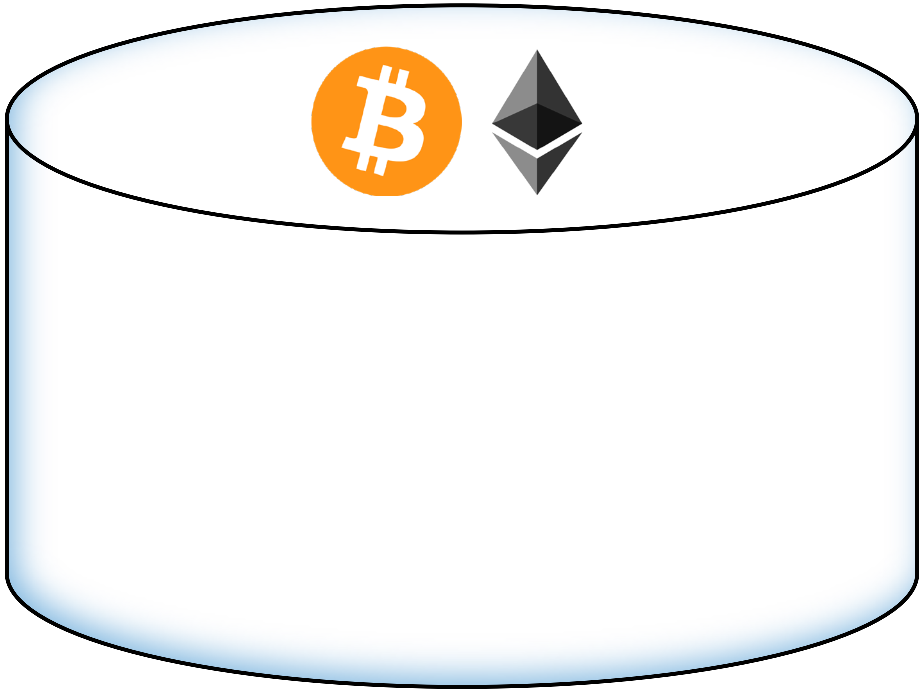
The Potential of Self-Regulation for Front-Running Prevention on DEXes

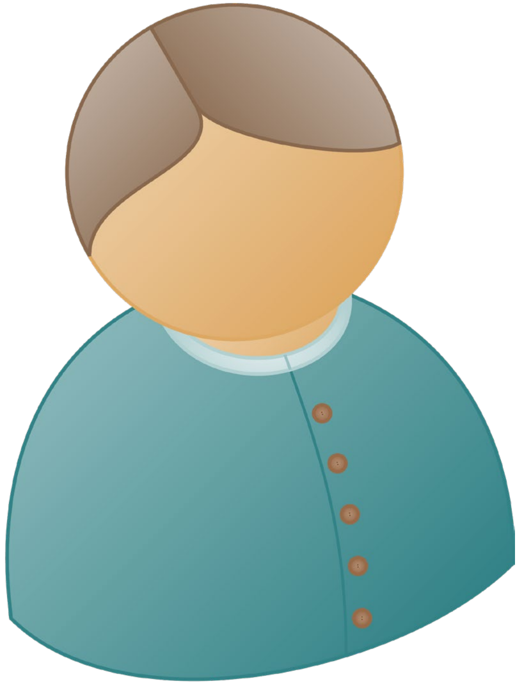


Lioba Heimbach, Eric Schertenleib, Roger Wattenhofer

WEIS 2023

ETH Zurich

Decentralized exchanges (DEXes)



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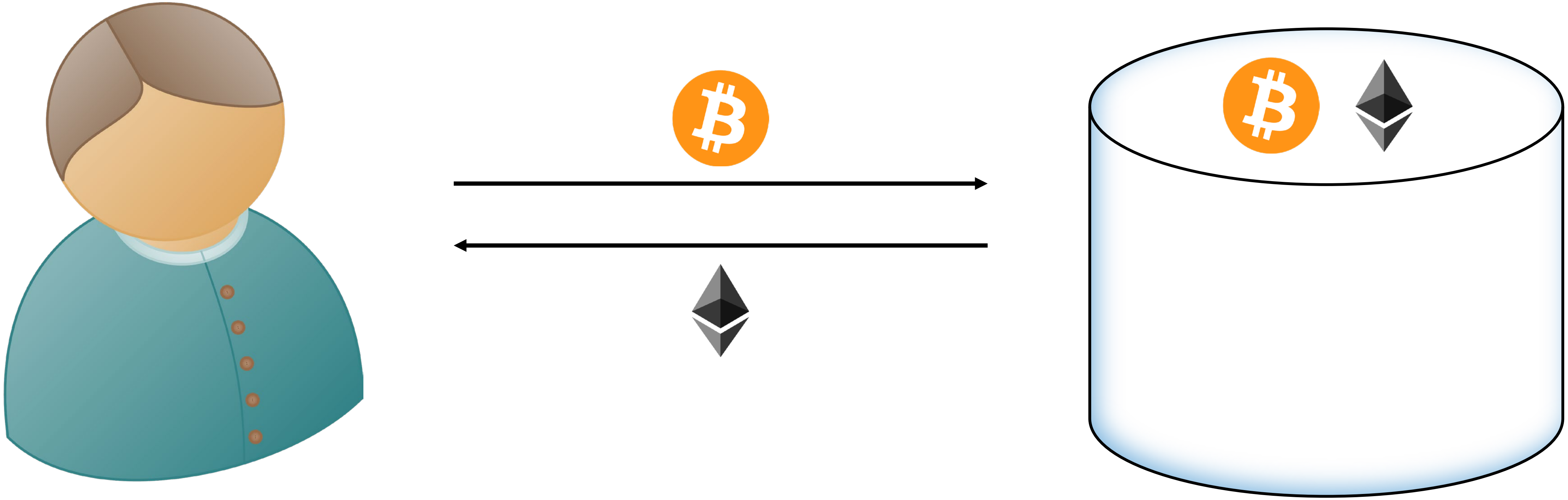
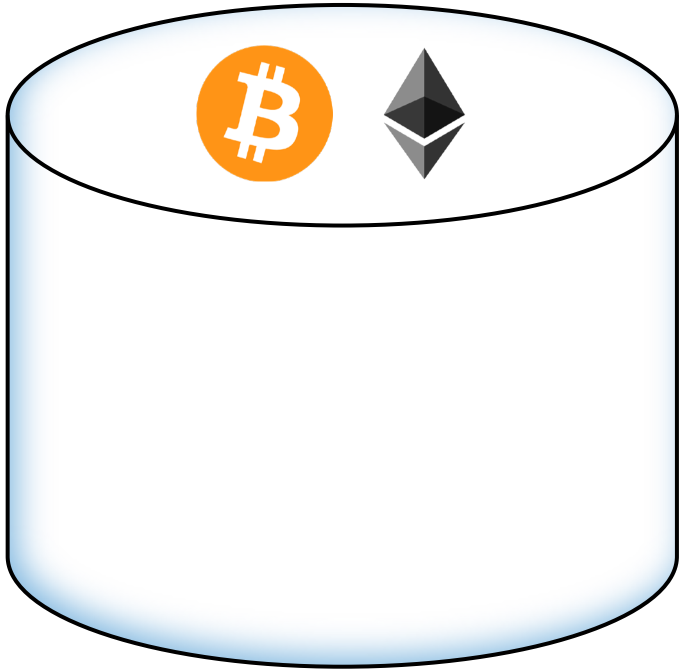
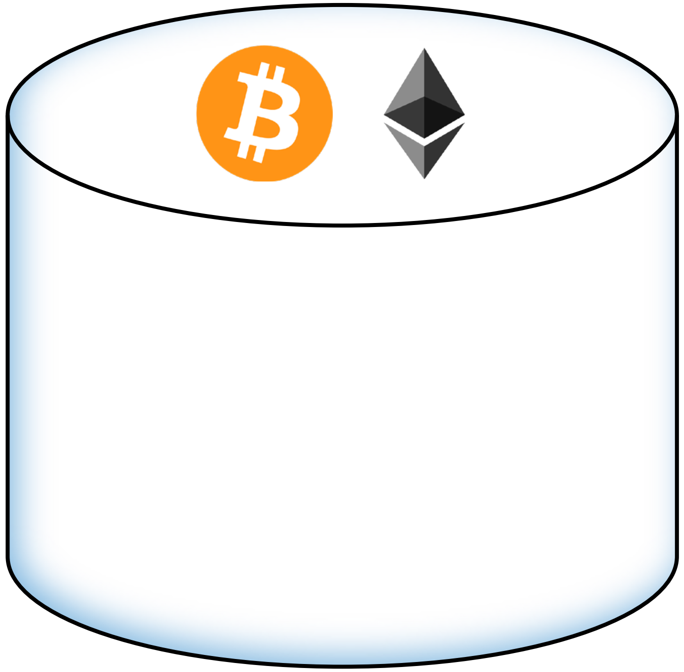


Constant product market makers (CPMMs)



liquidity pool for every token pair

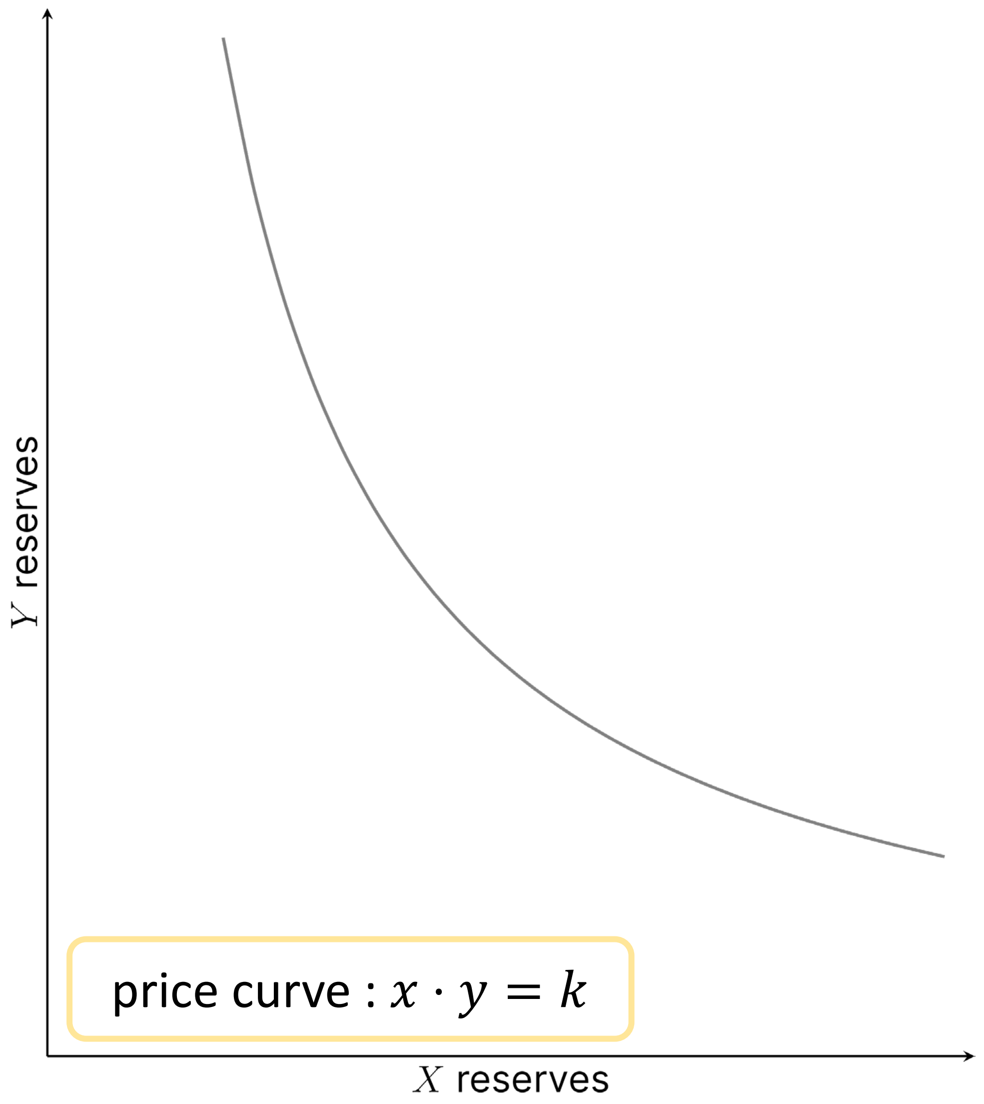
Constant product market makers (CPMMs)



liquidity pool for every token pair

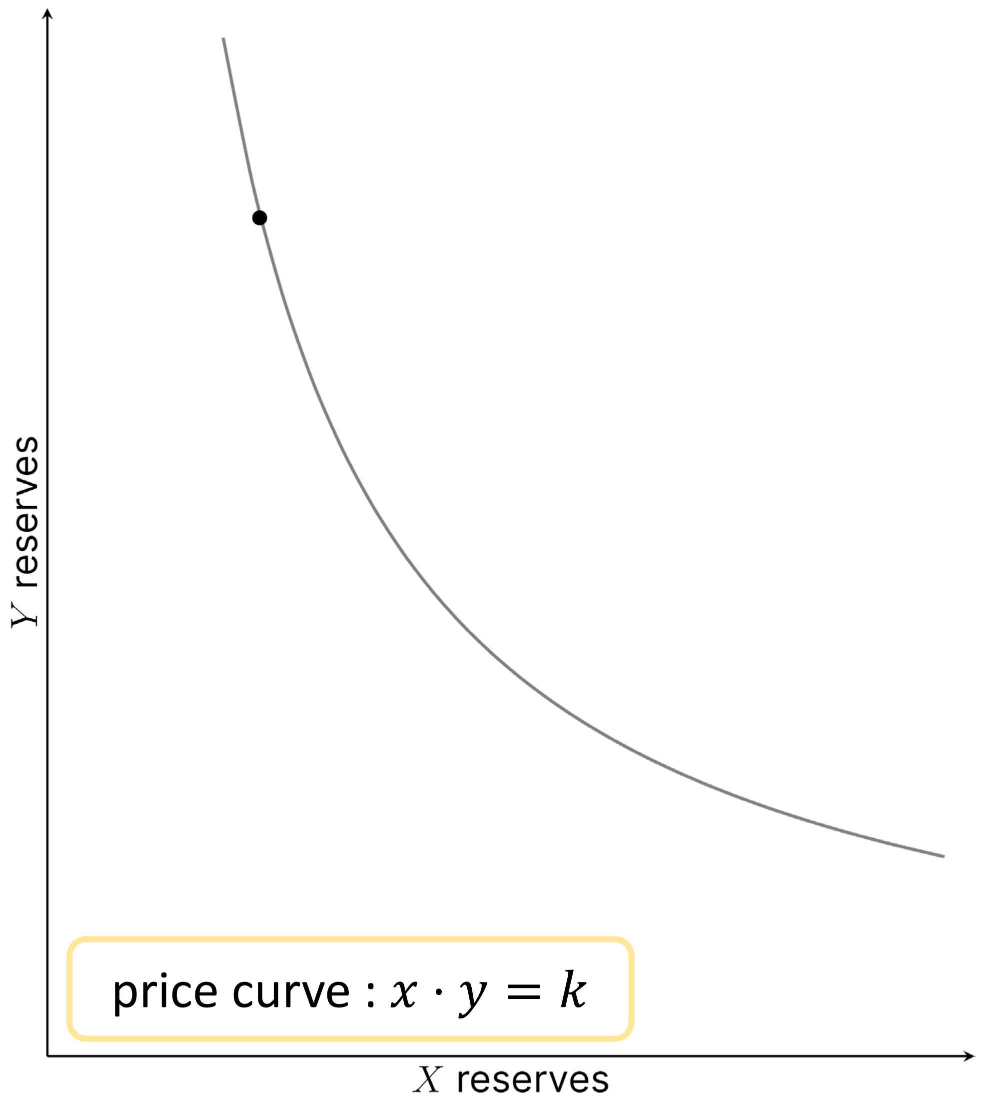
liquidity providers deposit reserves in pools

Constant product market makers (CPMMs)



trading along price curve

Constant product market makers (CPMMs)



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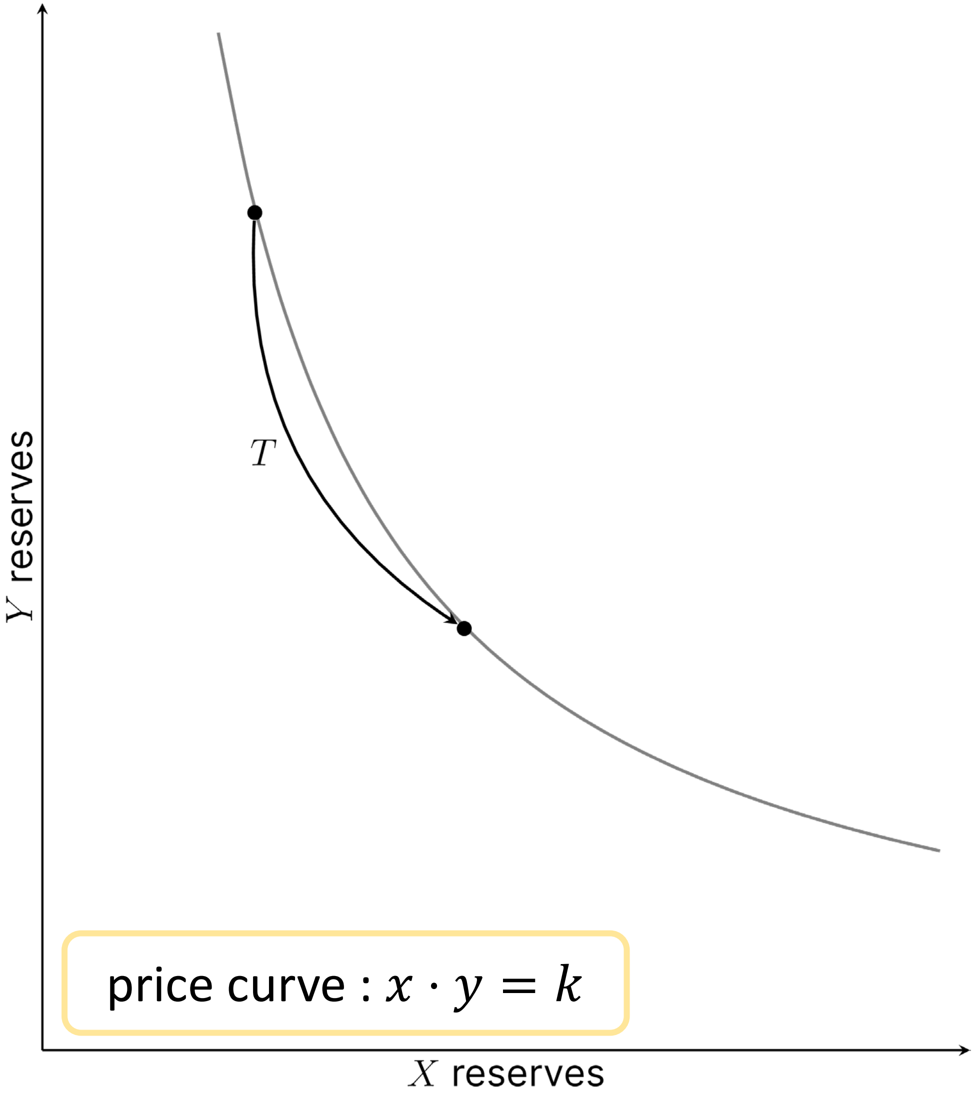
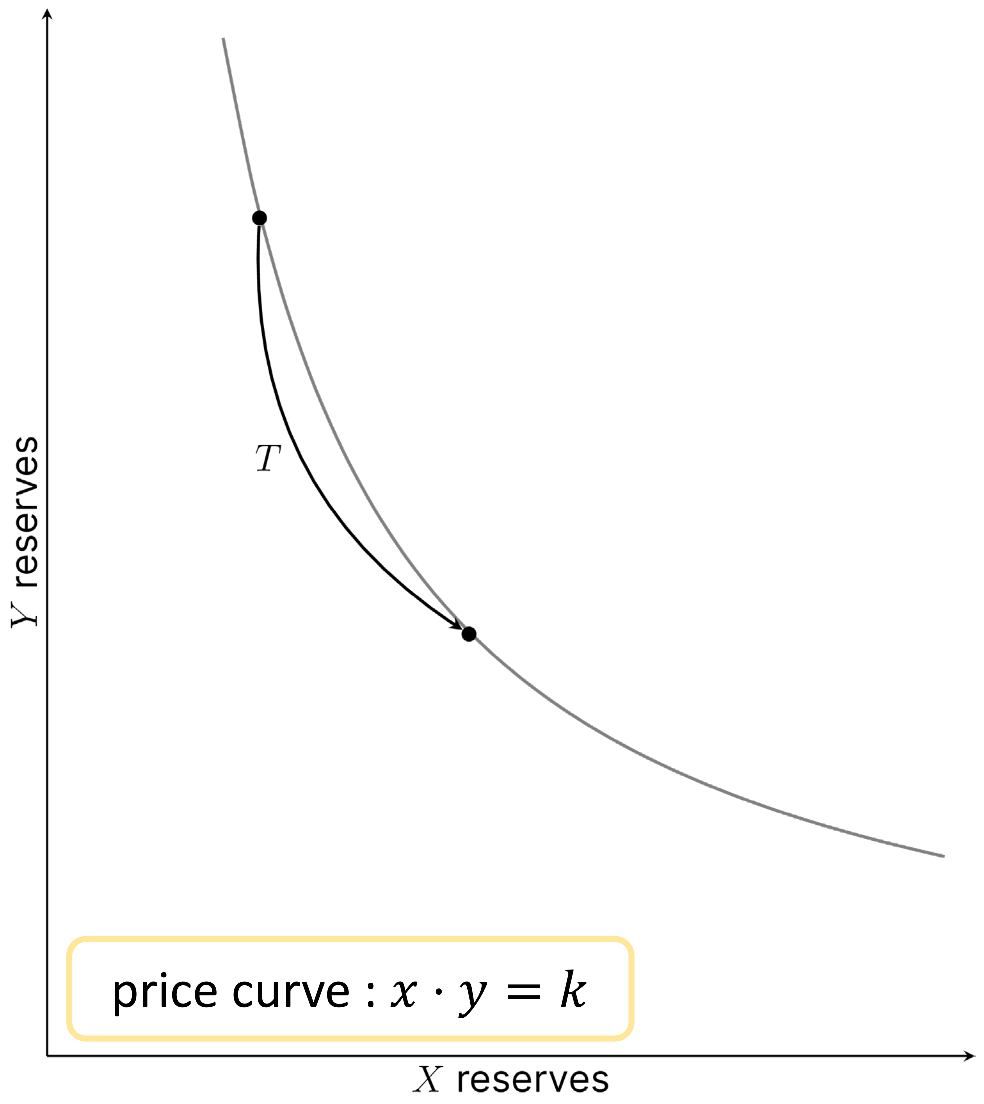


price curve : $x \cdot y = k$

trading along price curve

T: trade X → Y

Constant product market makers (CPMMs)

