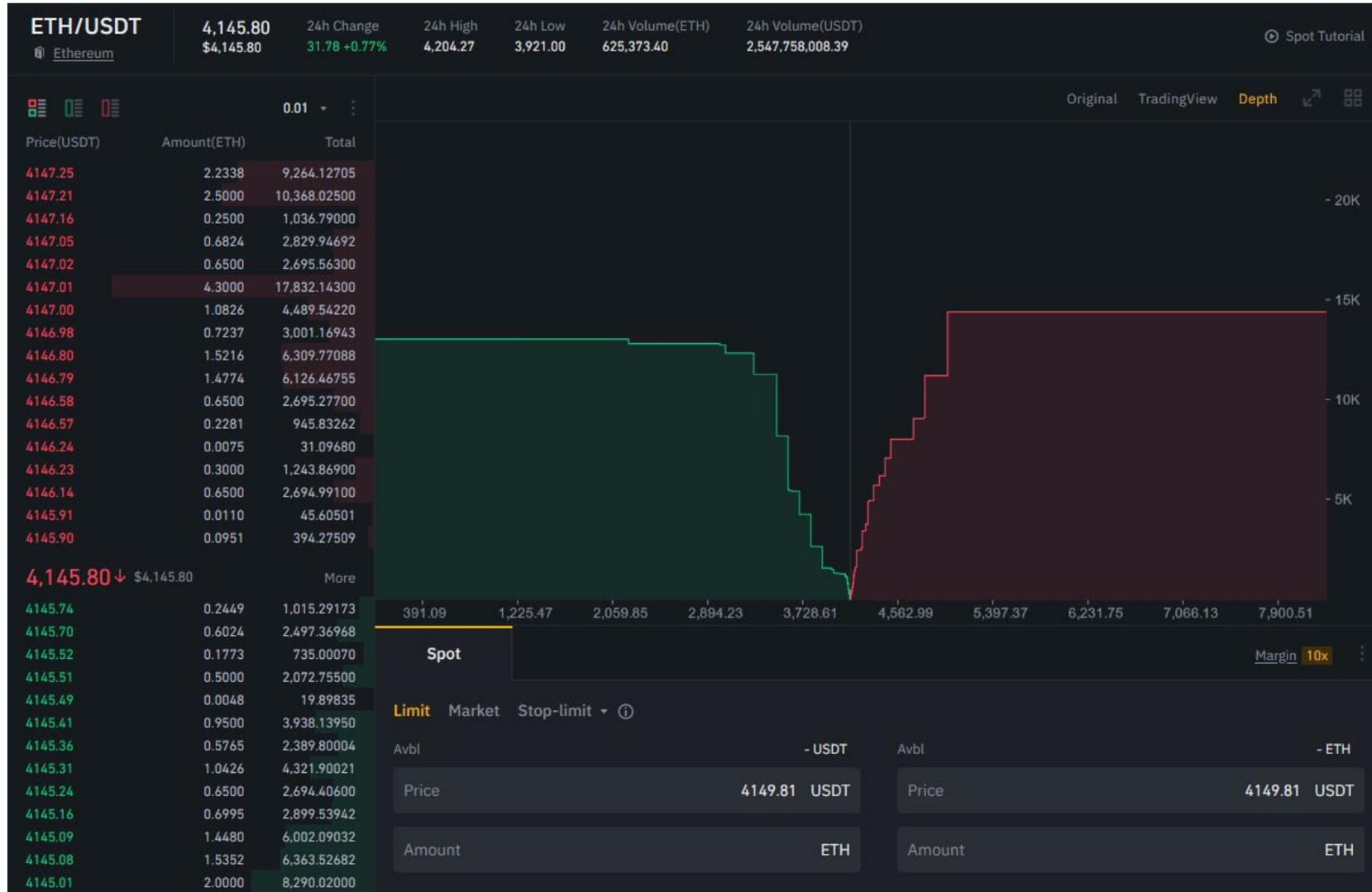


# Behavior of Liquidity Providers in Decentralized Exchanges

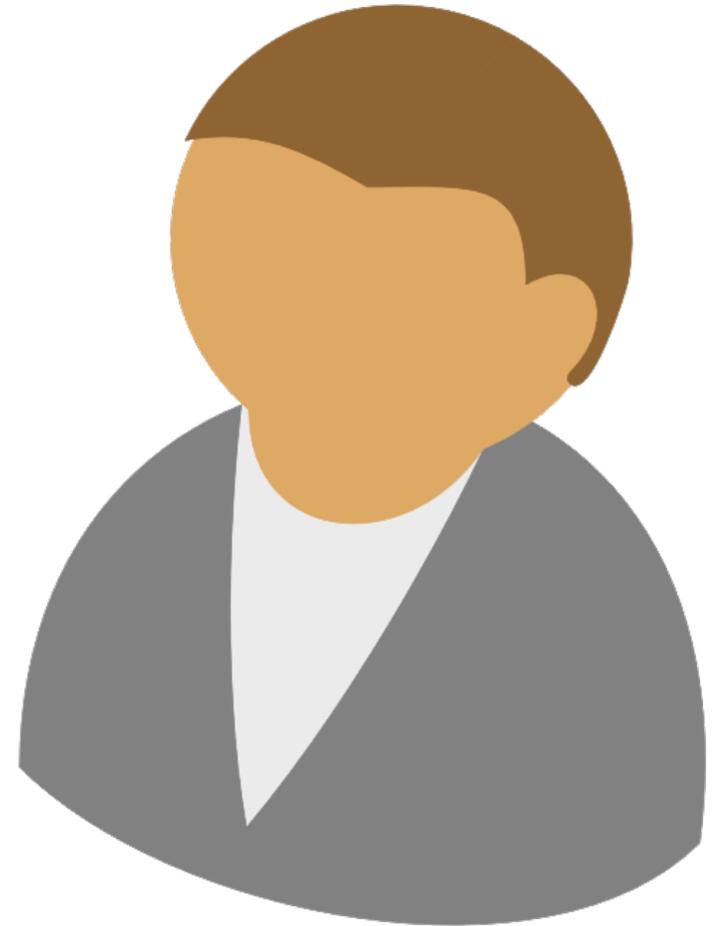


