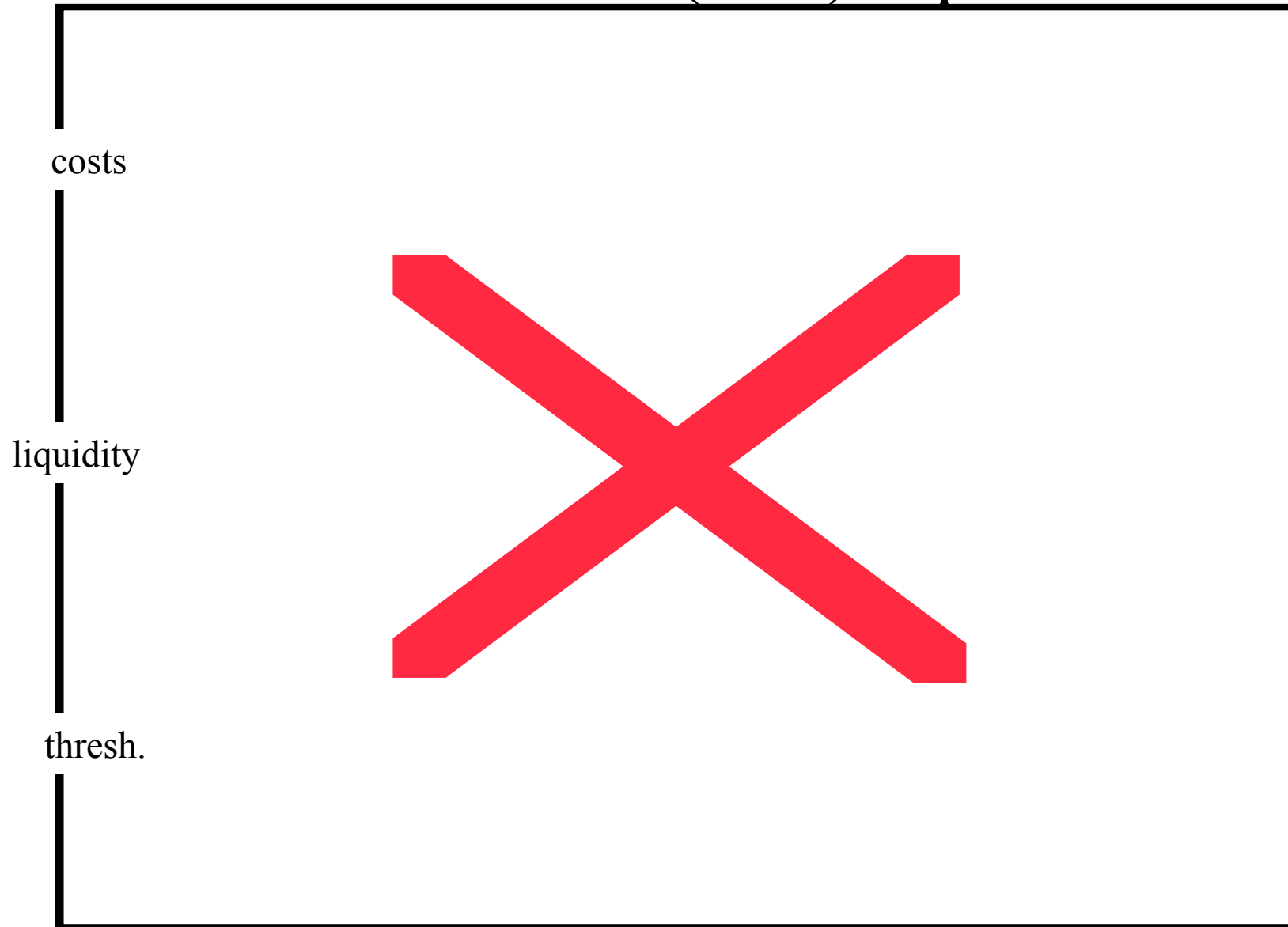
LMM vs LSM (good) equilibria



LMM vs LSM (good) equilibria



LMM vs LSM (bad) equilibria



Conclusions

In the hands of a ‘planner’,
LSM can save substantial amounts of liquidity,
and largely improve settlement speed

Conclusions

In the hands of a ‘planner’,
LSM can save substantial amounts of liquidity,
and largely improve settlement speed
(but may require radical choices)

In the hands of individual banks,
LSM may require some ‘coordination device’
to yield its potential benefits

Conclusions

In the hands of a ‘planner’,
LSM can save substantial amounts of liquidity,
and largely improve settlement speed

In the hands of individual banks,
LSM may require some ‘coordination device’
to yield its potential benefits

Slide 112

Slide 113 (!)

~ _ ~

Many thanks