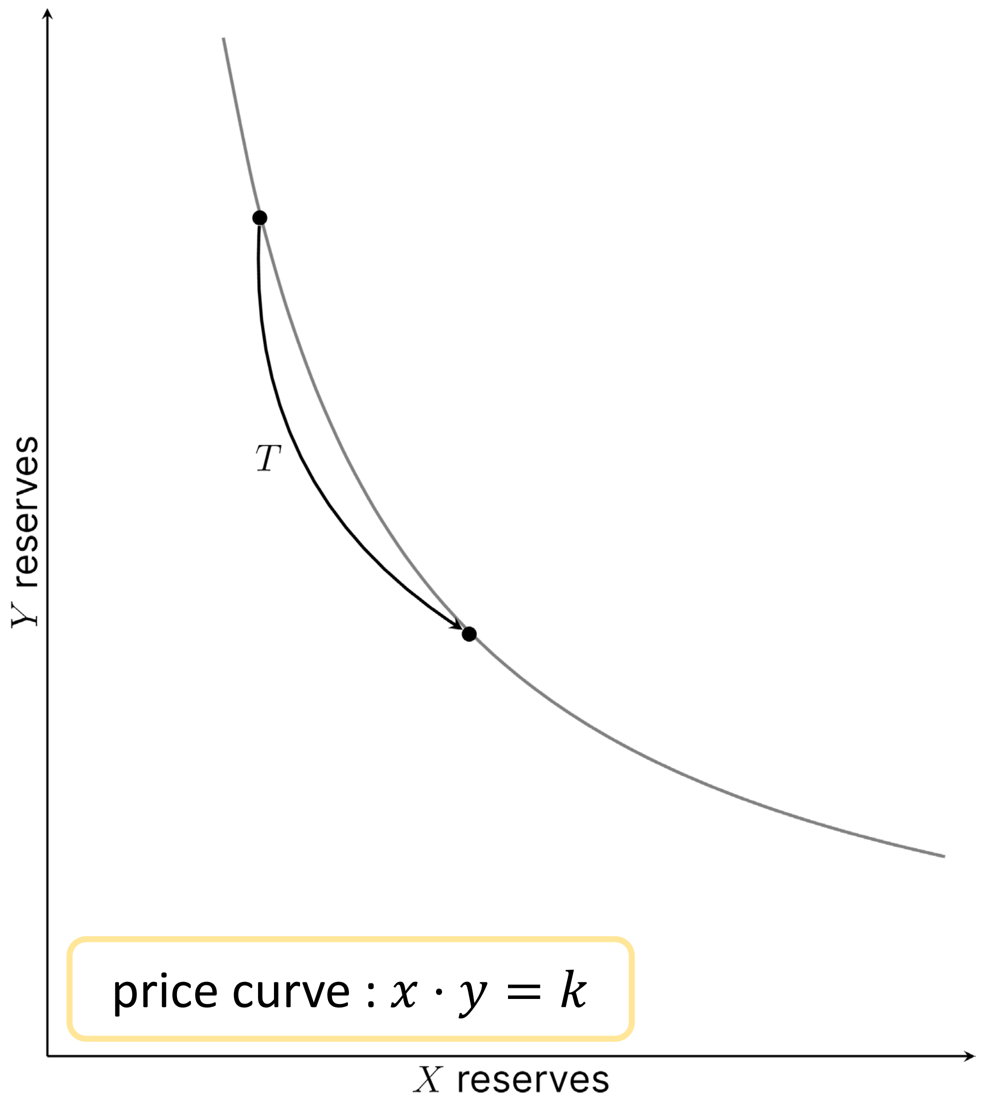


trading along price curve

T: trade X → Y

liquidity providers earn fees proportional to trade input

Constant product market makers (CPMMs)



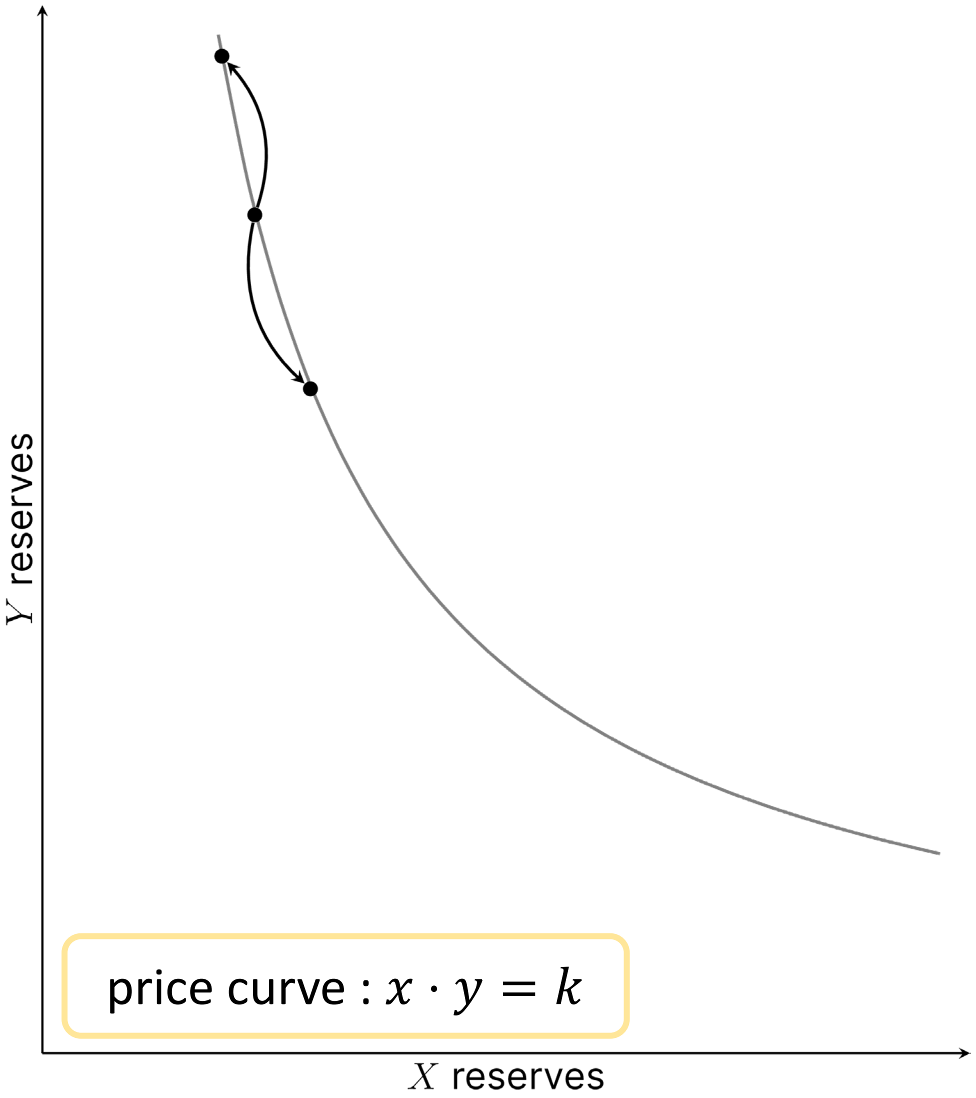
trading along price curve

T: trade X → Y

liquidity providers earn fees proportional to trade input

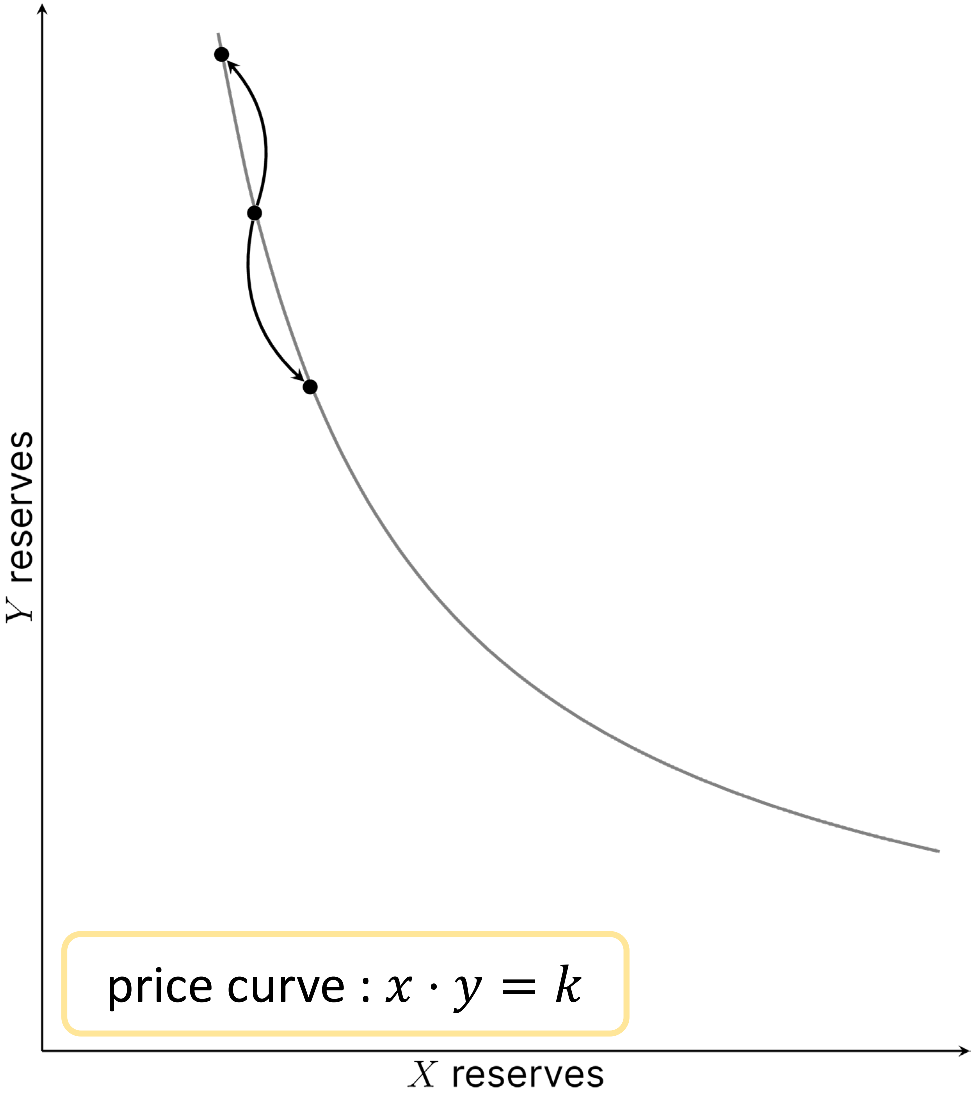
the higher the liquidity the better the price

Unexpected slippage



unexpected slippage: unexpected price increase/decrease

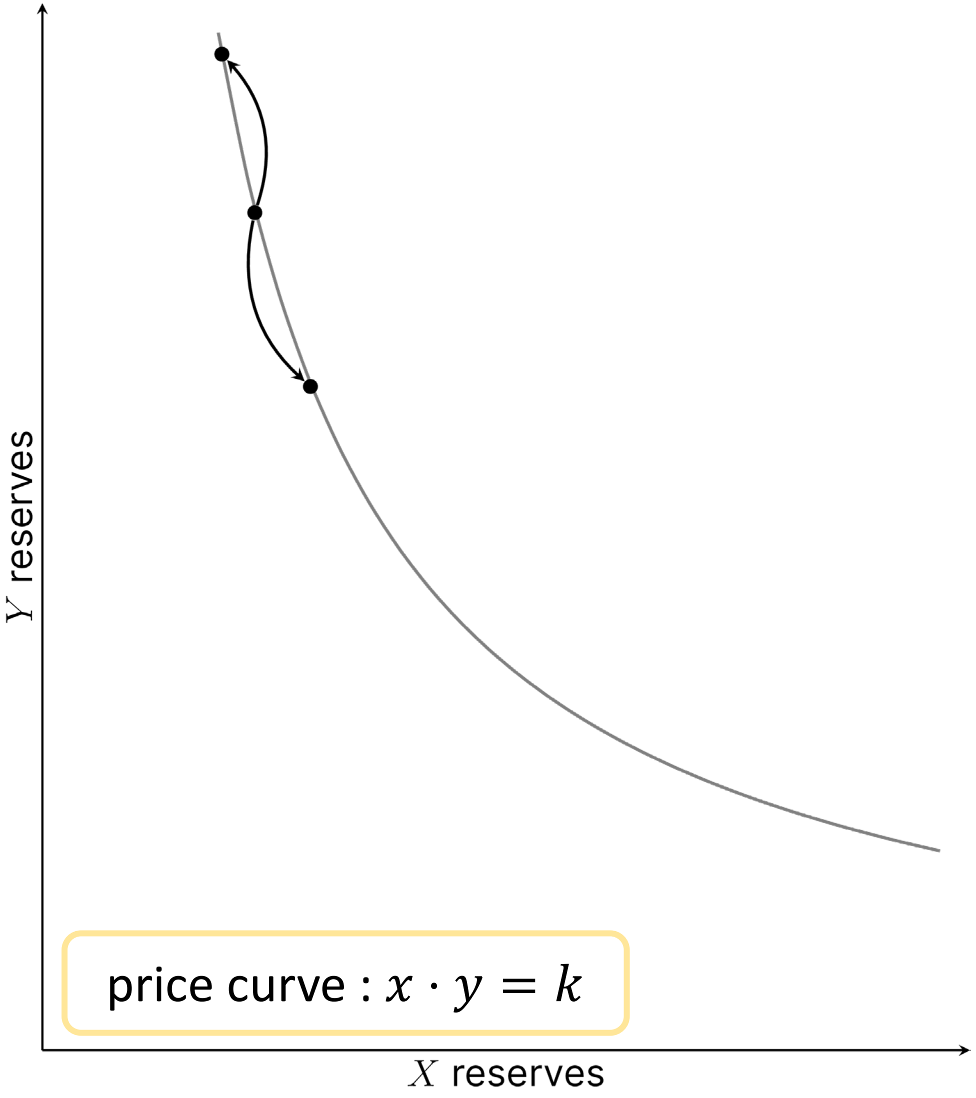
Unexpected slippage



unexpected slippage: unexpected price increase/decrease

slippage tolerance specifies maximum price movement

Unexpected slippage

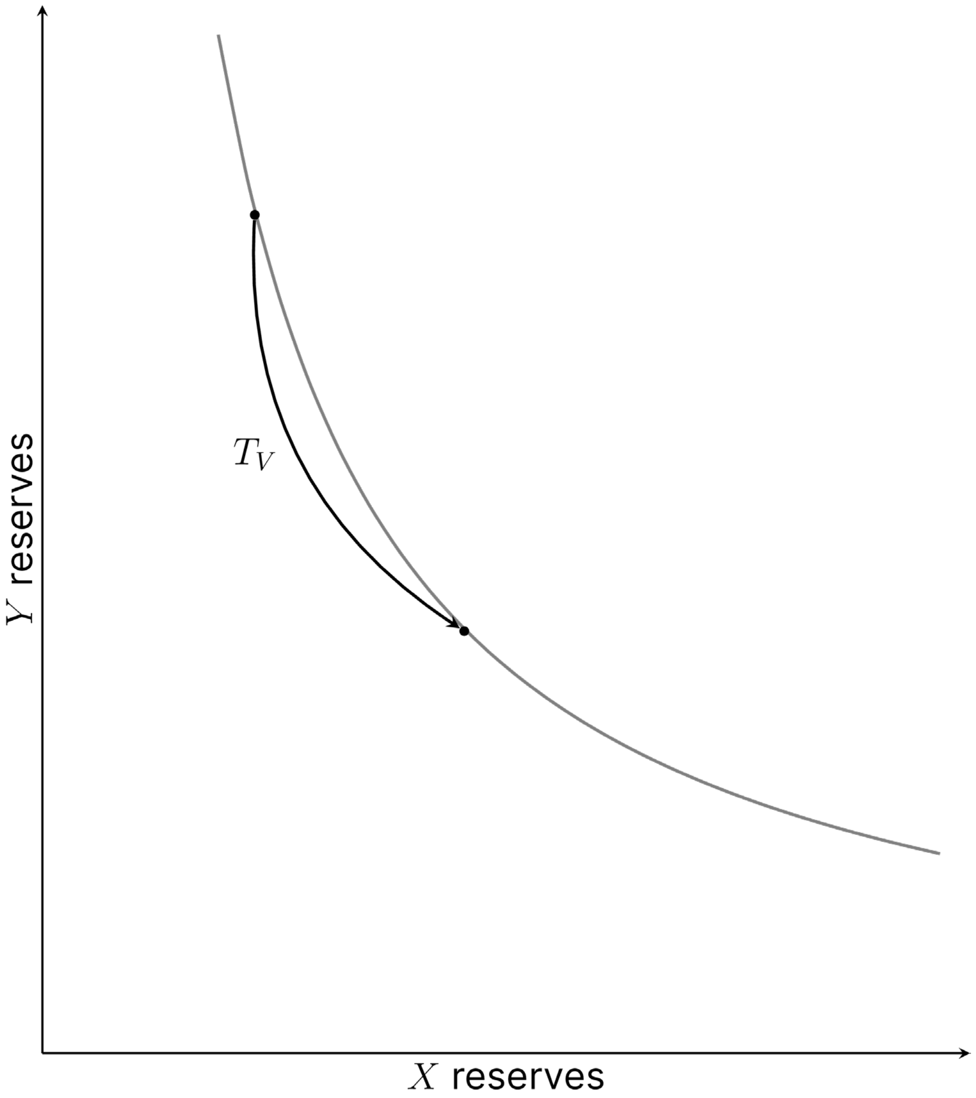


unexpected slippage: unexpected price increase/decrease

slippage tolerance specifies maximum price movement

trade fails if slippage tolerance exceeded

Sandwich attack mechanism



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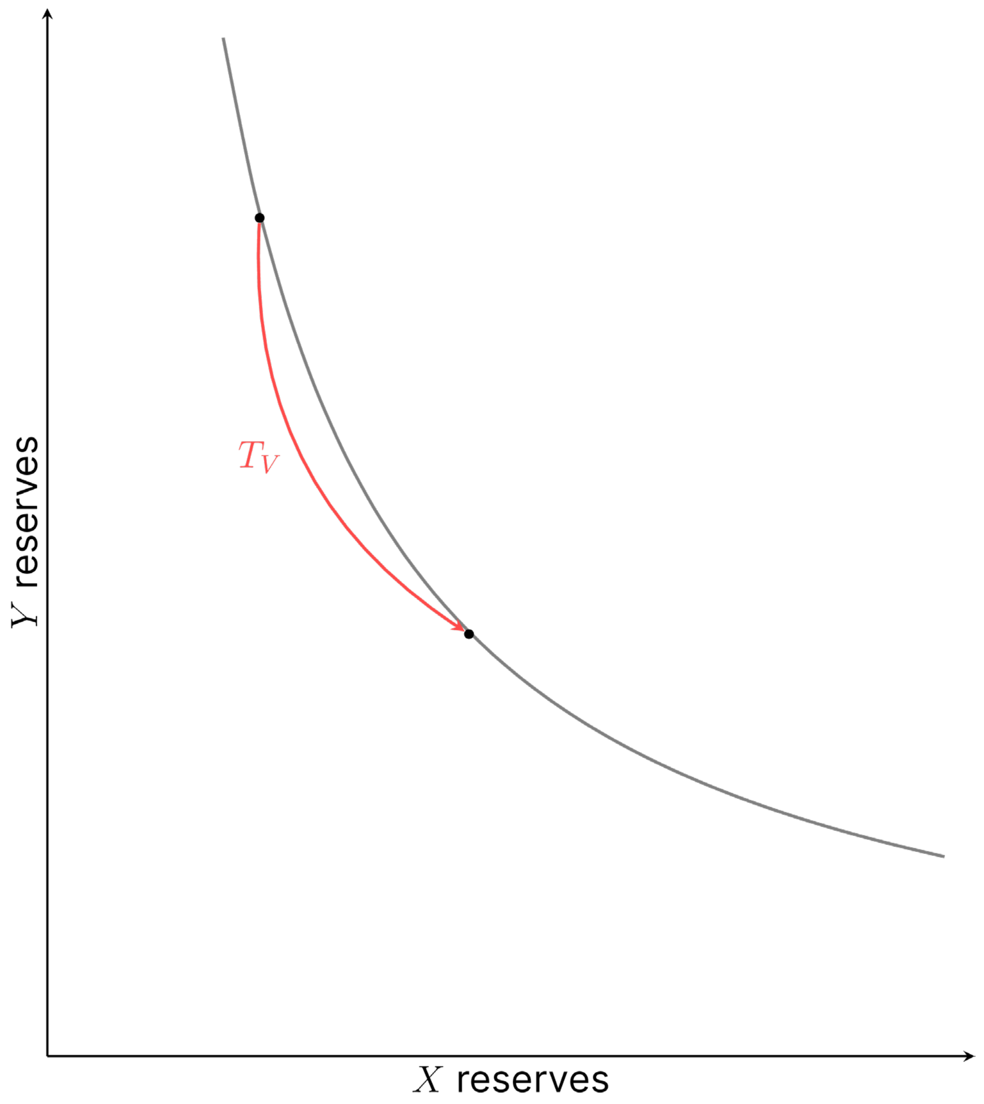

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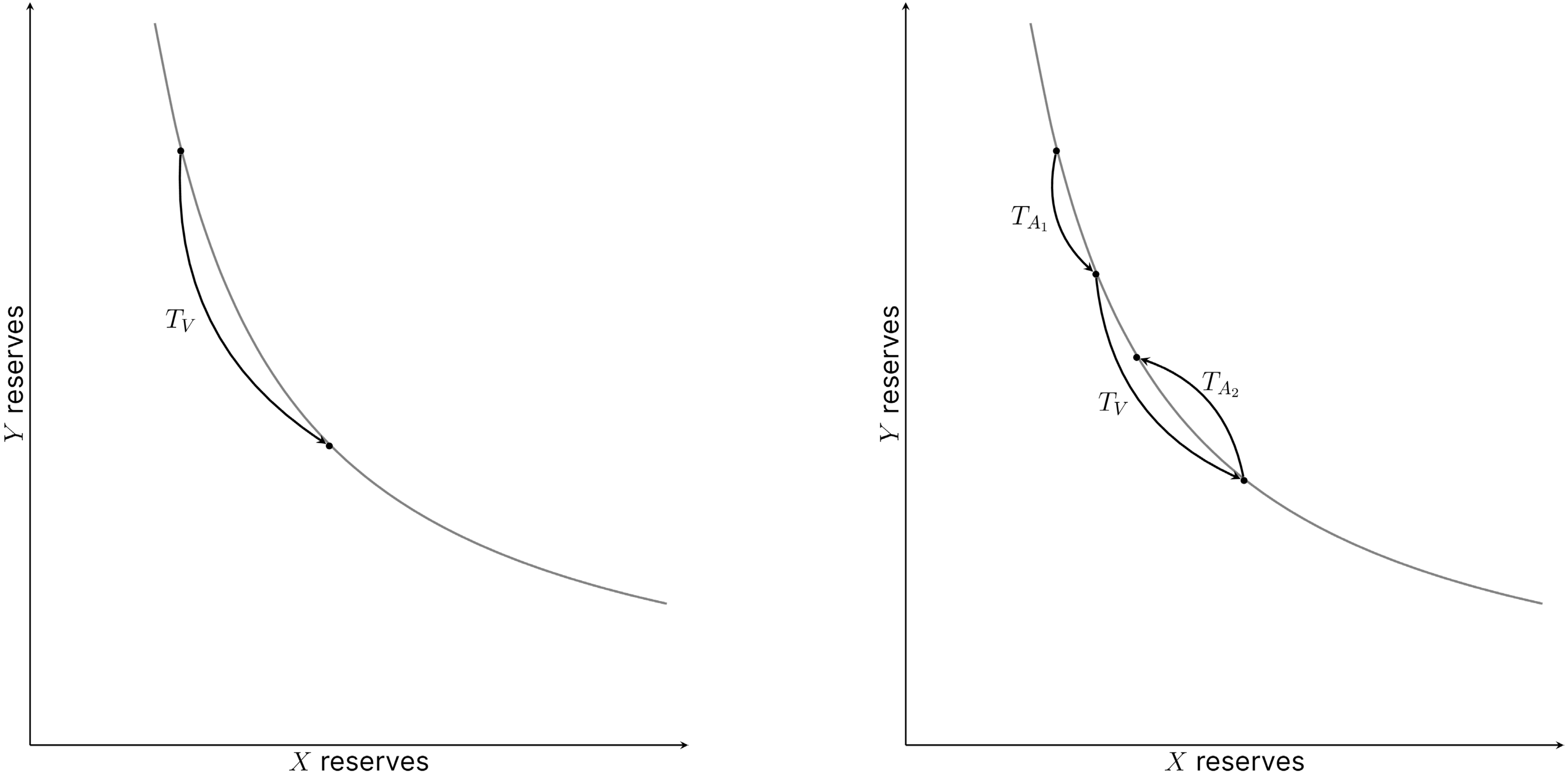