**Lioba Heimbach**, Ye Wang, Roger Wattenhofer  
ETH Zurich – Distributed Computing – [www.disco.ethz.ch](http://www.disco.ethz.ch)

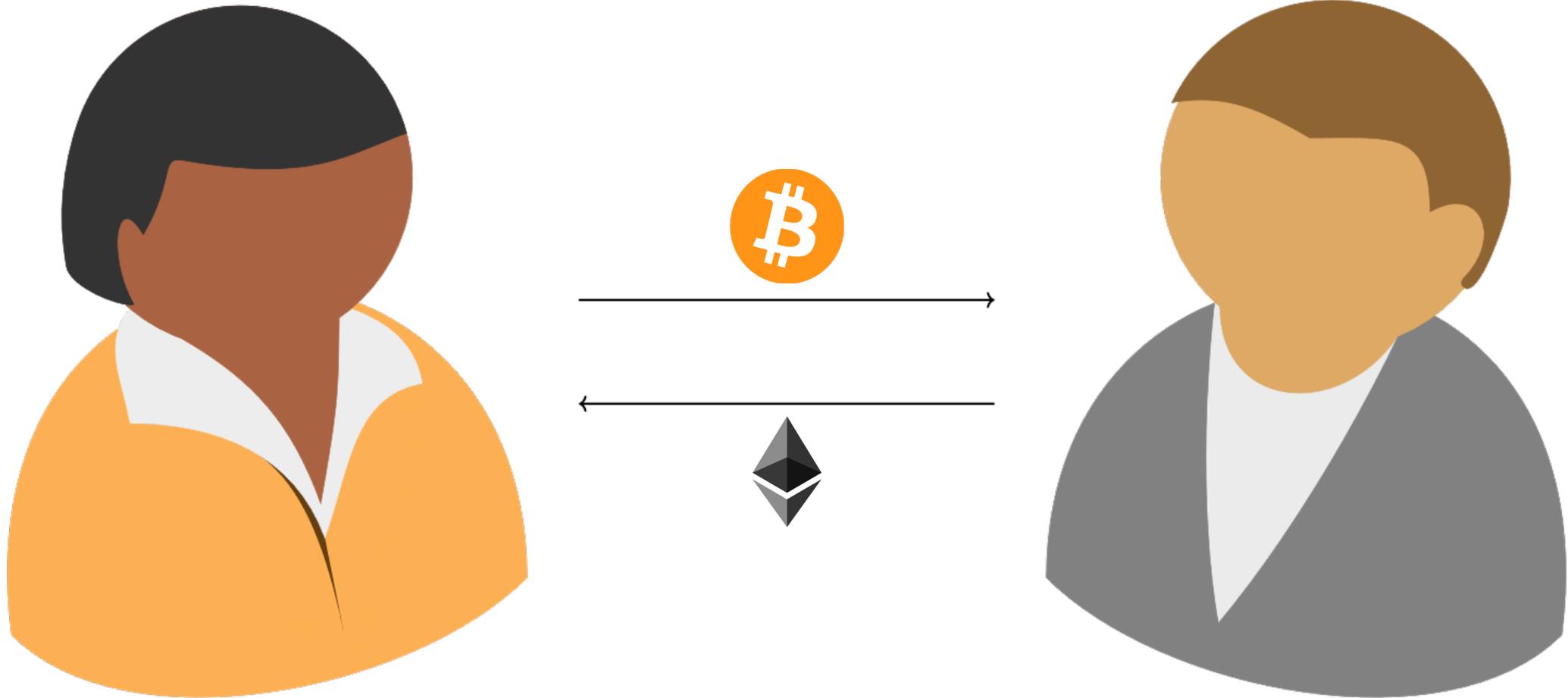
# Centralized exchanges (CEXes)



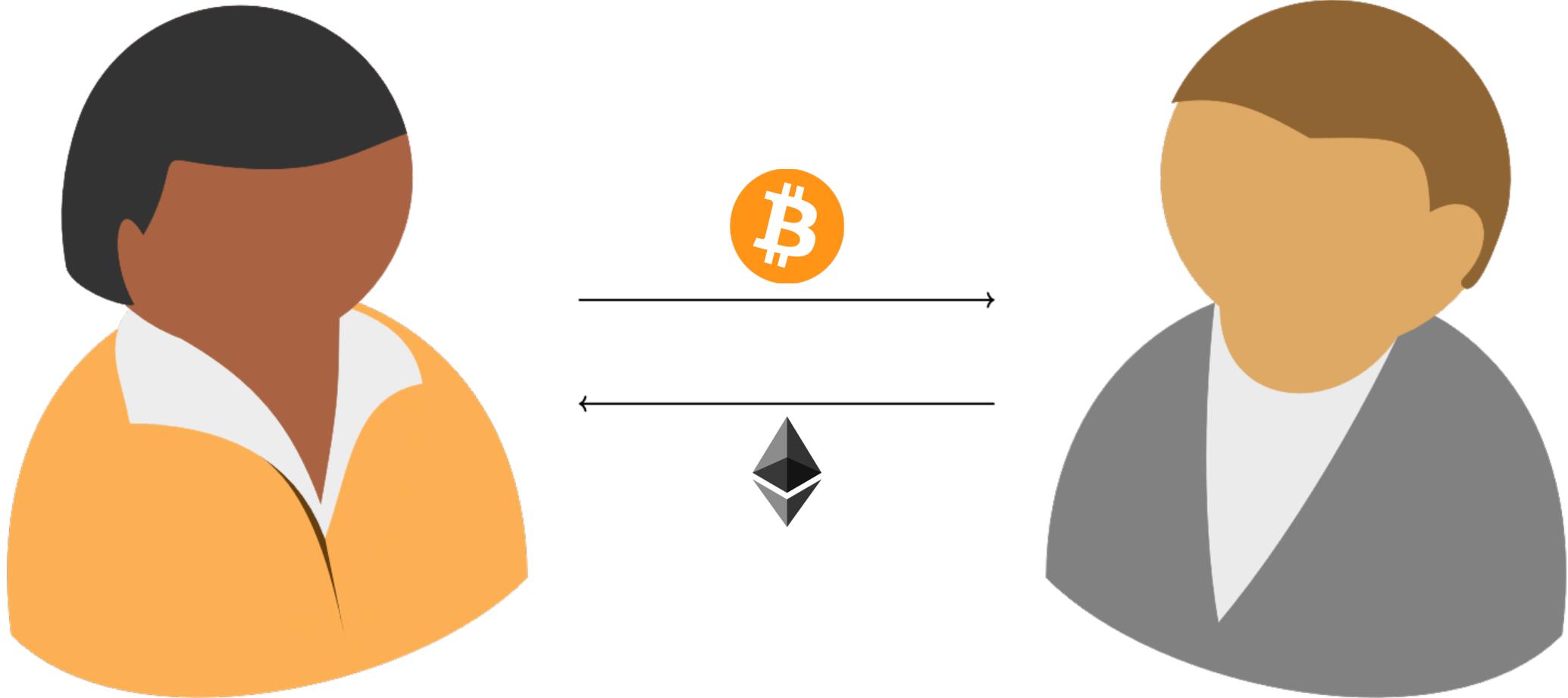