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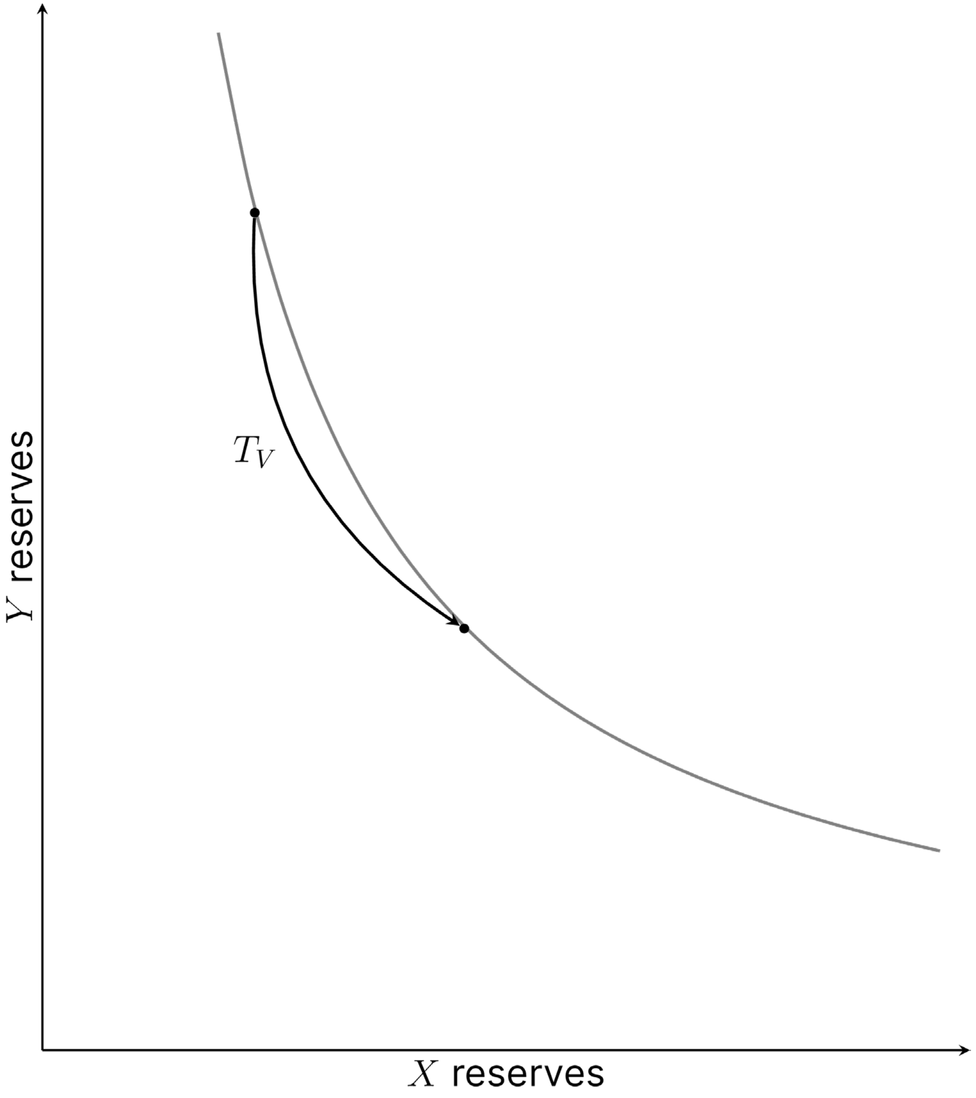

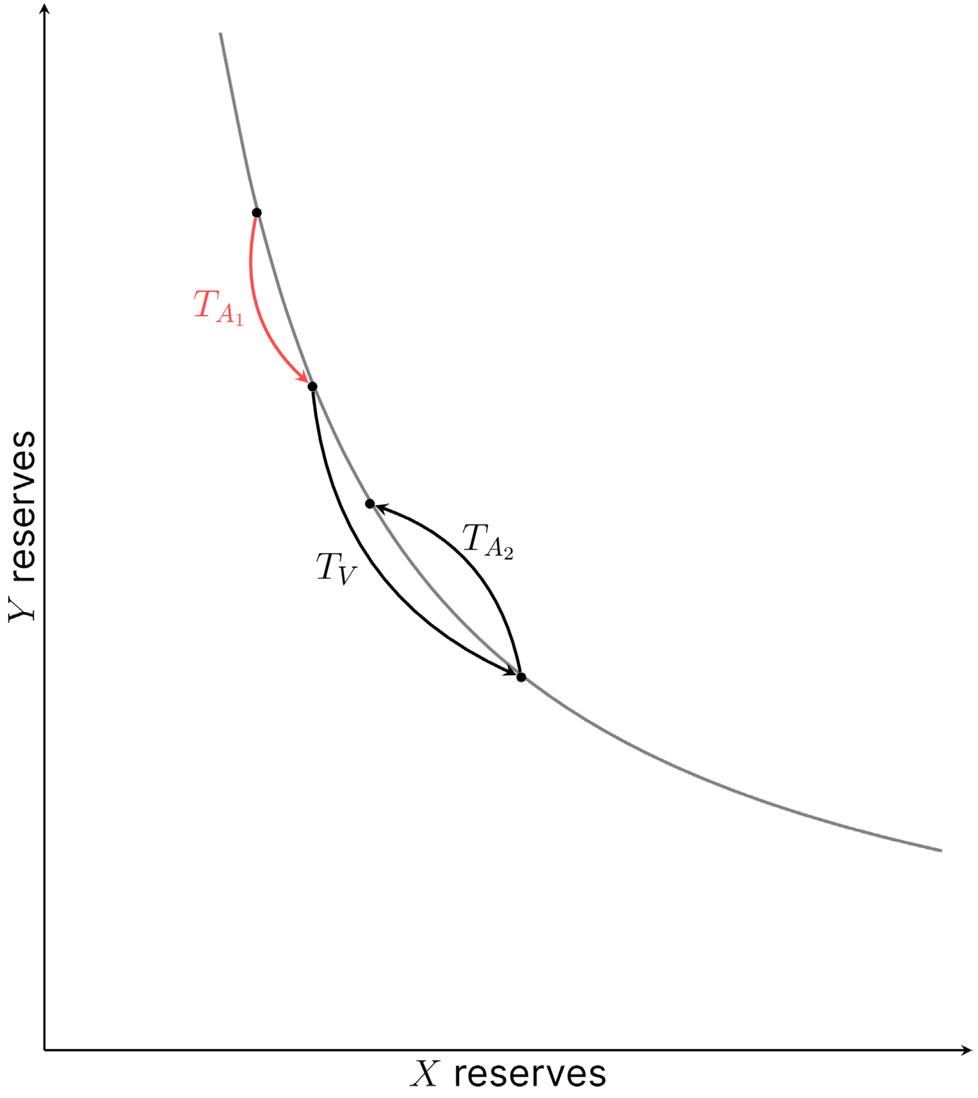

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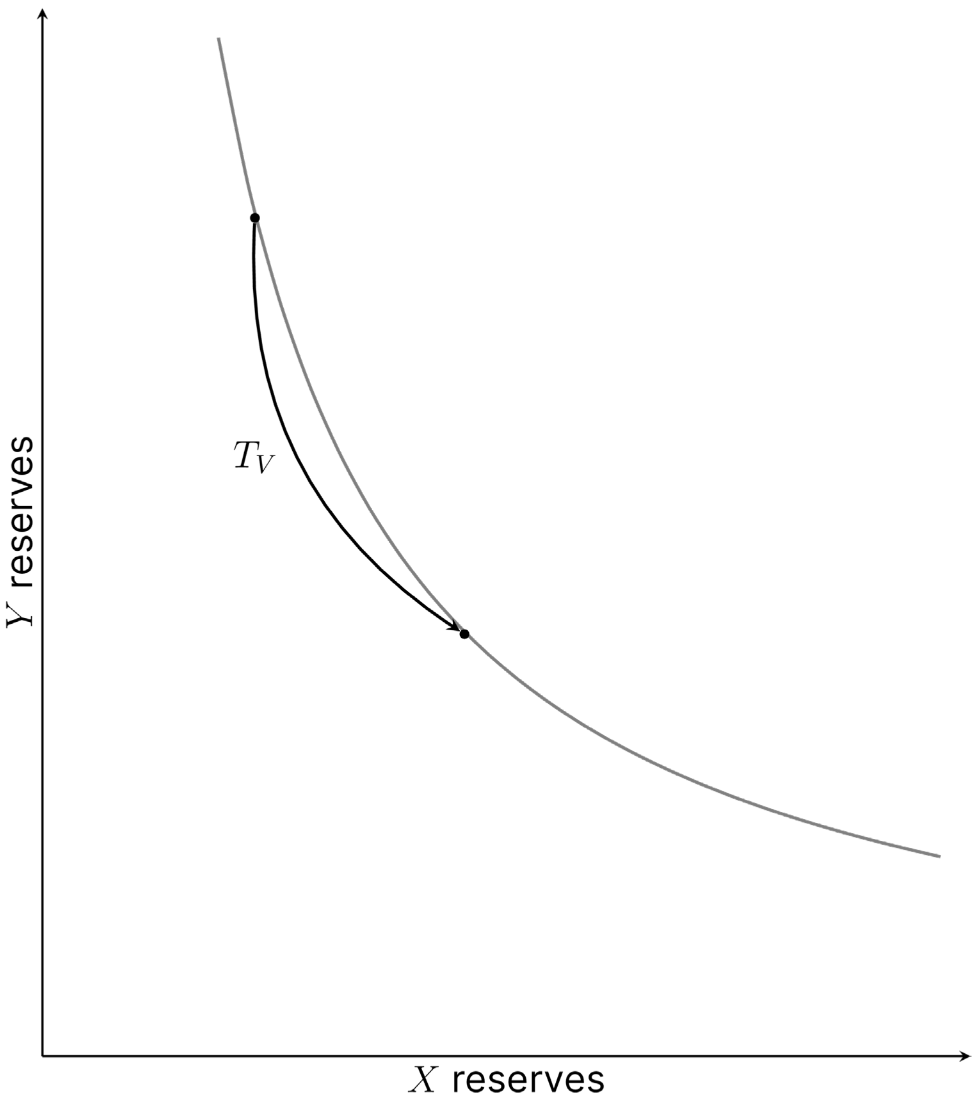

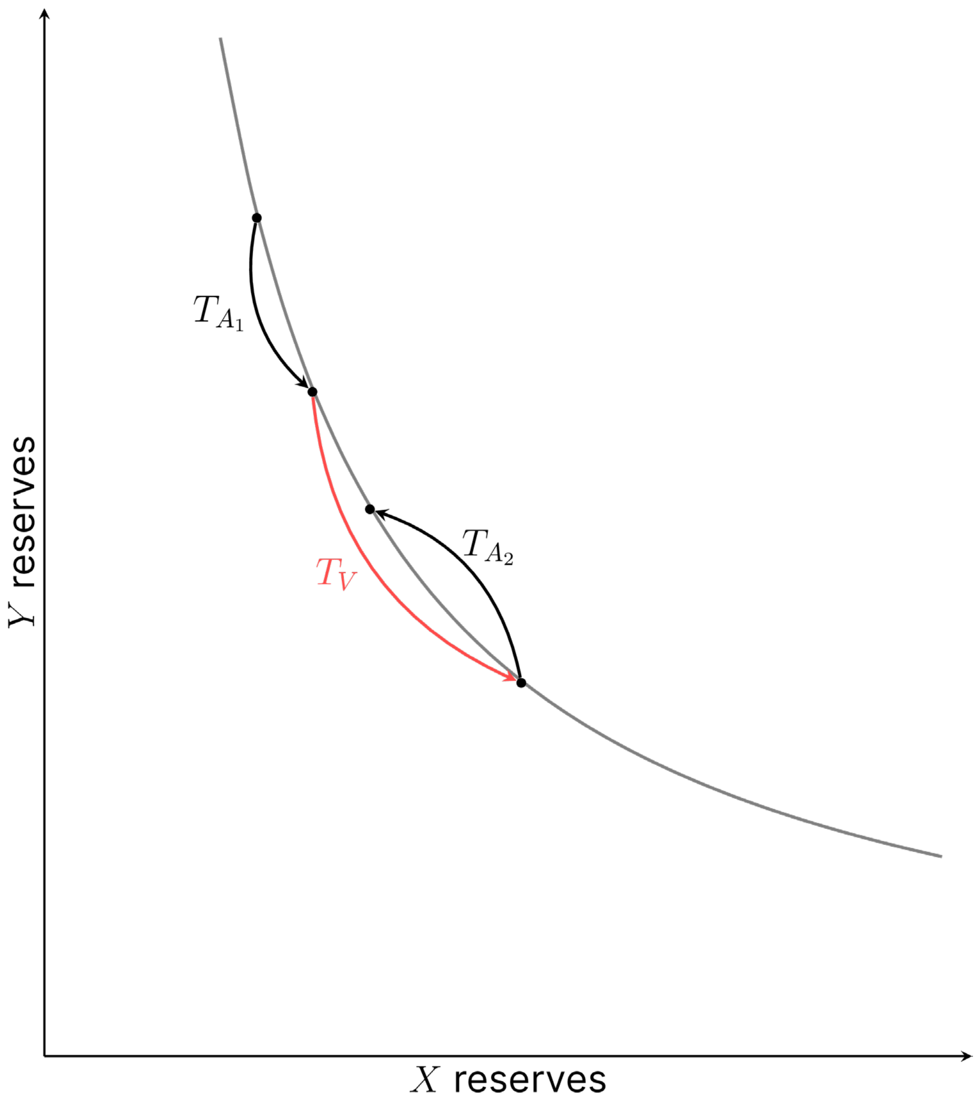

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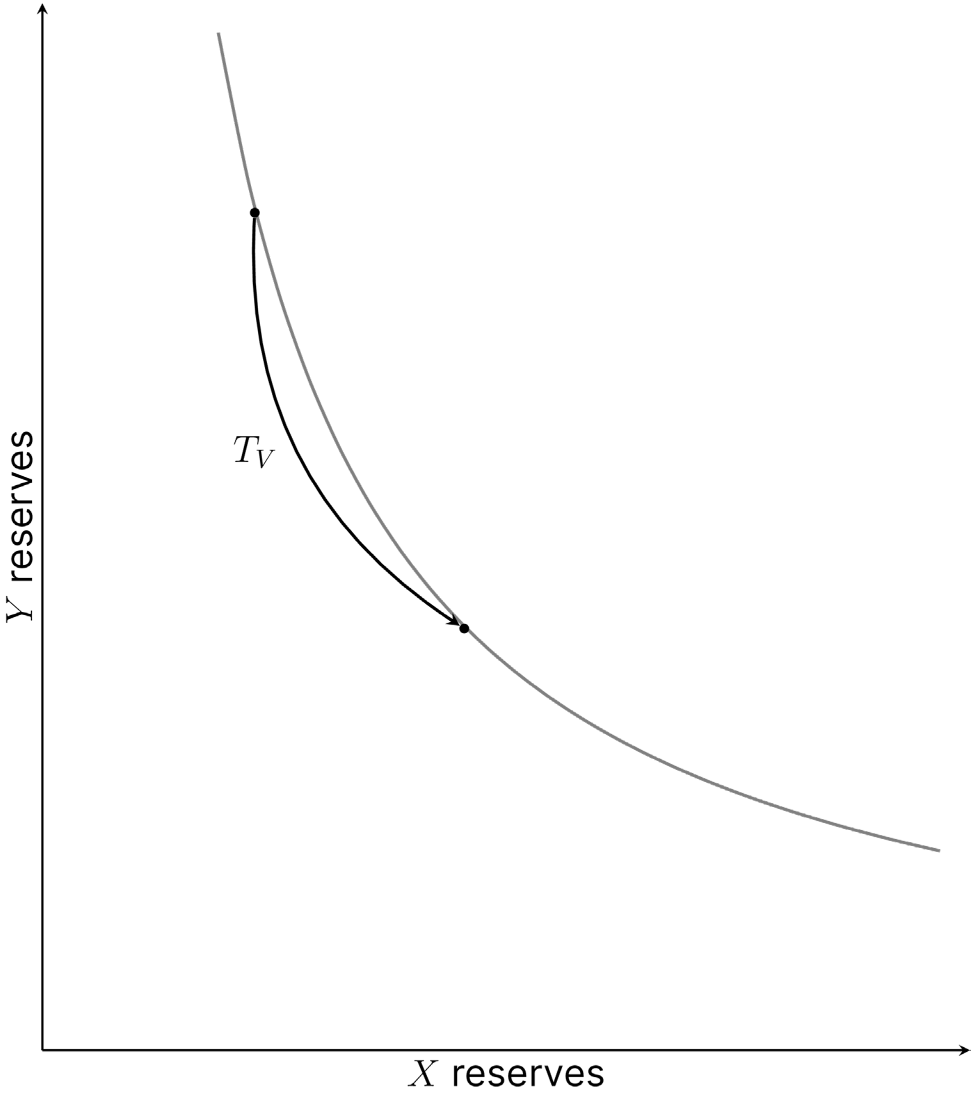

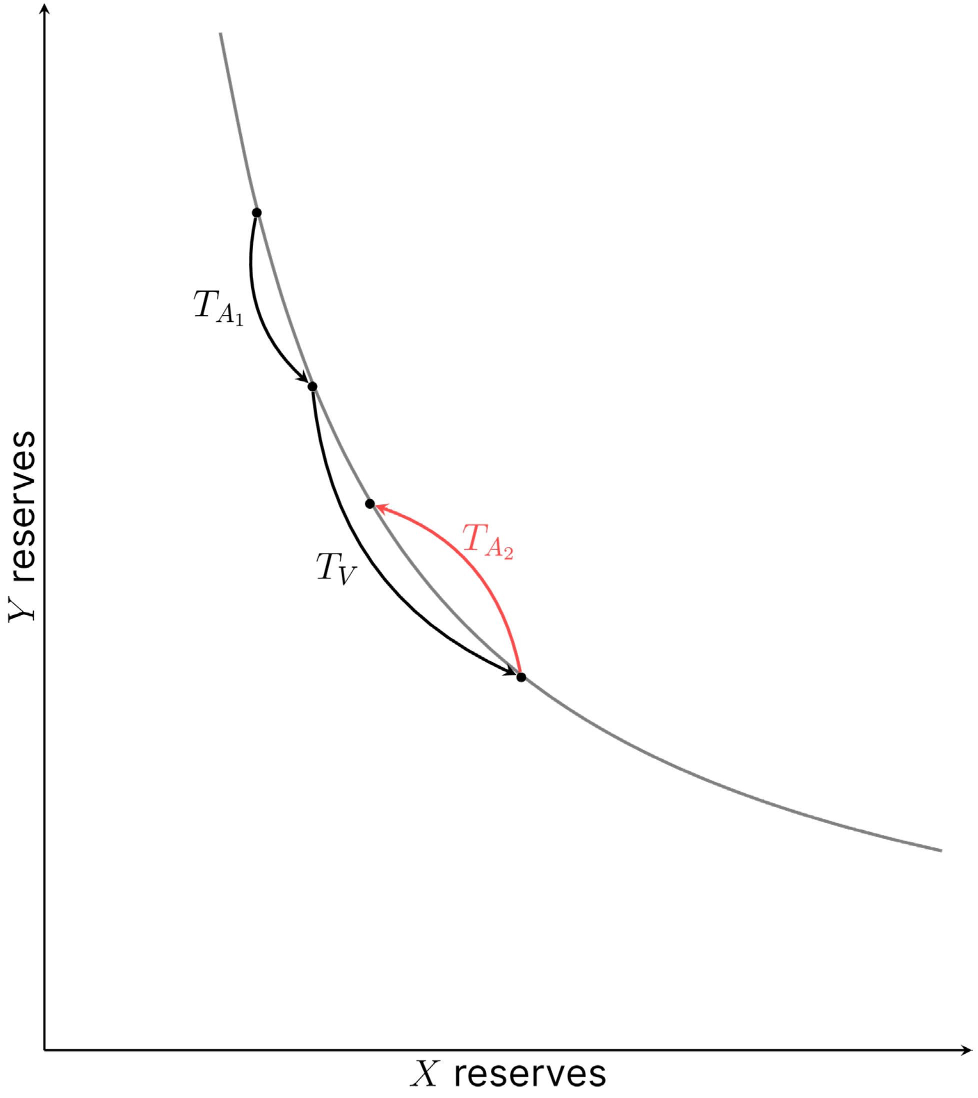

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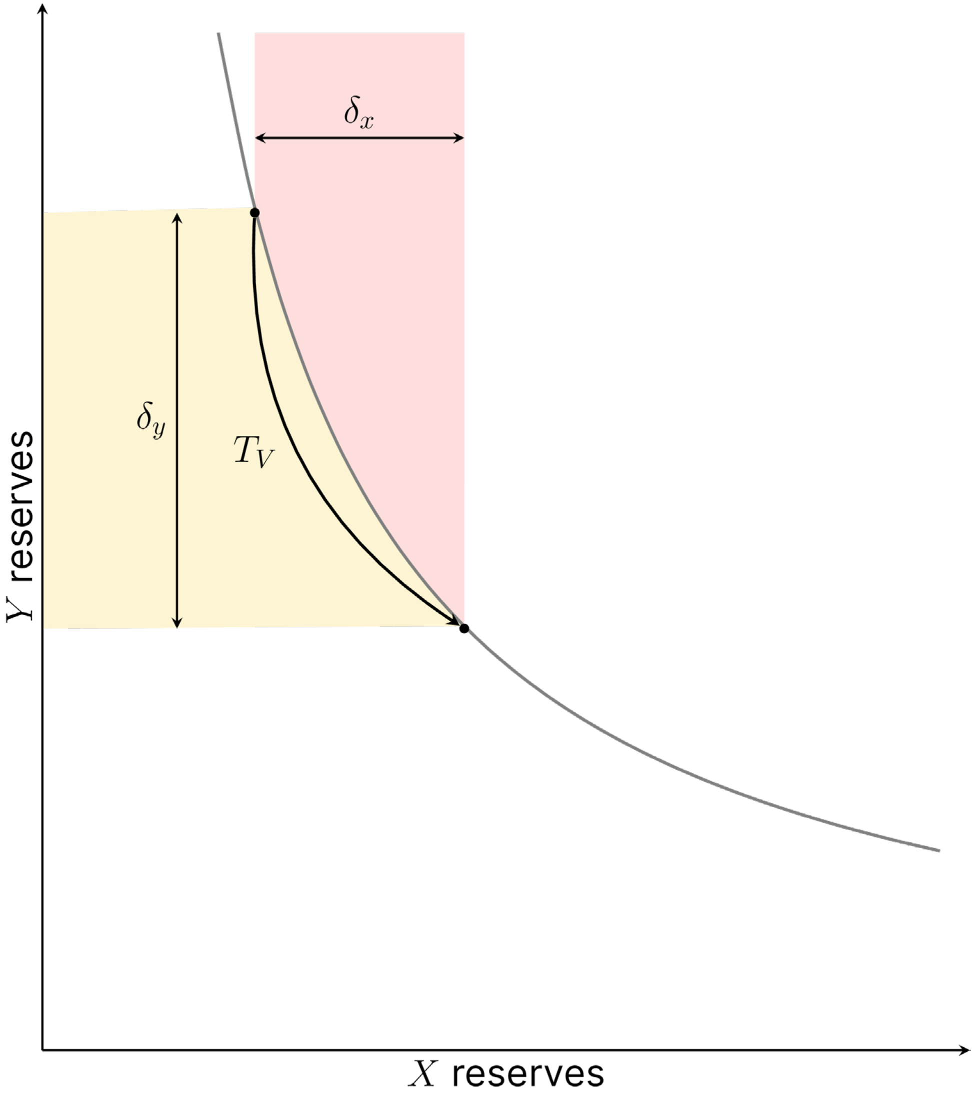

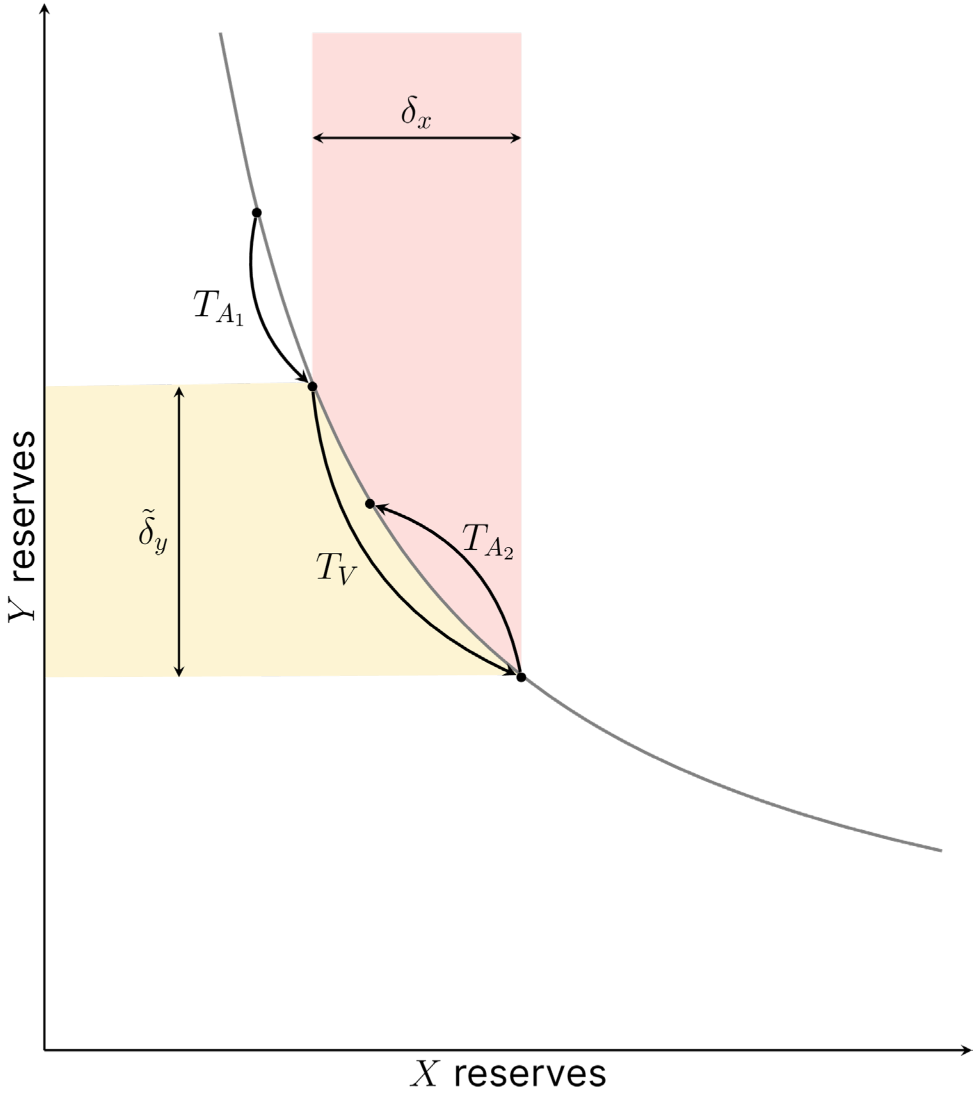

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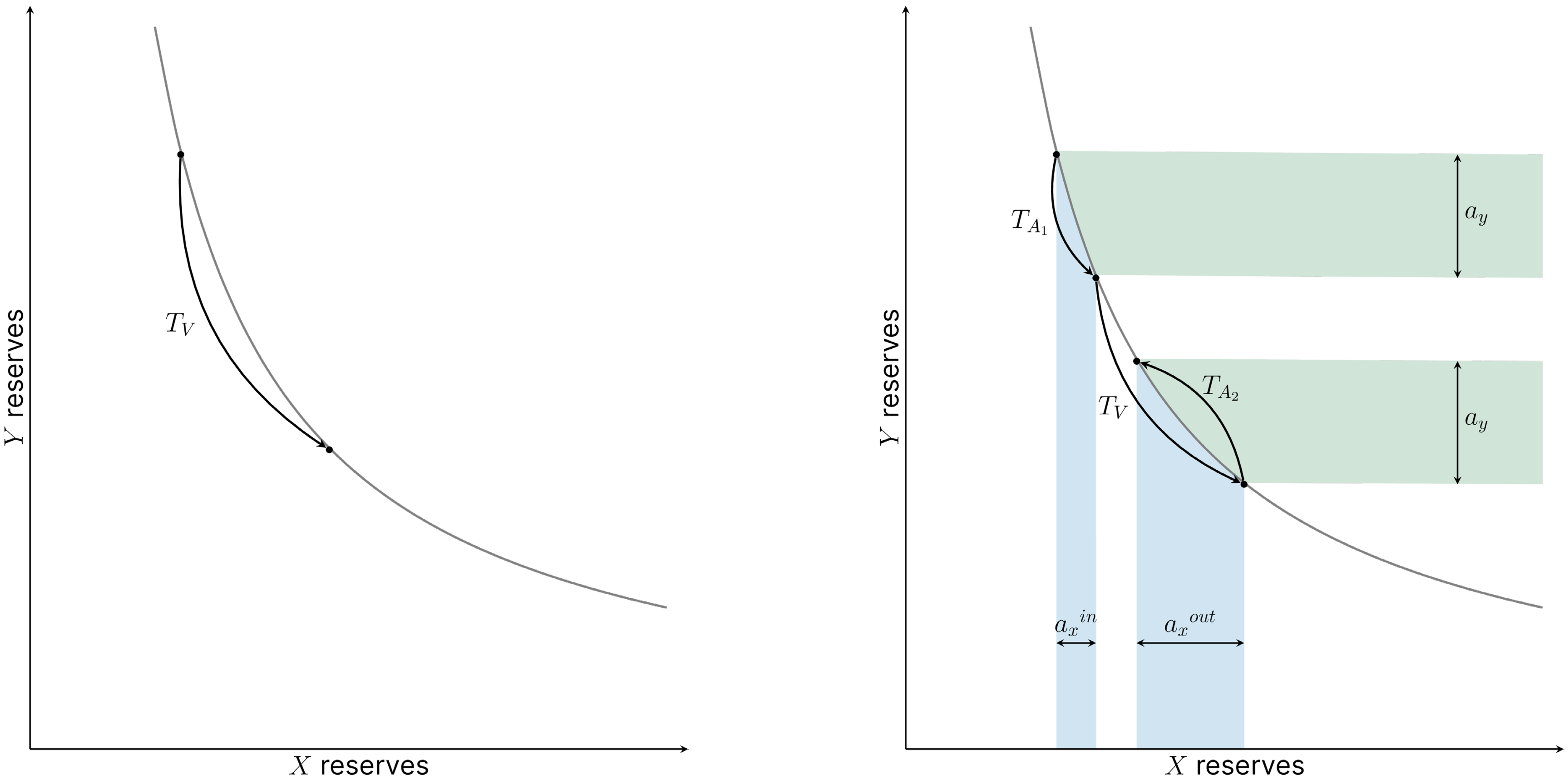

Front-running on DEXes

Sandwich Overview

24H | 7D | **30D**

Summary

Tx Count	156866
Profit	$2,362,169.39
Cost	$11,782,863.77
Attackers	198
Victims	73418

https://eigenphi.io/mev/ethereum/sandwich

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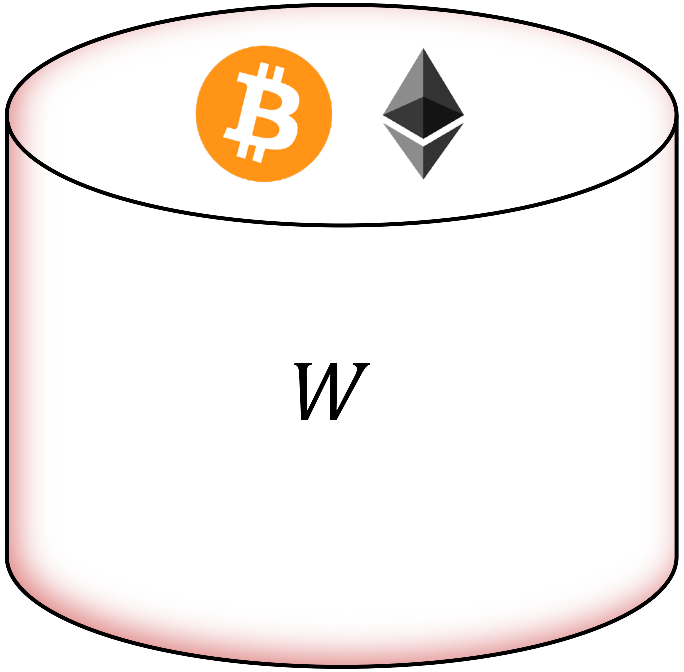
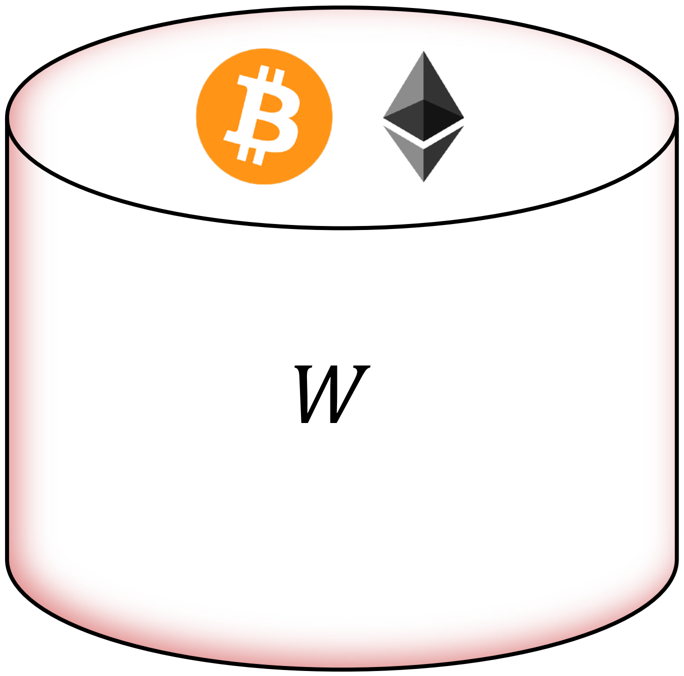
Are liquidity providers incentivized to move to DEXes that implement front-running protection?

Pools

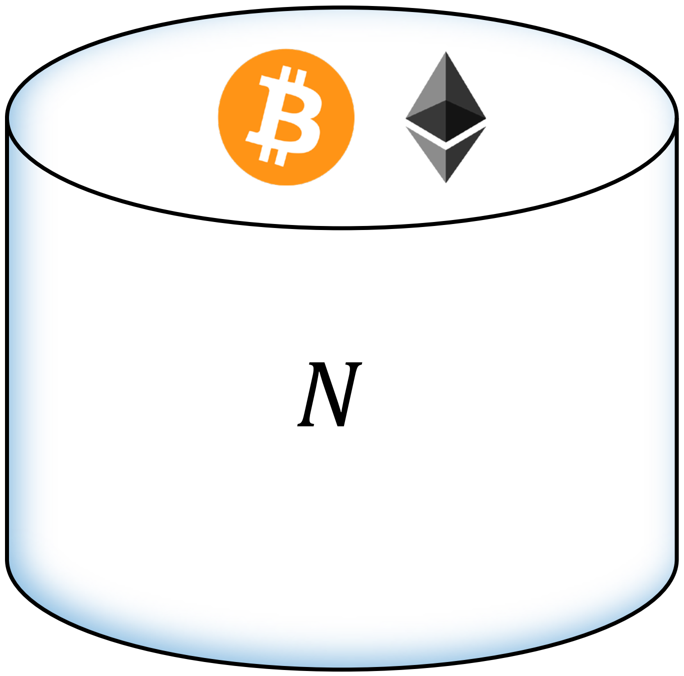


liquidity pool with
front-running

Pools

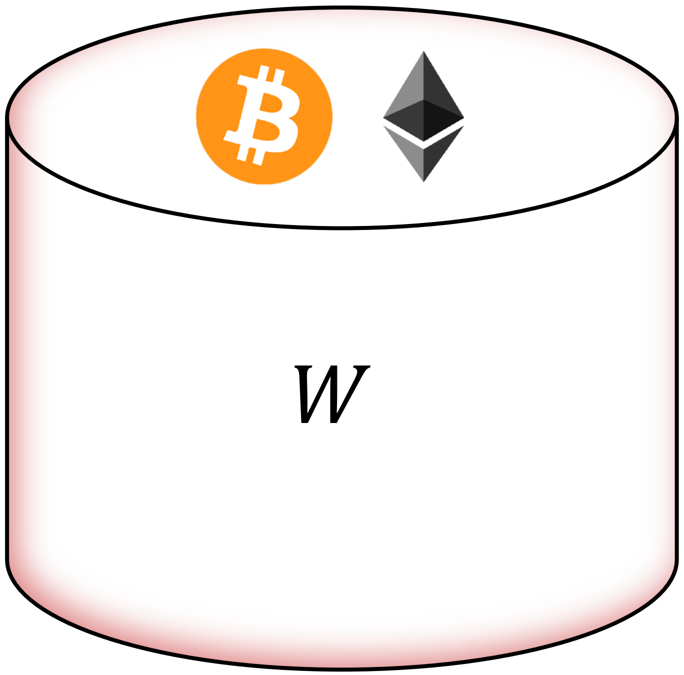


liquidity pool with
front-running



liquidity pool without
front-running

Pools



liquidity pool with
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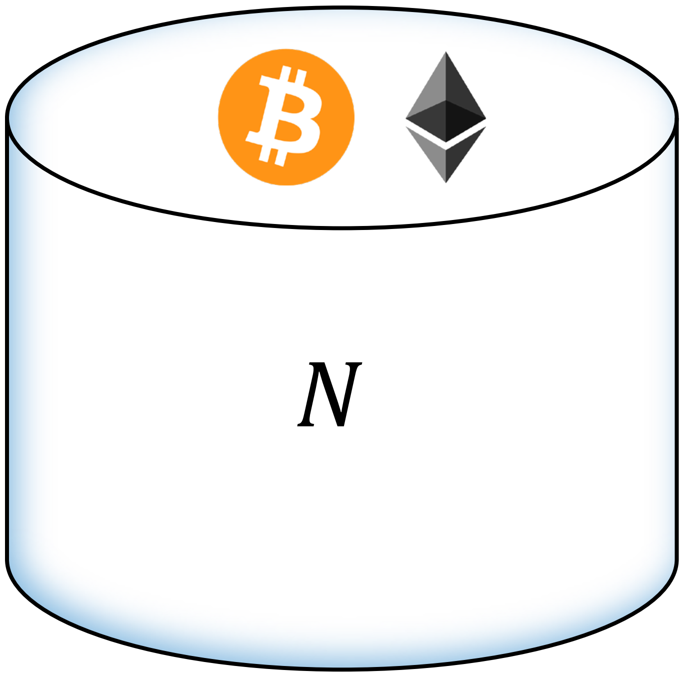
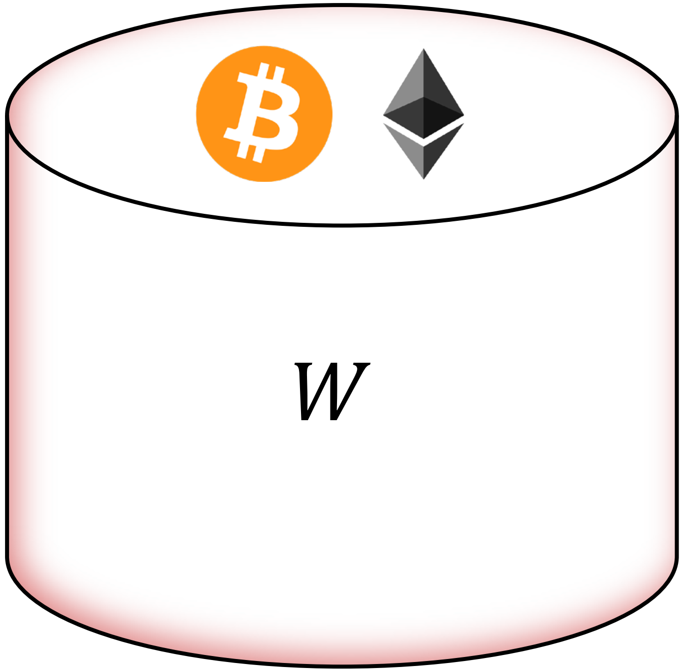


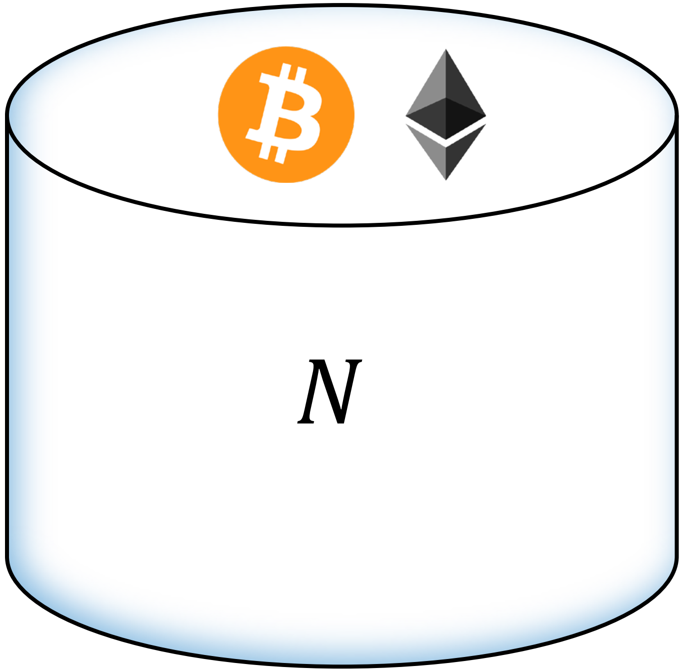
liquidity pool without
front-running

external market price constant

Pools



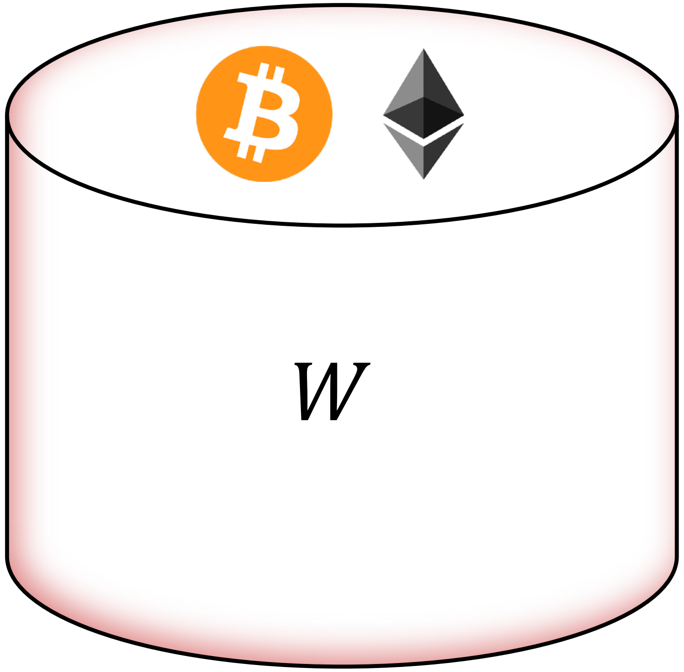
liquidity pool with front-running



liquidity pool without front-running

same fee f in both pools

Pools



liquidity pool with
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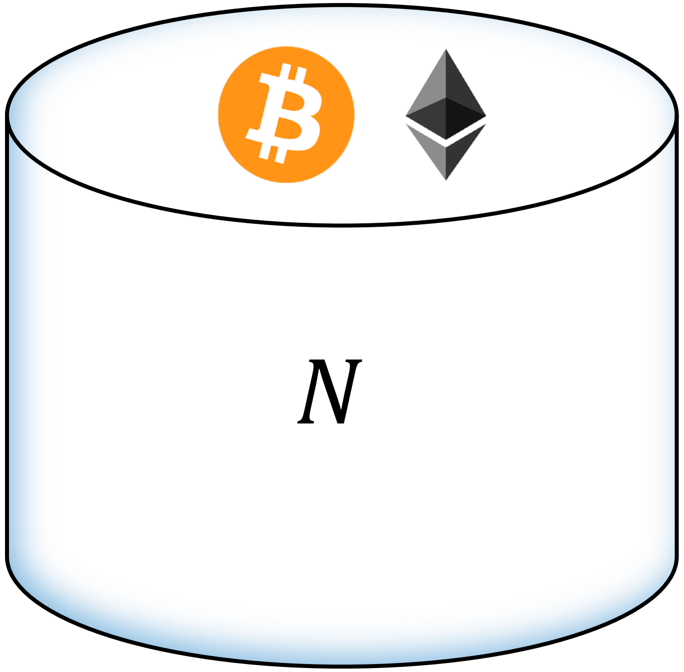
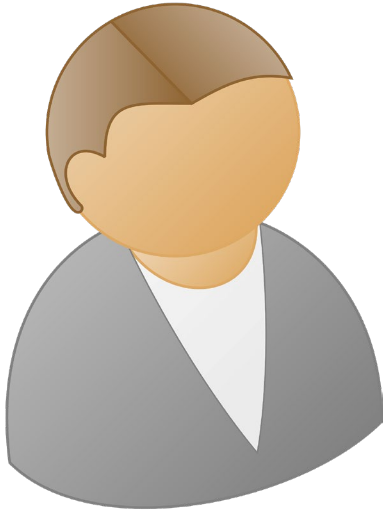