# Decentralized exchanges (DEXes)



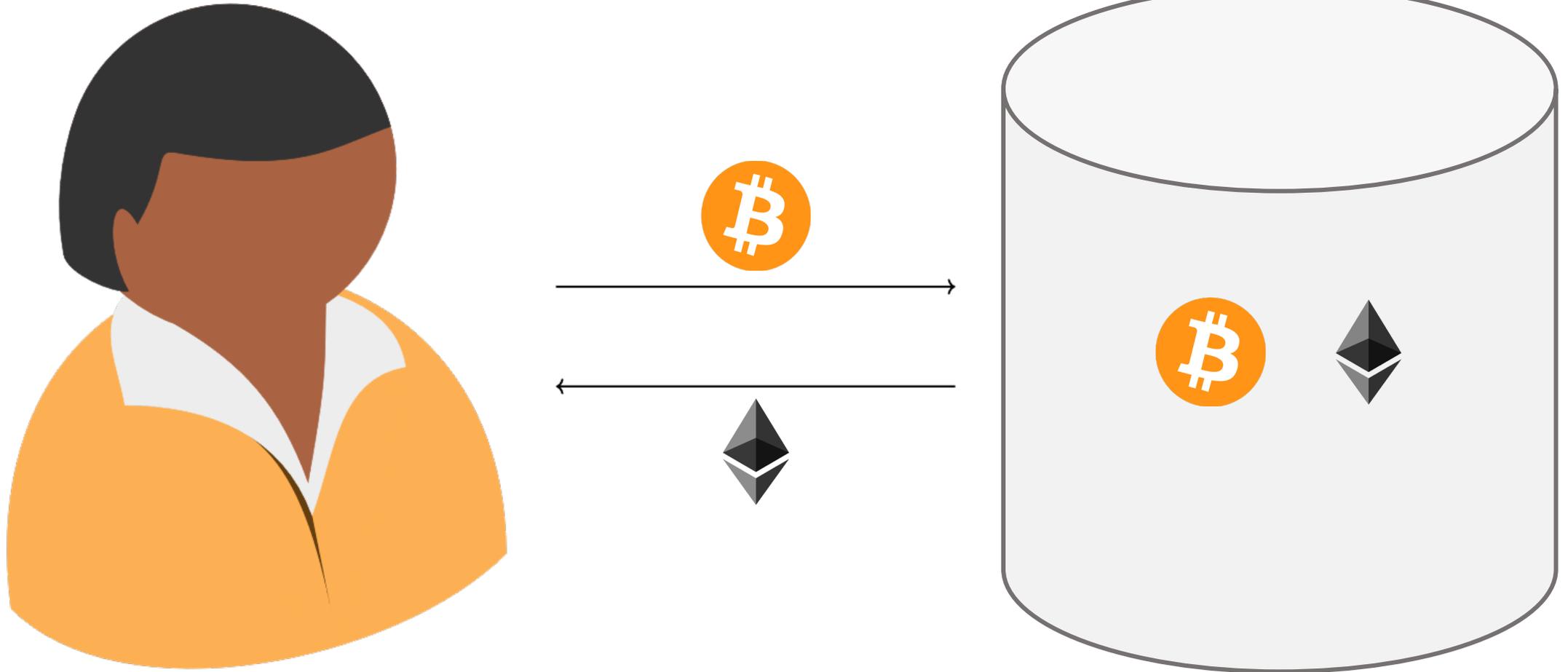
# Decentralized exchanges (DEXes)



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