liquidity pool without
front-running

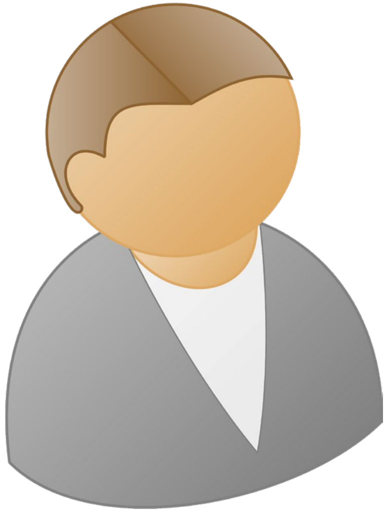
same slippage tolerance s in both pools

Players



sandwich attacker

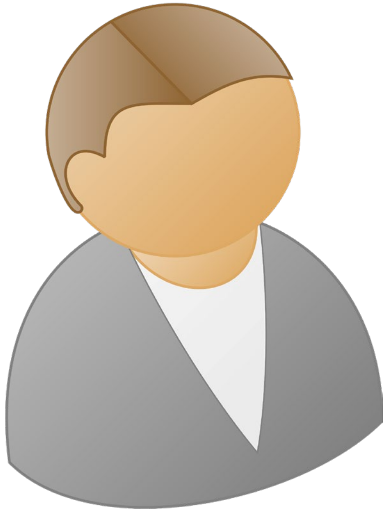
Players



sandwich attacker

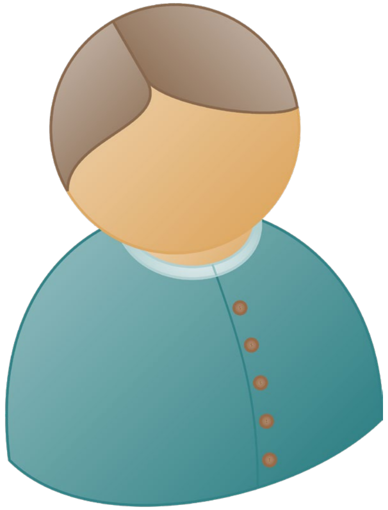
arbitrageur

Players



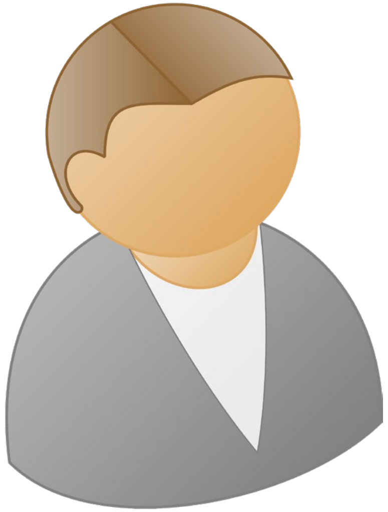
sandwich attacker

arbitrageur



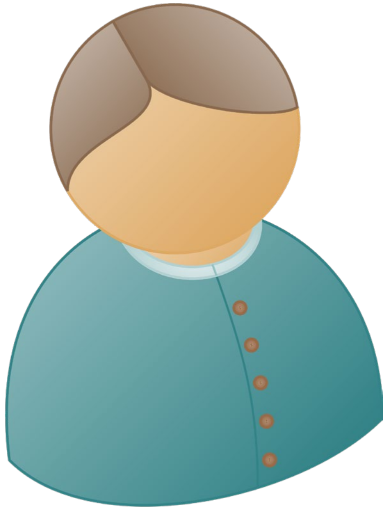
trader

Players



sandwich attacker

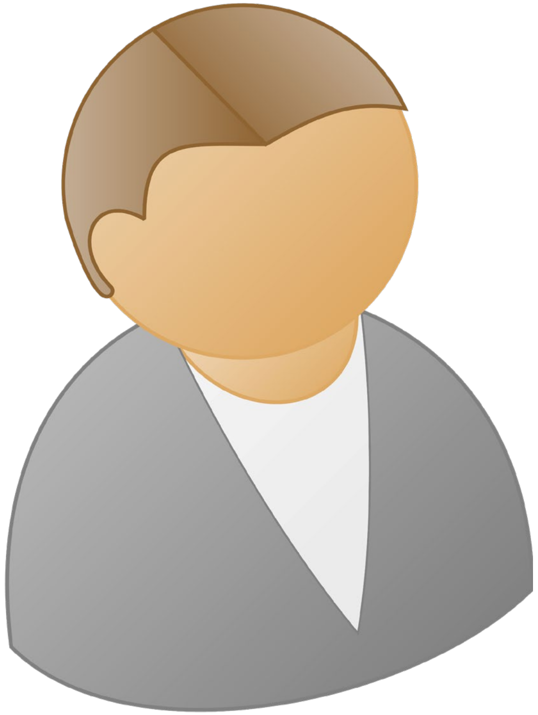
arbitrageur



trader

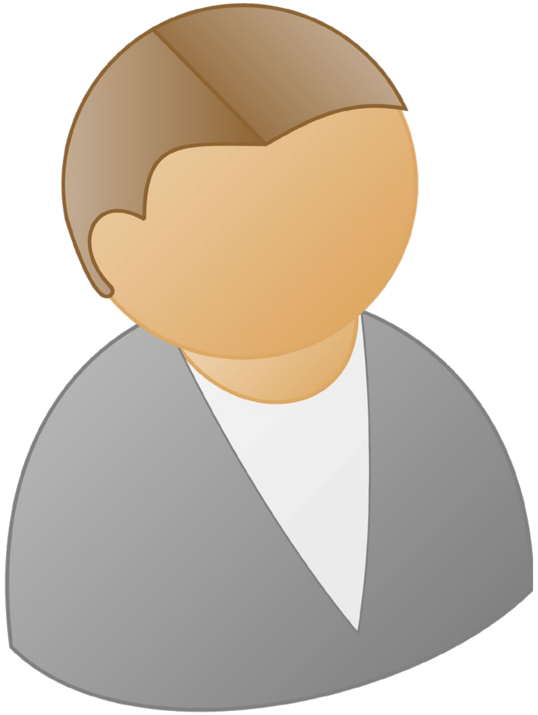
liquidity provider

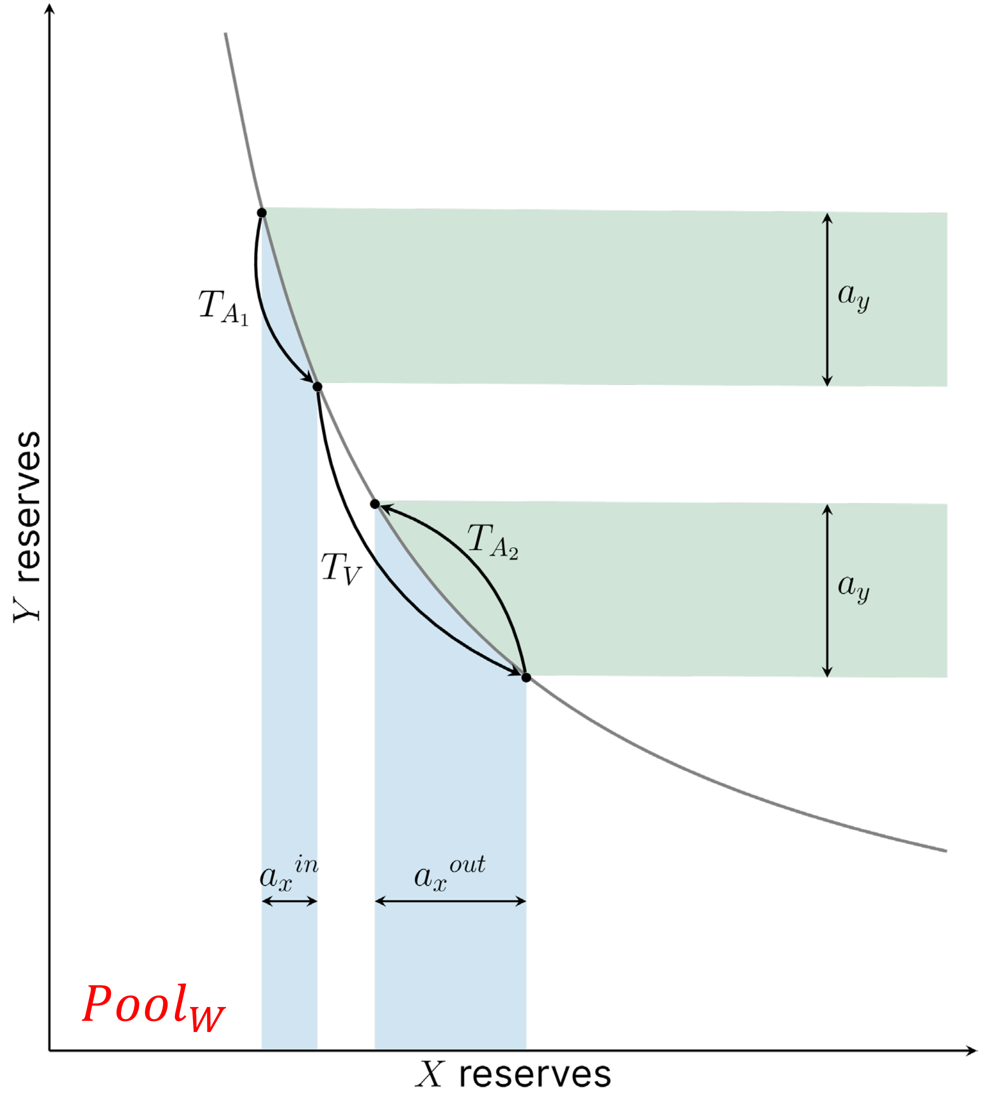
Sandwich attacker



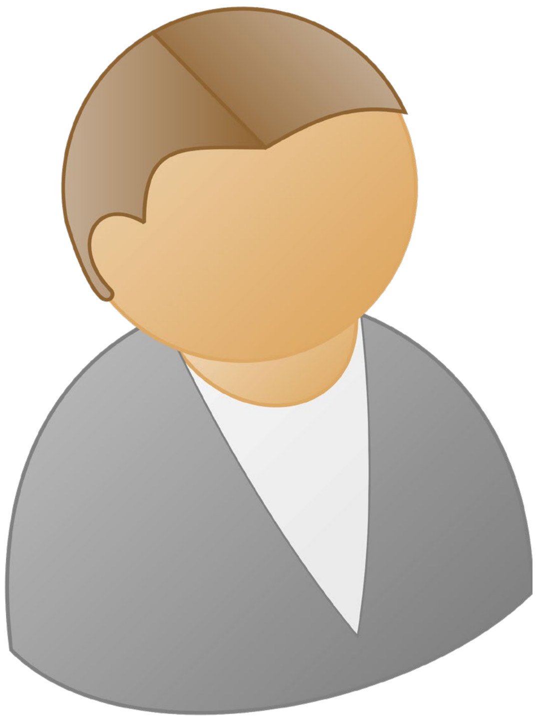
maximize profit from attack

Sandwich attacker

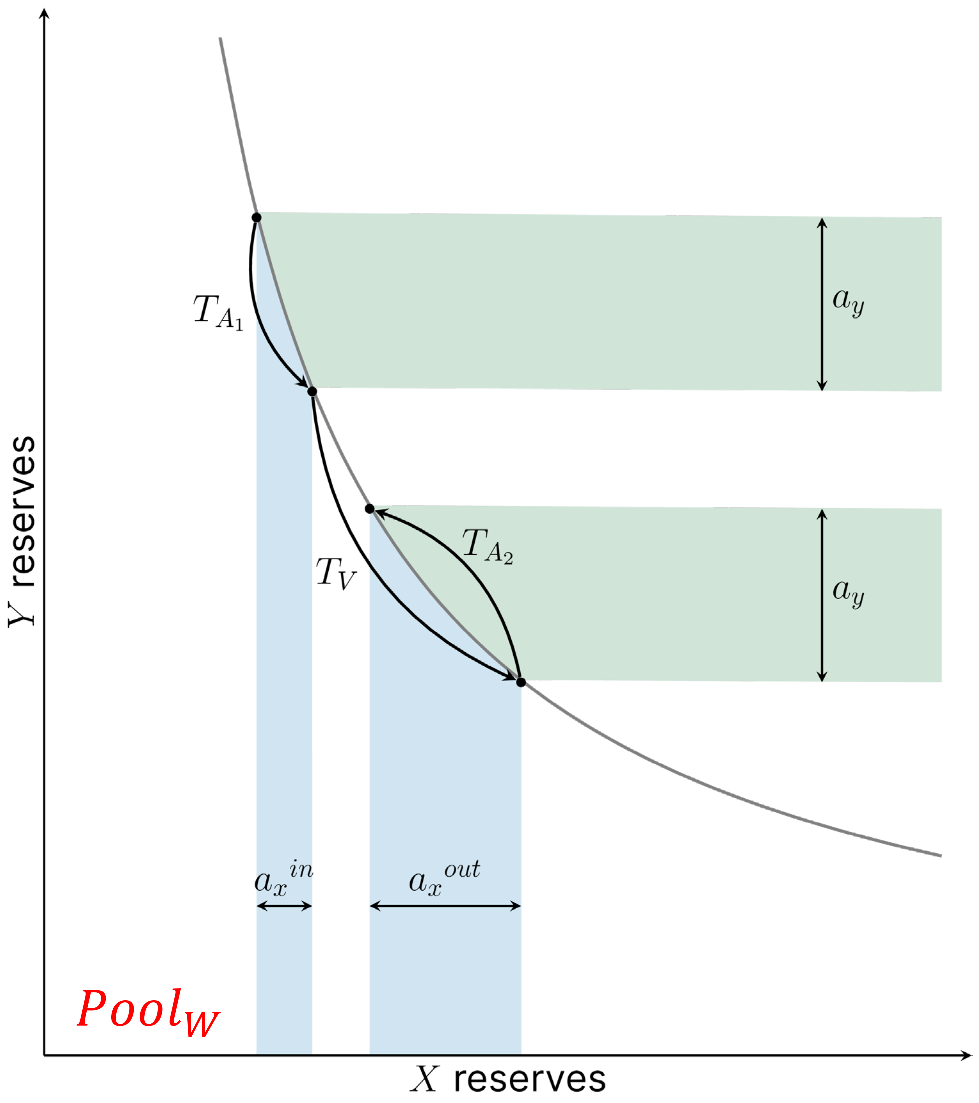




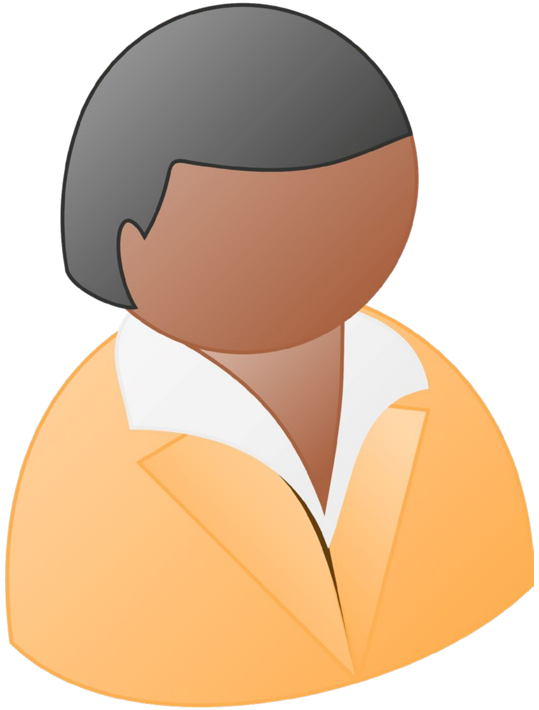
Sandwich attacker



$$\max\ a_x^{out} - a_x^{in}$$

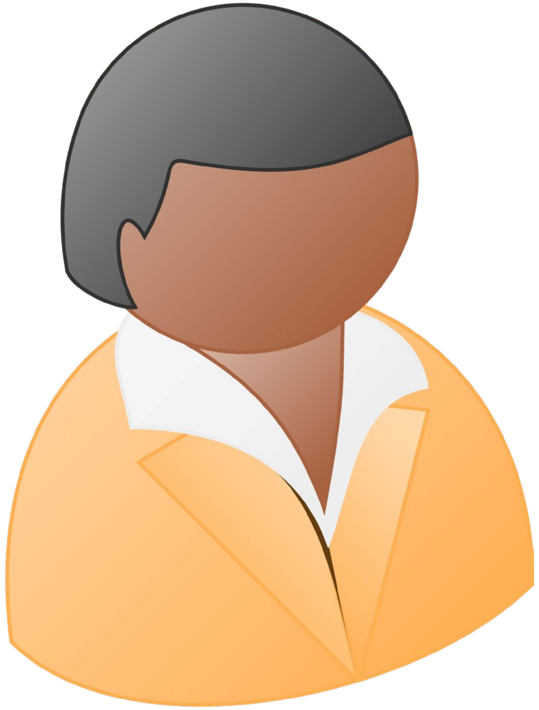


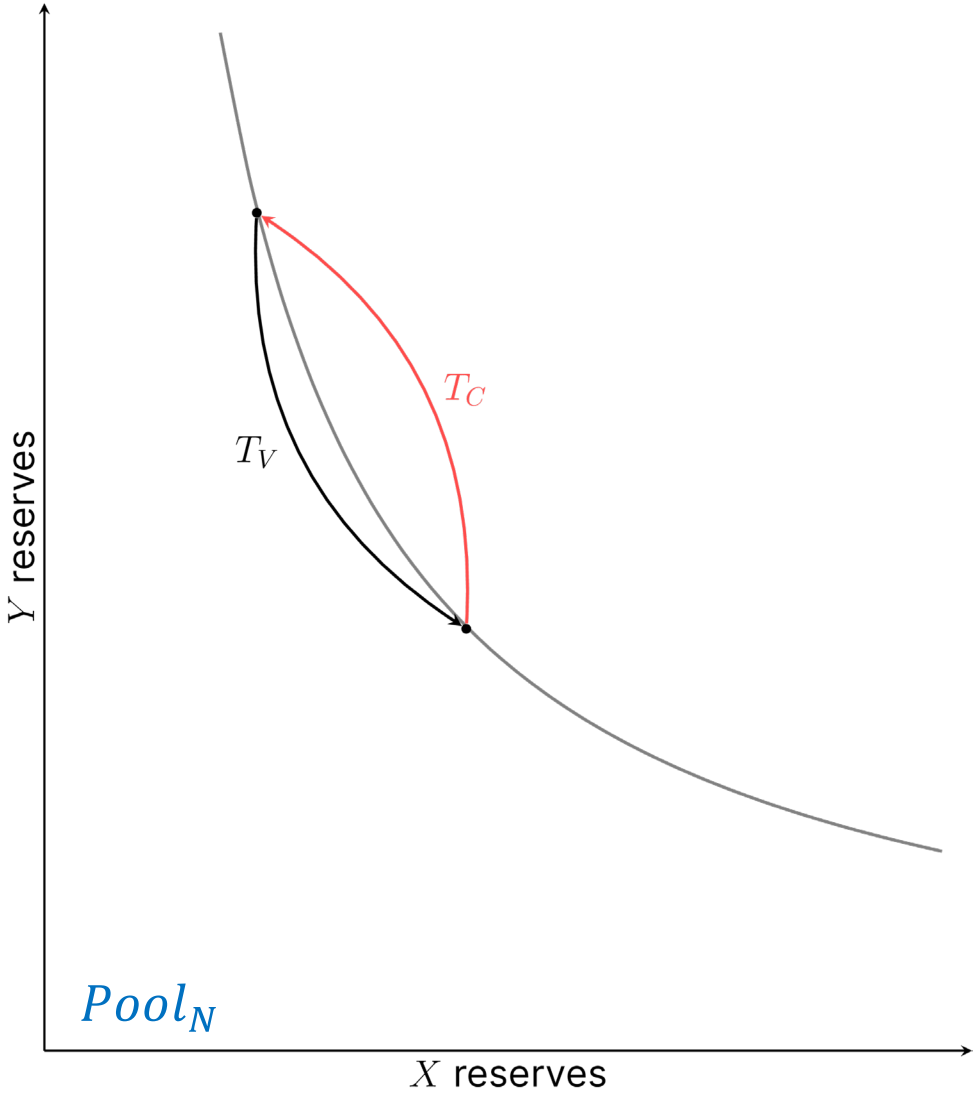
Arbitrageur



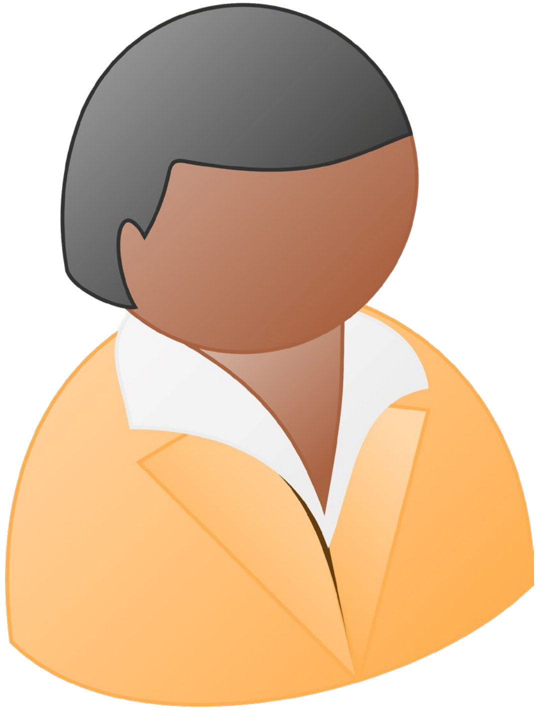
restore price in pools

Arbitrageur

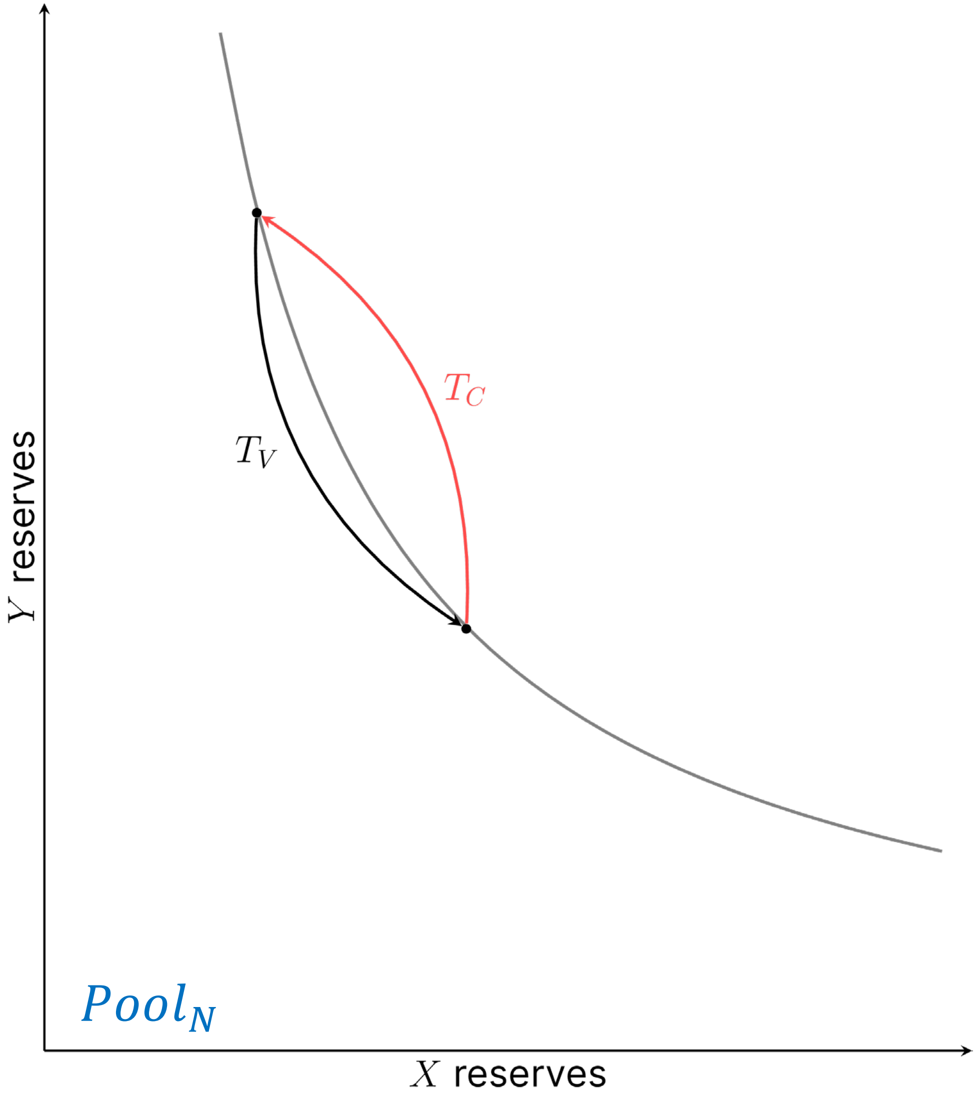




Arbitrageur



$$P = P_N = \frac{y_N}{x_N}$$



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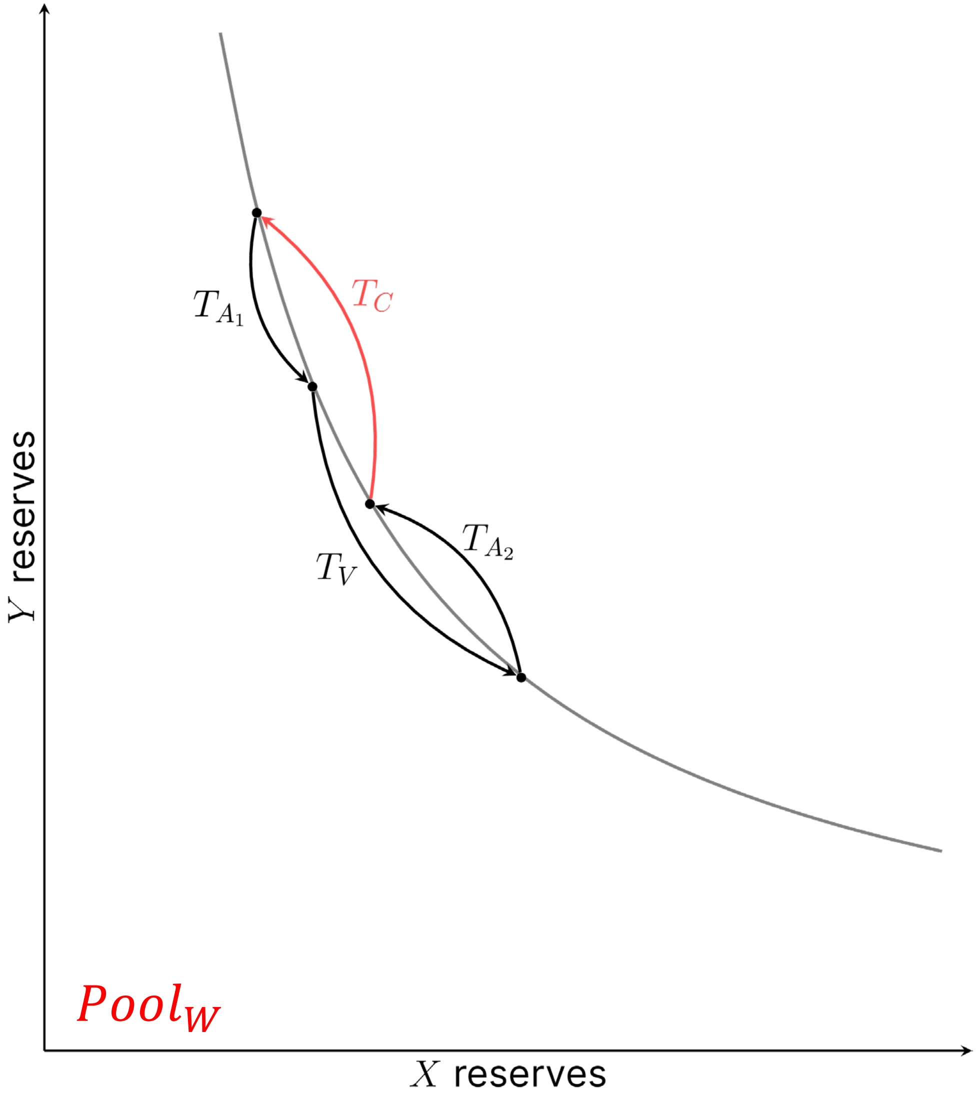
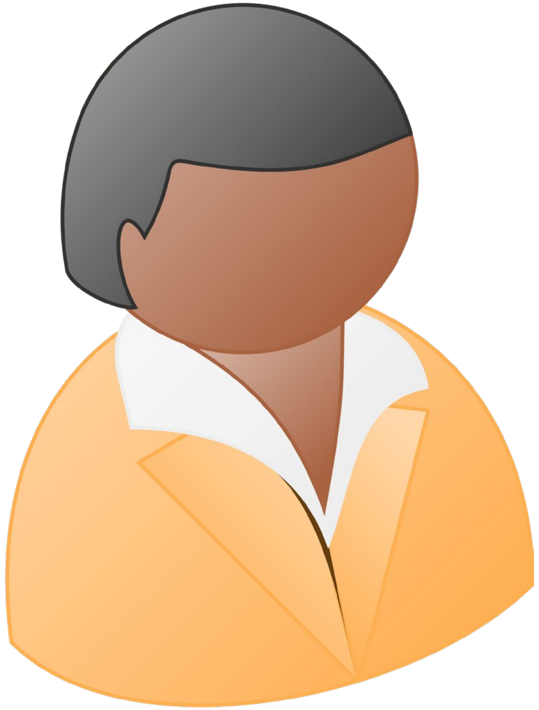
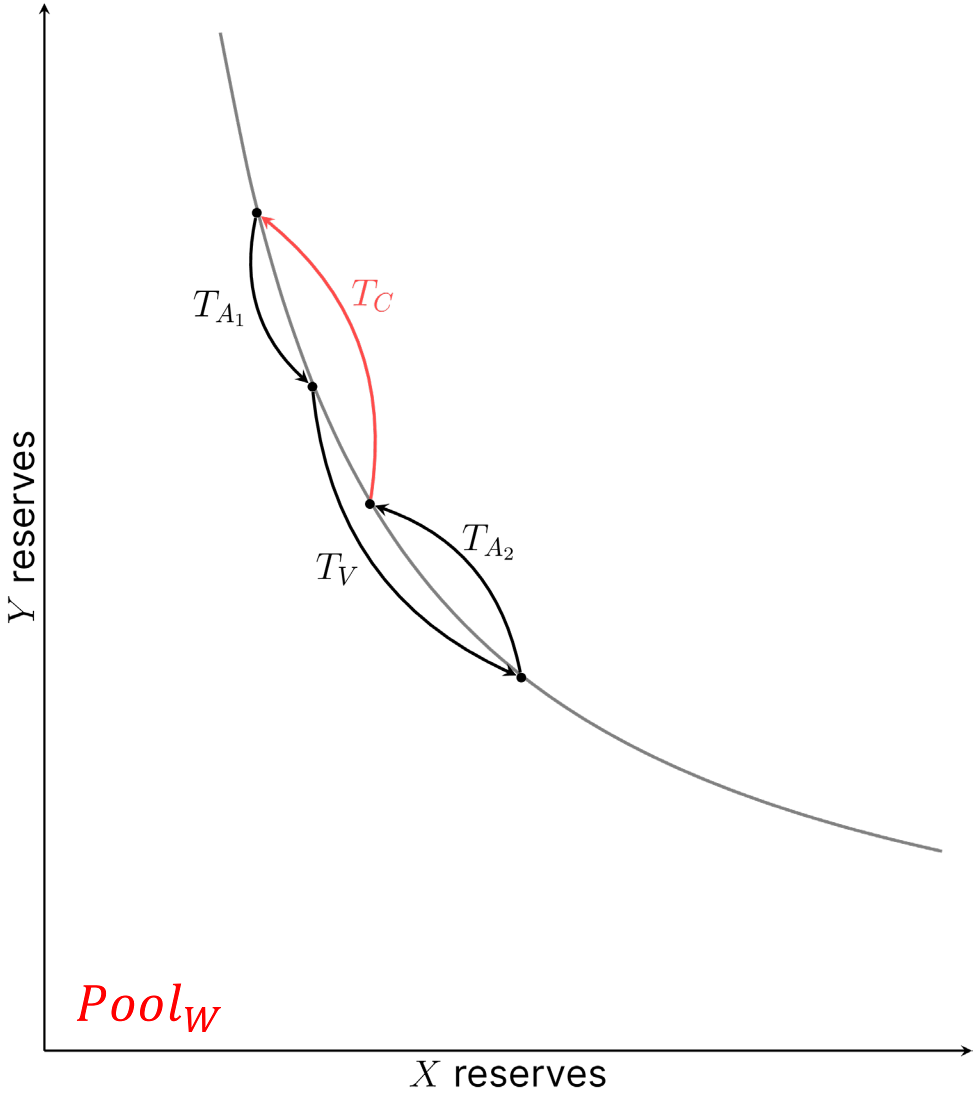


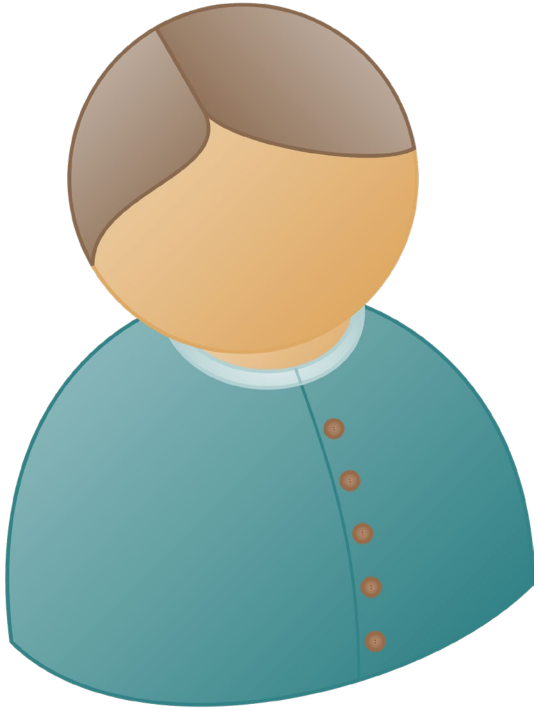
Arbitrageur



$$P = P_W = \frac{y_W}{x_W}$$

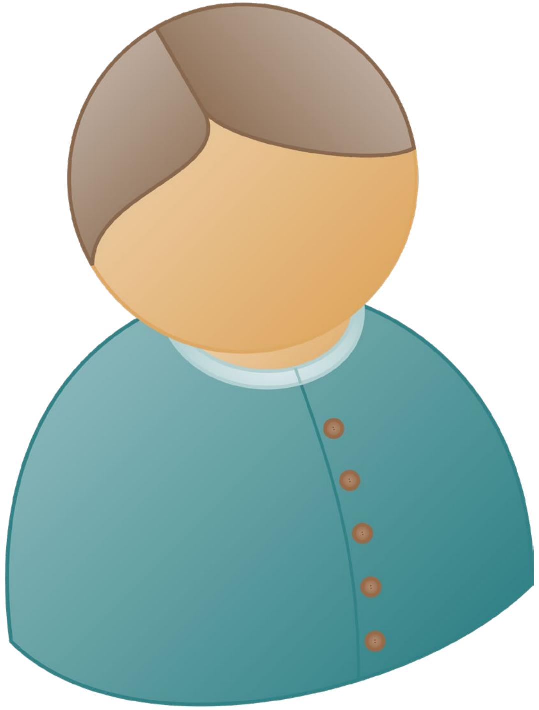


Trader



maximize personal benefit

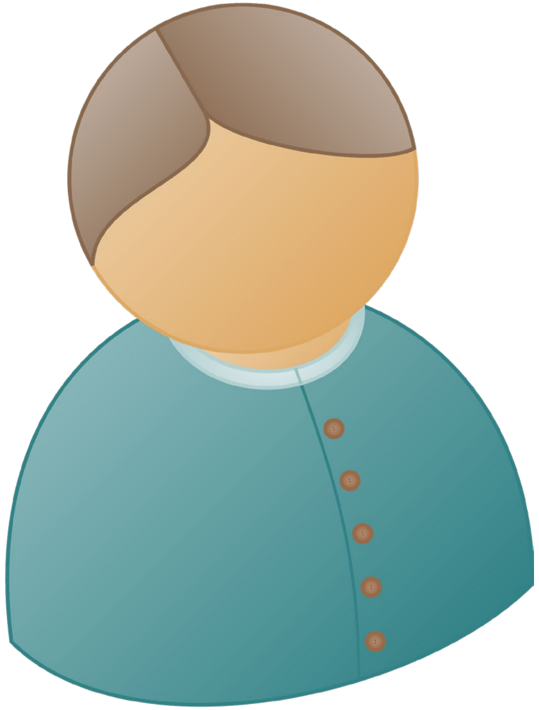
Trader

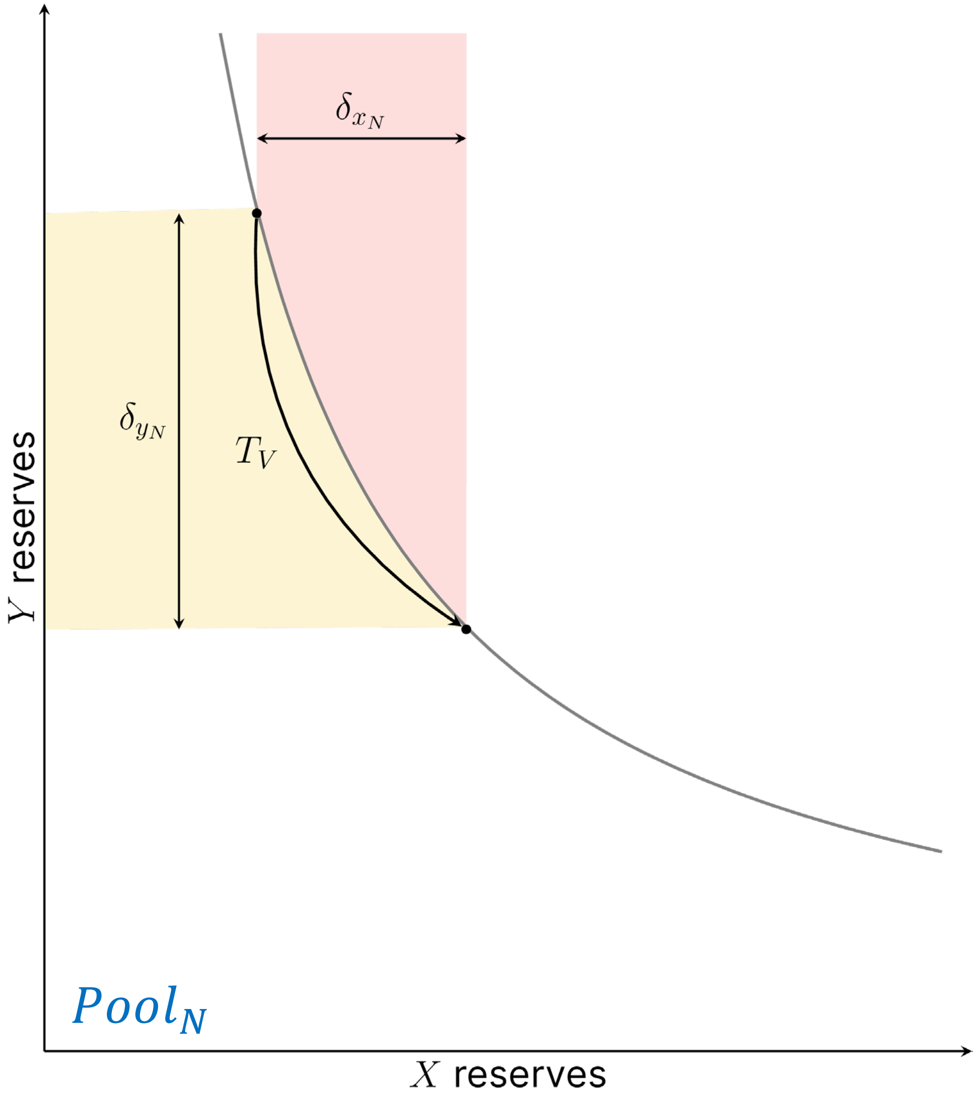


maximize personal benefit

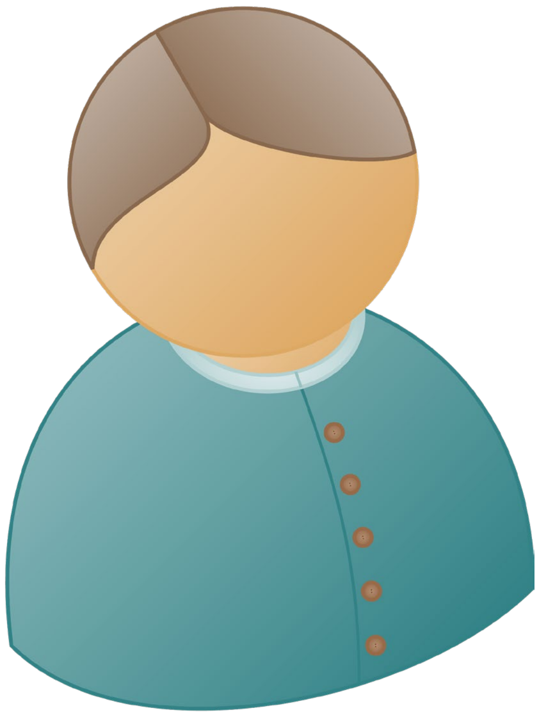
associates personal benefit α with token Y

Trader

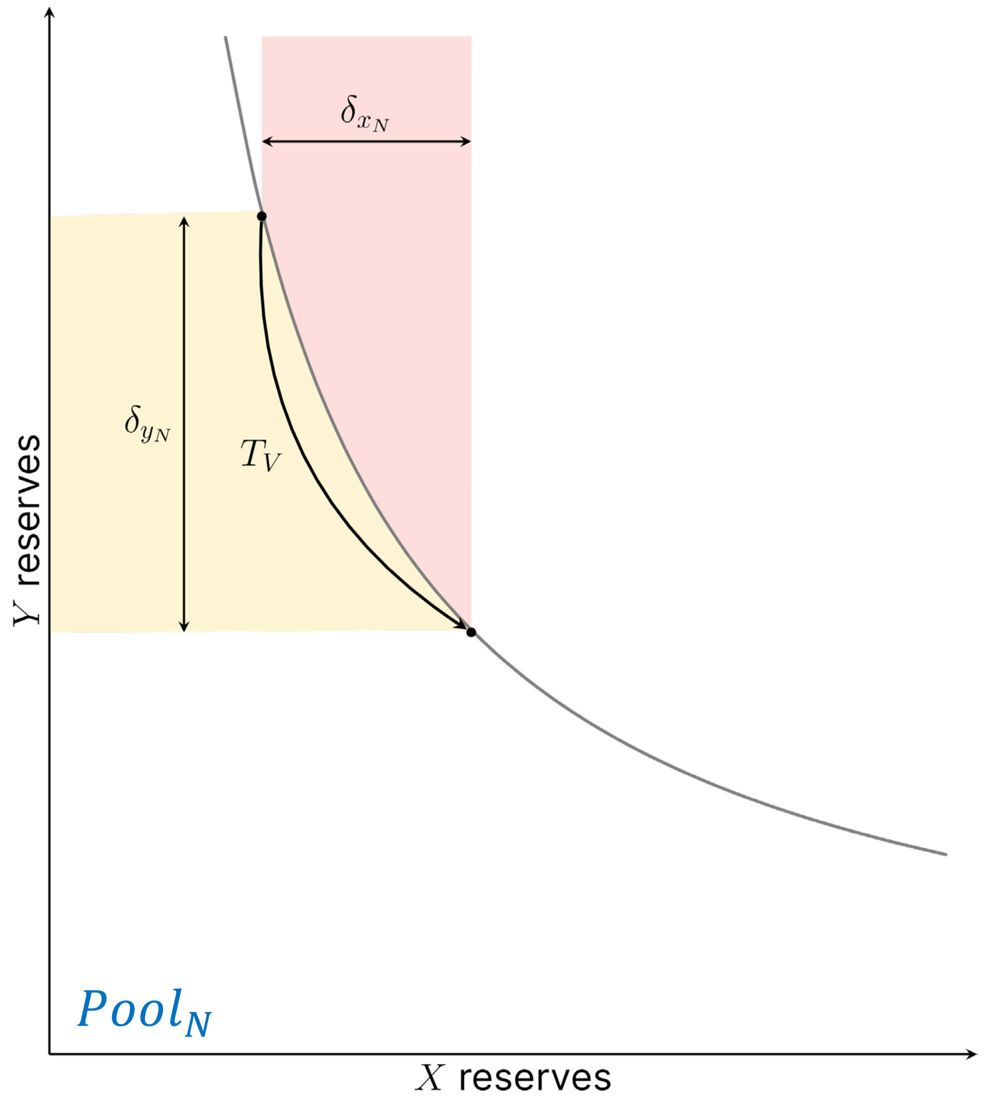




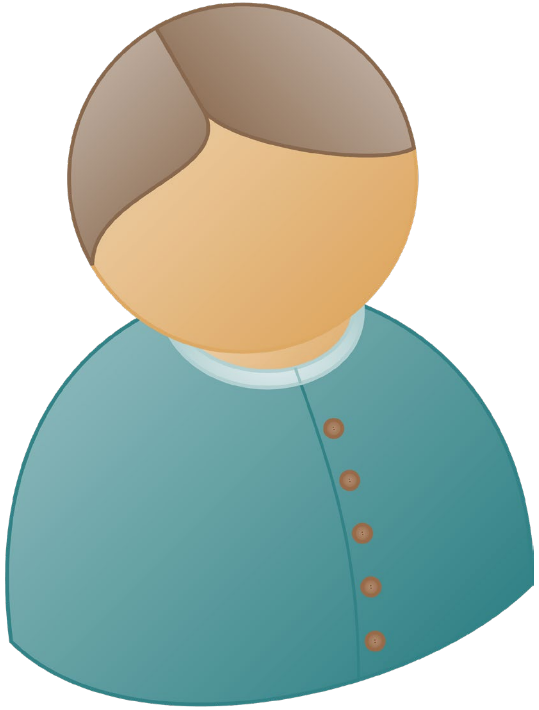
Trader

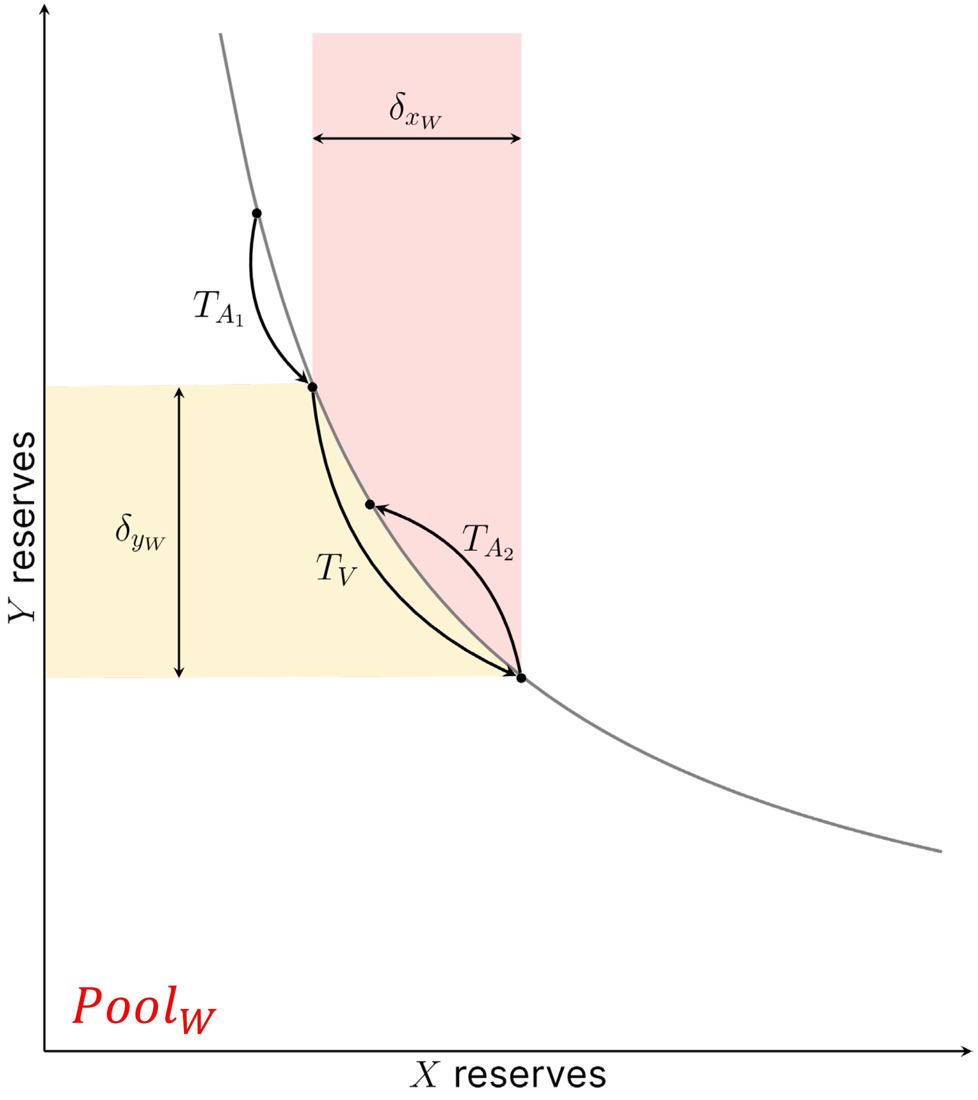


$$\max\ (1+\alpha)\delta_{y_N} - \frac{y}{x}\delta_{x_N}$$

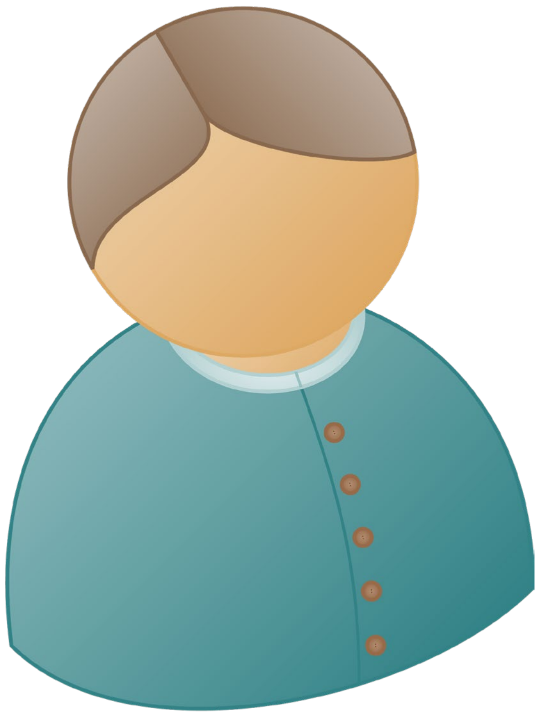


Trader

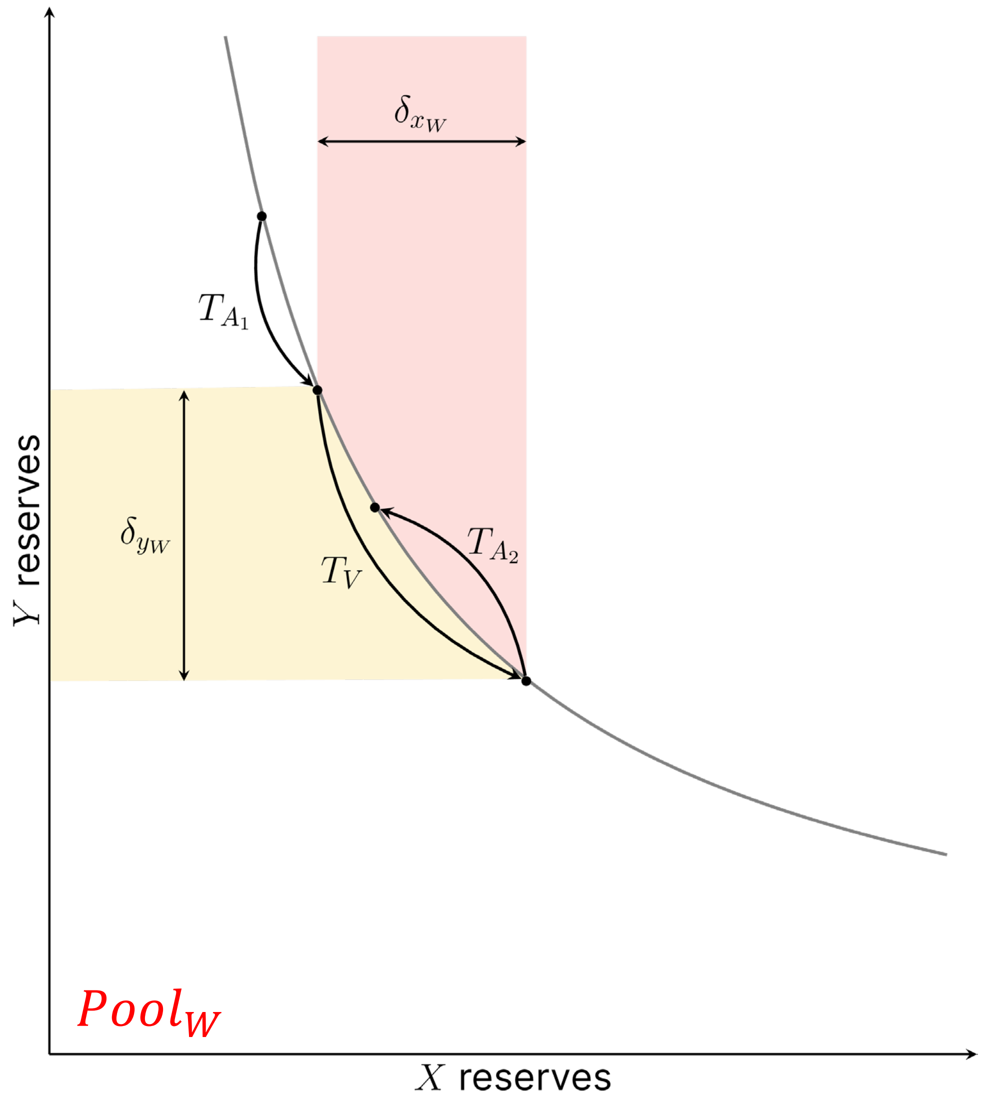




Trader



$$\max\ (1+\alpha)\delta_{y_W} - \frac{y}{x}\delta_{x_W}$$



Liquidity provider

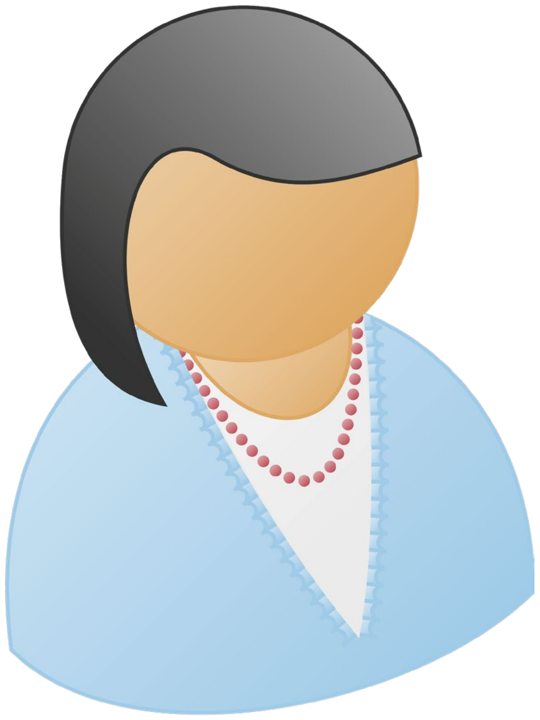
maximize fee revenue

Liquidity provider

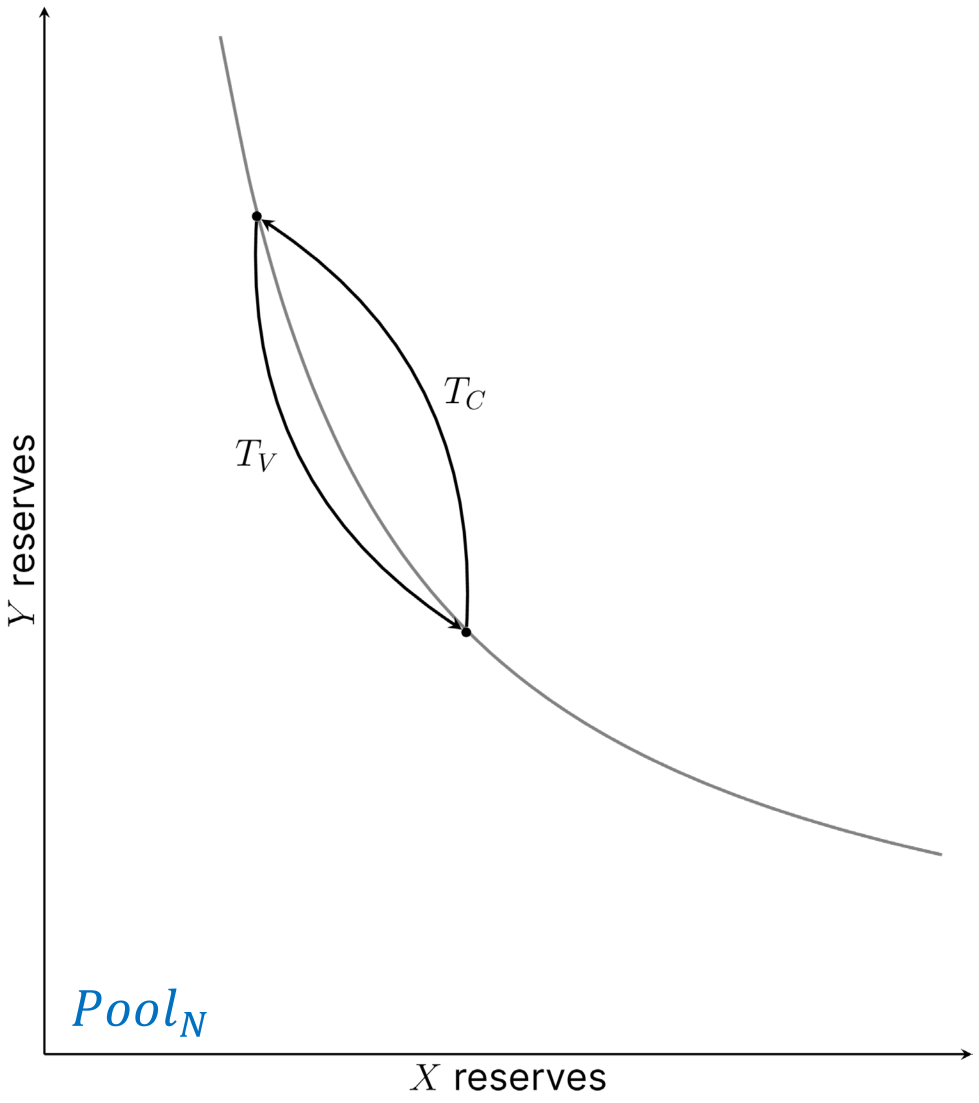
maximize fee revenue

receives fees proportional to trade input amount

Liquidity provider

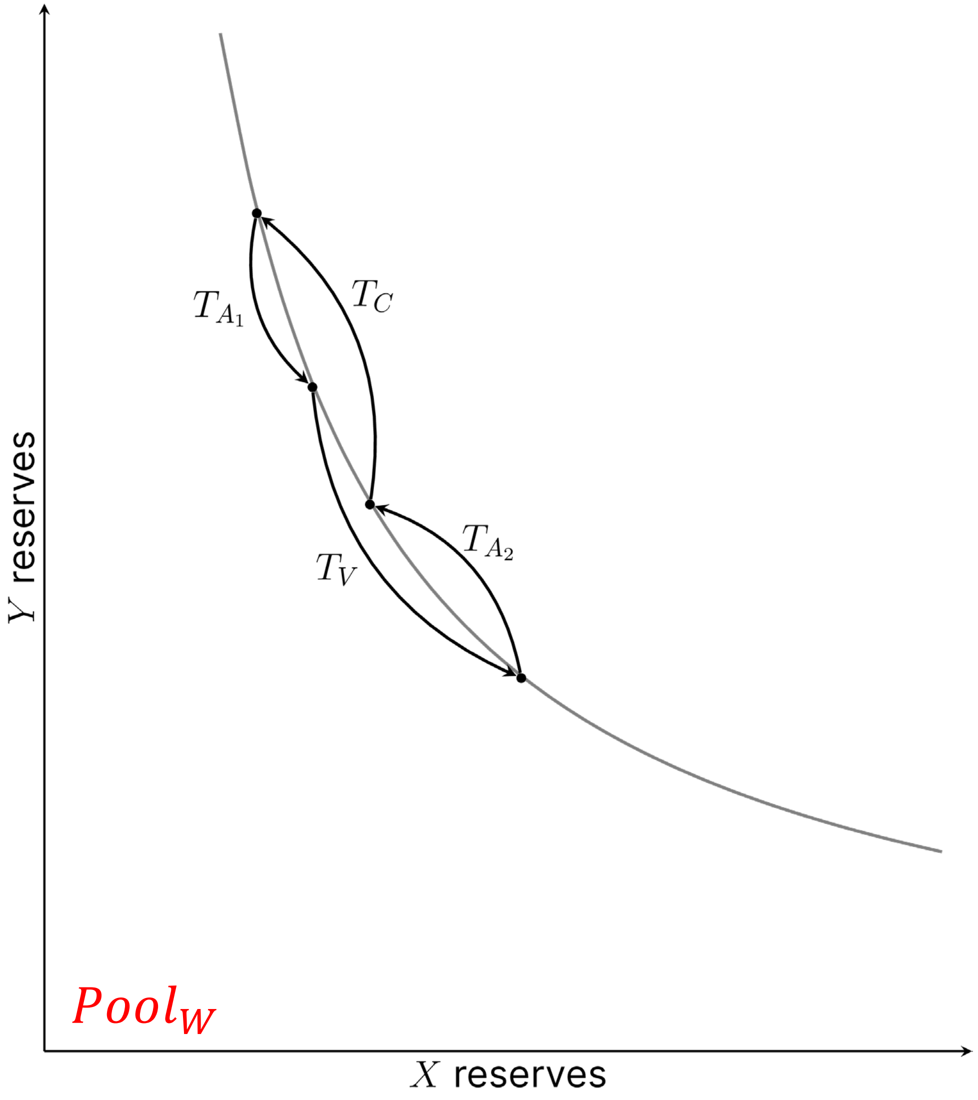


F_N



Liquidity provider

F_W

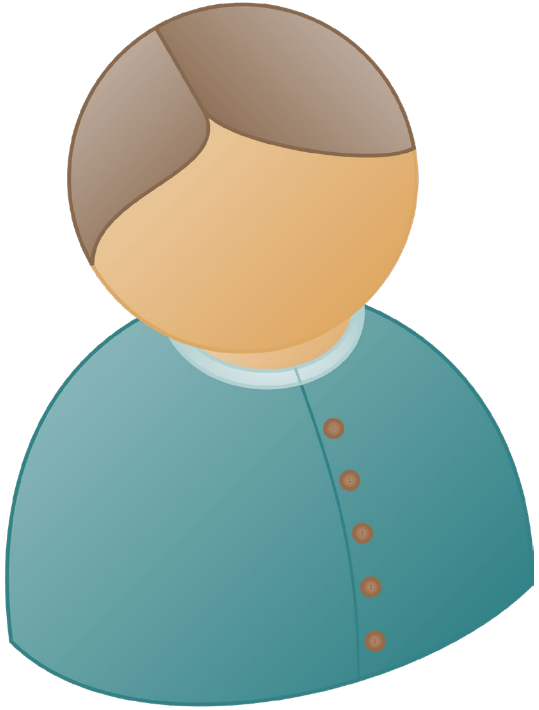


Liquidity provider

$\max\ F_N + F_W$

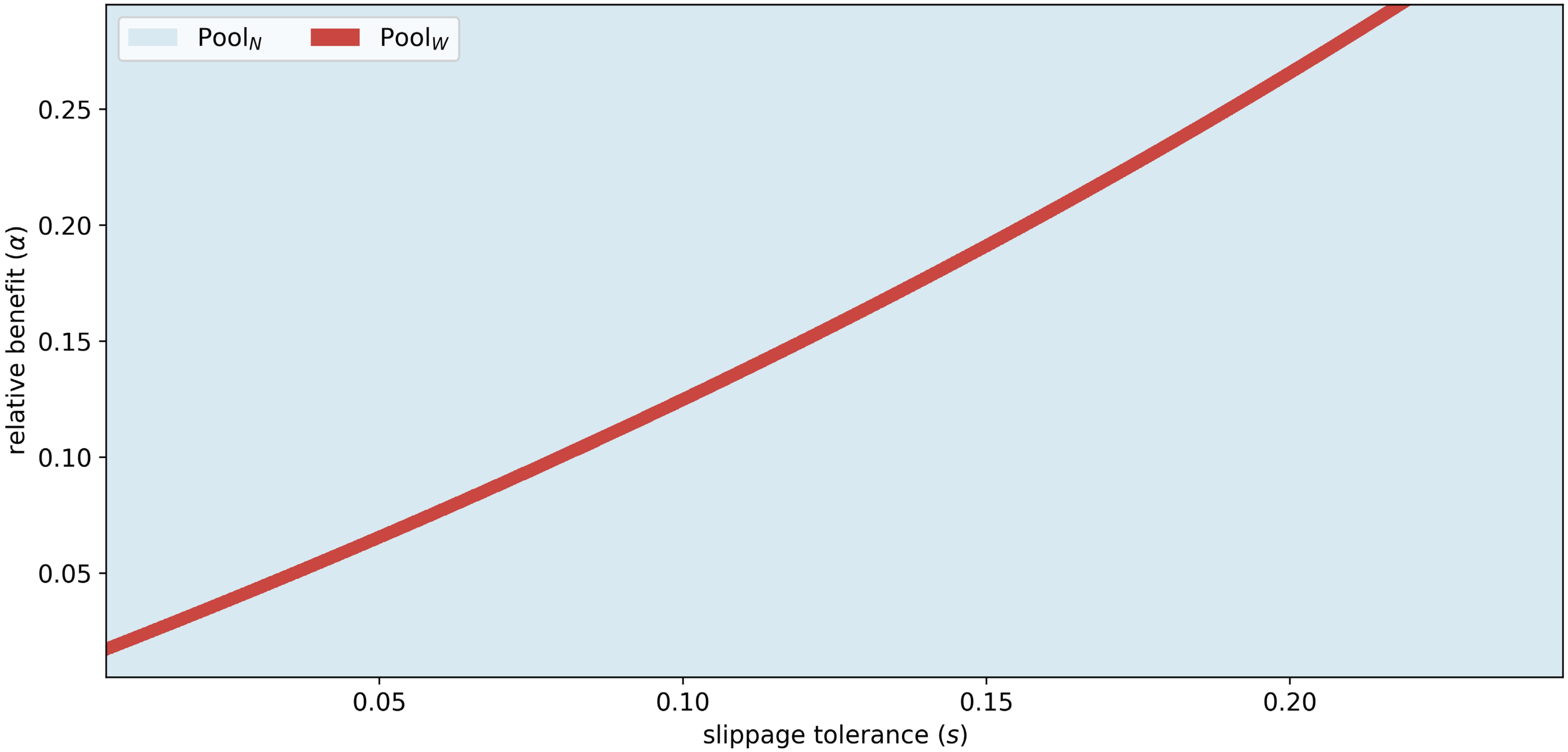
Are liquidity providers incentivized to move to DEXes that implement front-running protection?

Homogenous Traders



same relative benefit α for all traders

Nash Equilibrium in Homogenous Setting



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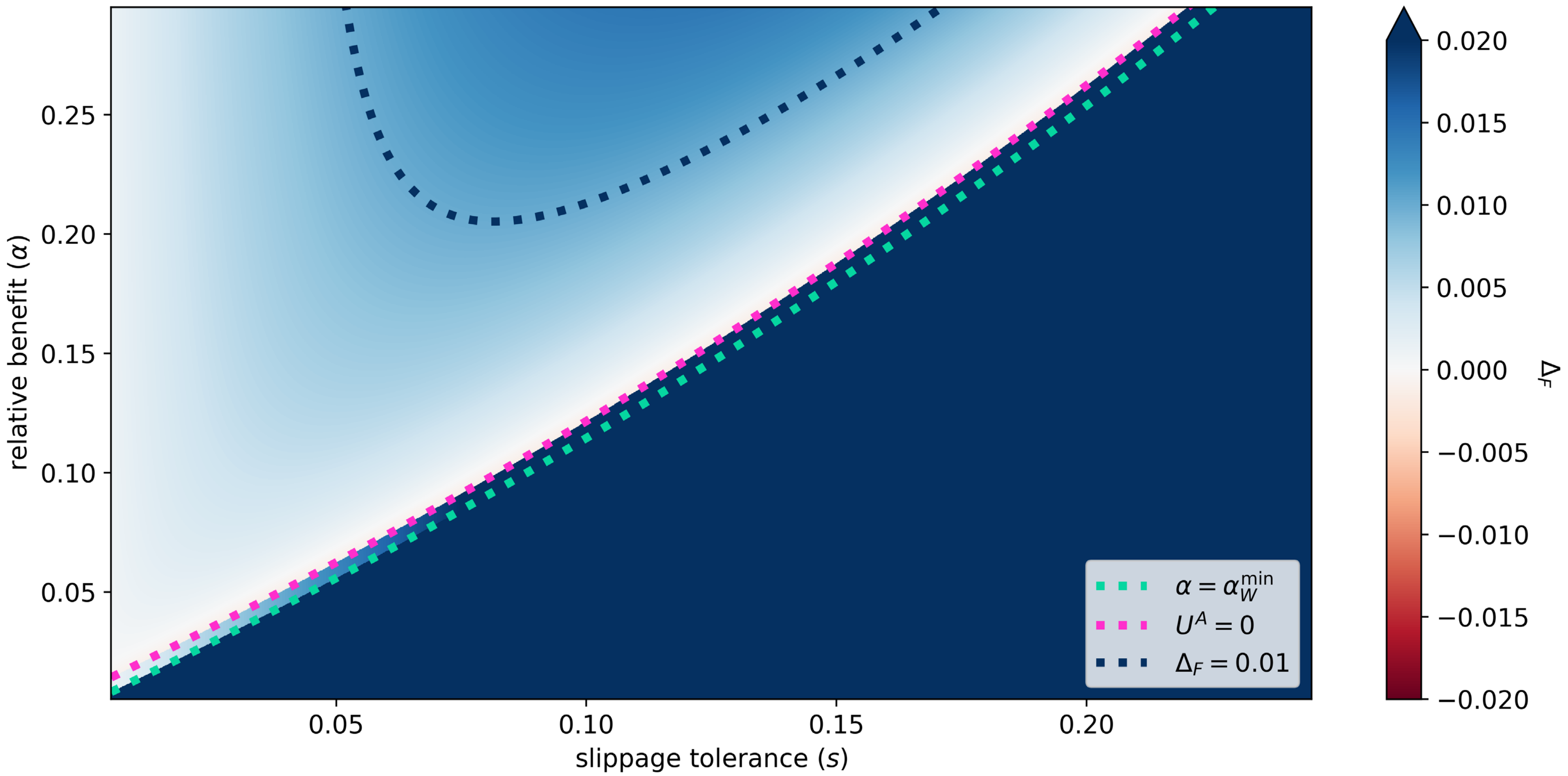

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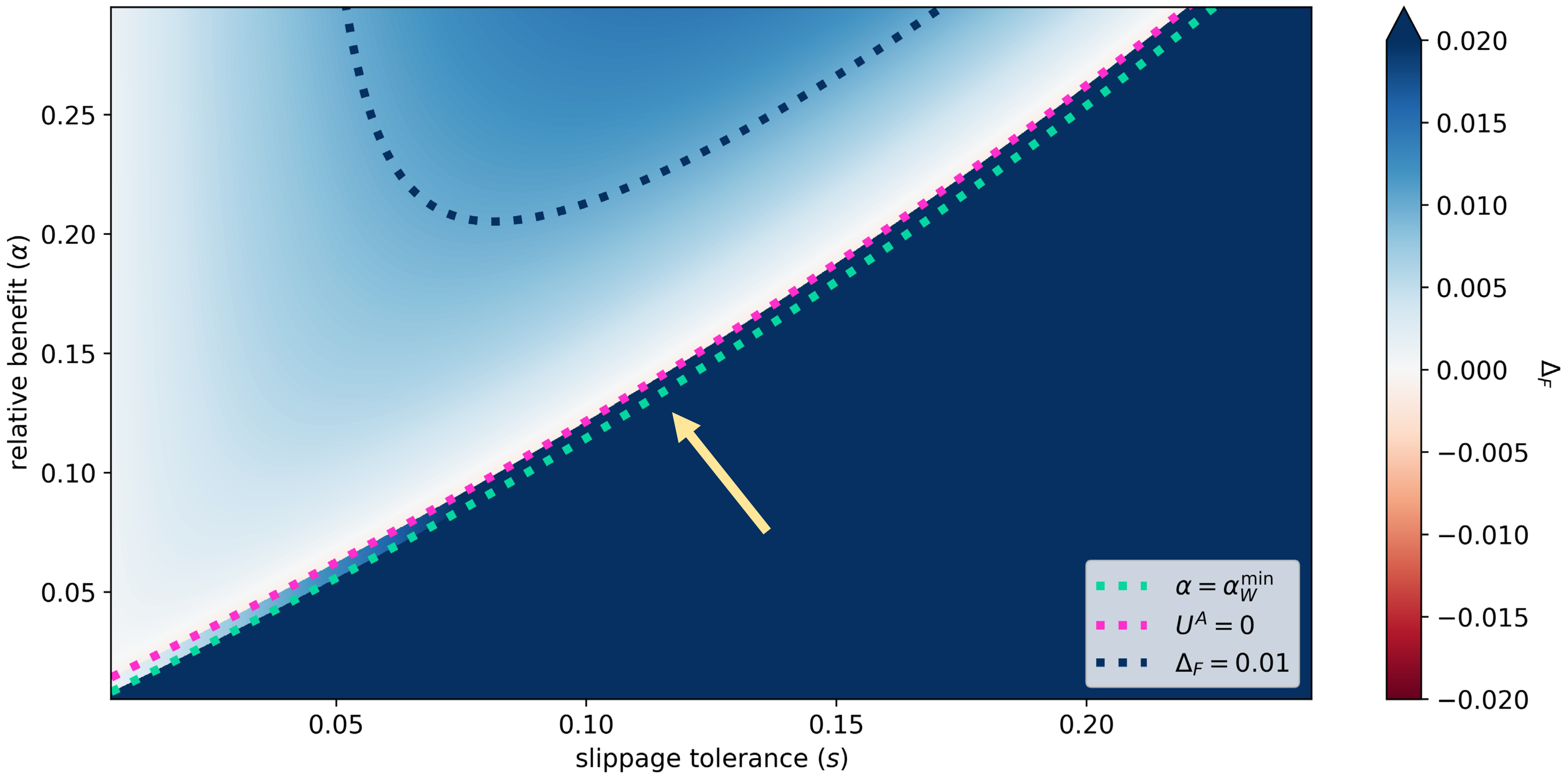
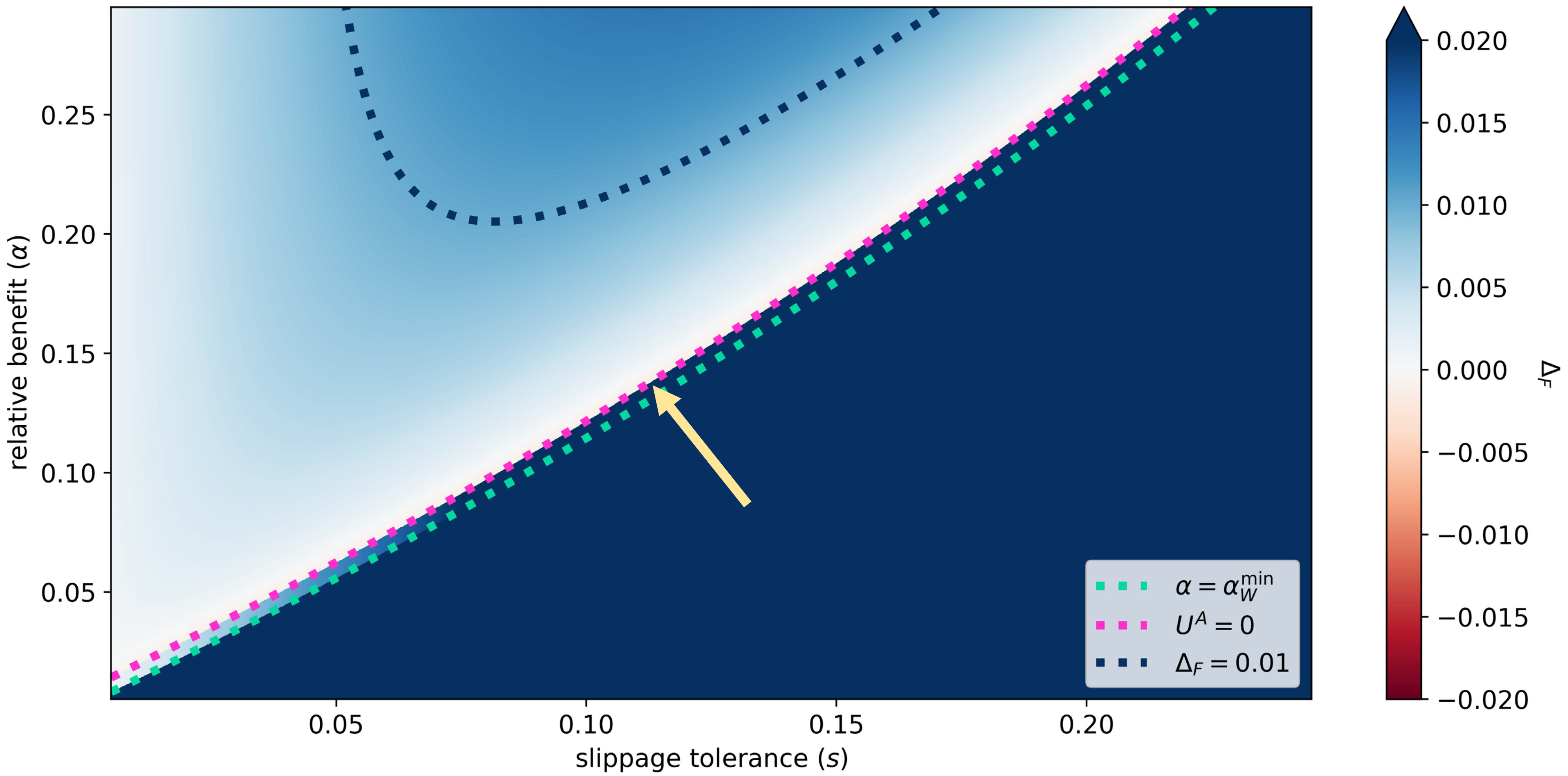
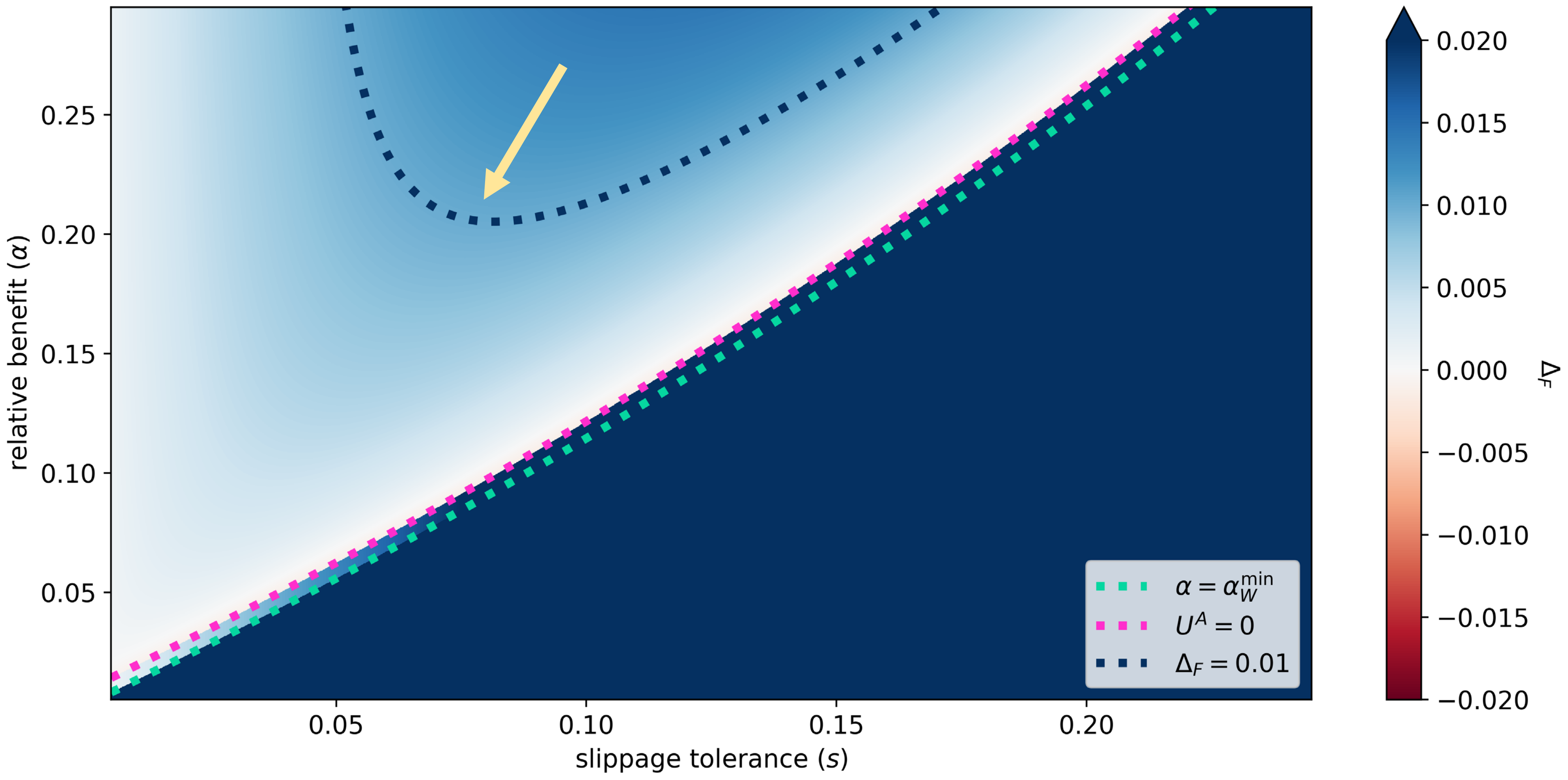


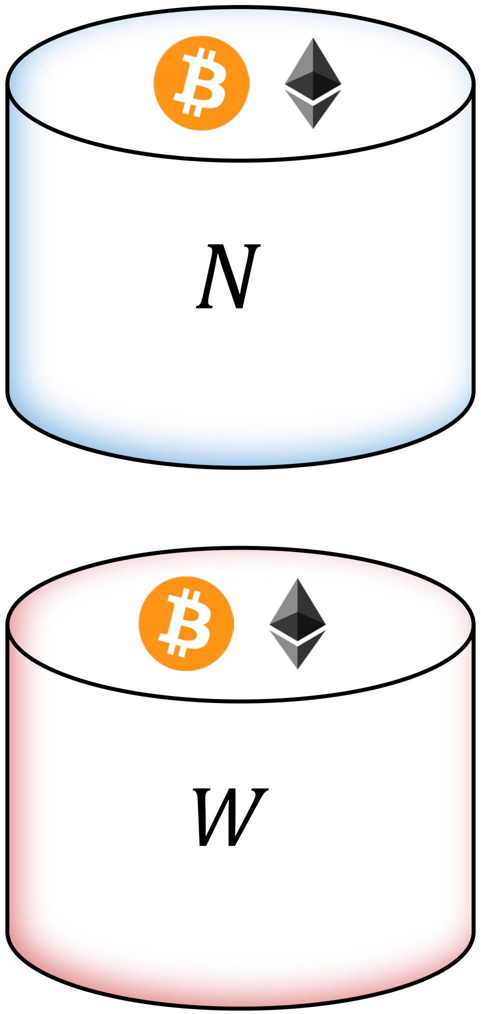
Nash Equilibrium in Homogenous Setting



Nash Equilibrium in Homogenous Setting

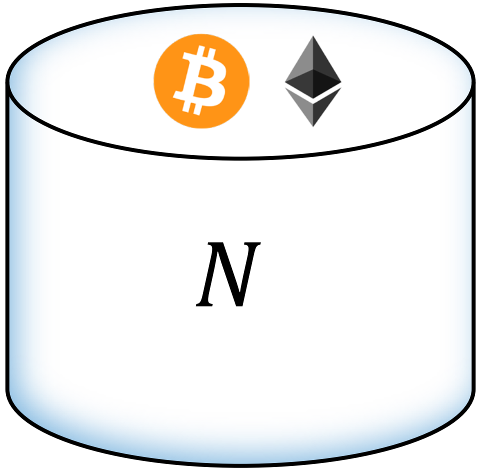


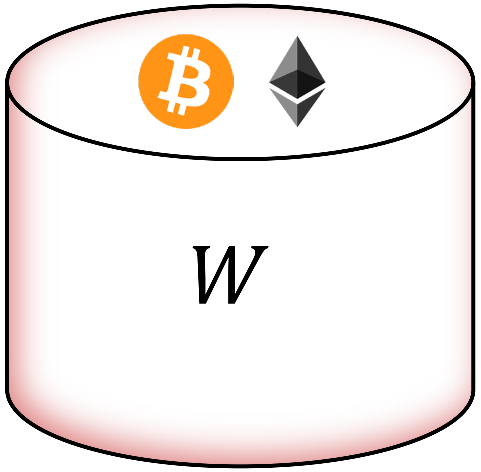
Summary



for most parameter configurations $Pool_N$ is the Nash equilibrium

Summary





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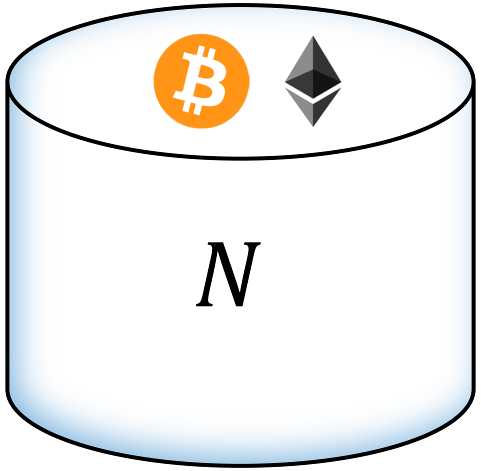

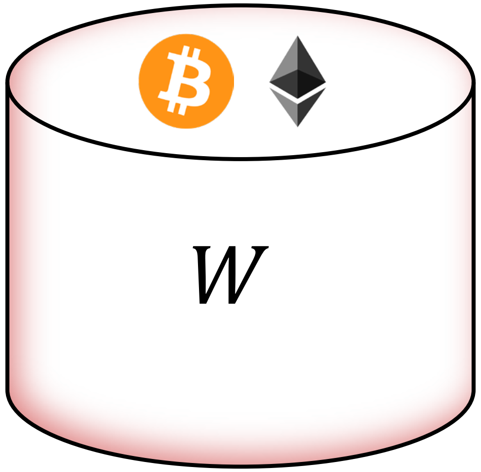

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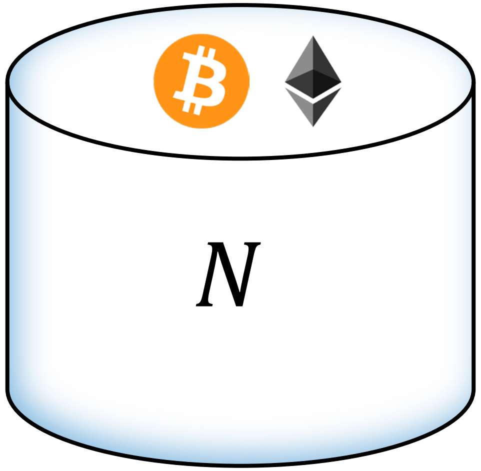
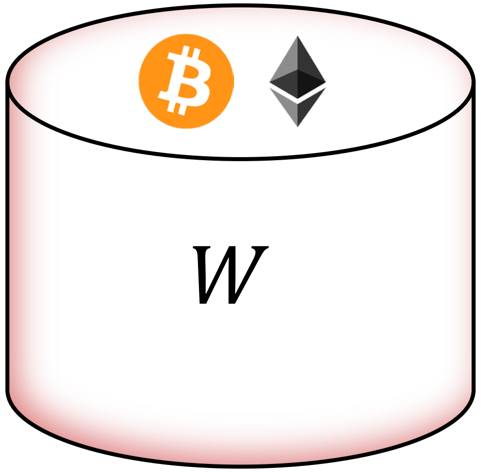




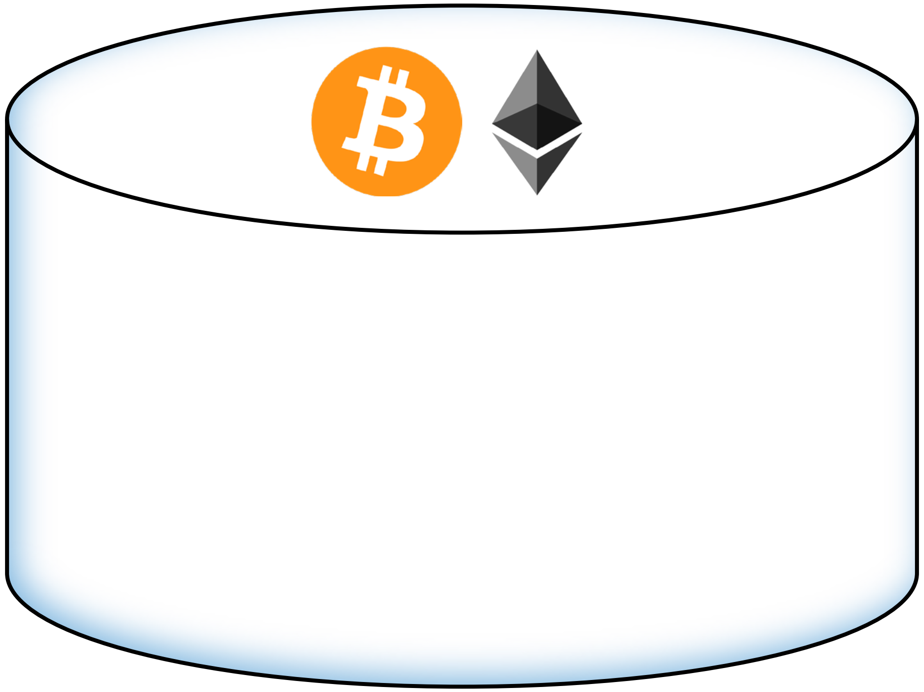
for most parameter configurations $Pool_N$ is the Nash equilibrium

liquidity providers are currently in markets without front-running protection

benefit from adjusting a liquidity distribution is often only small

liquidity provider might require additional benefits to move liquidity

The Potential of Self-Regulation for Front-Running Prevention on DEXes



Questions?

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