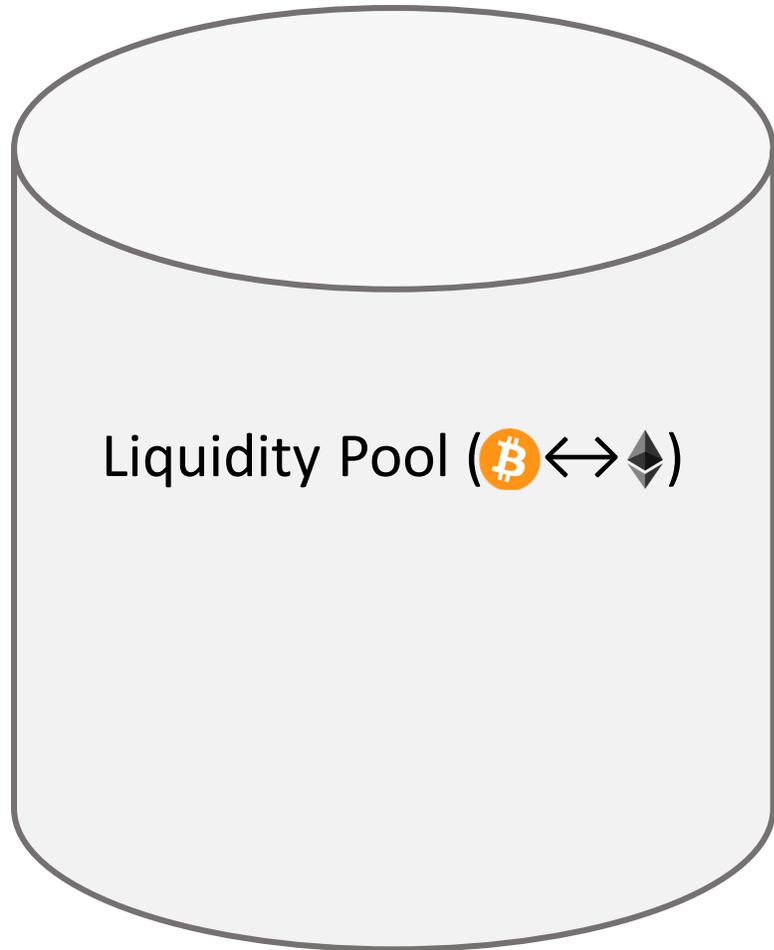
# Decentralized exchanges (DEXes)



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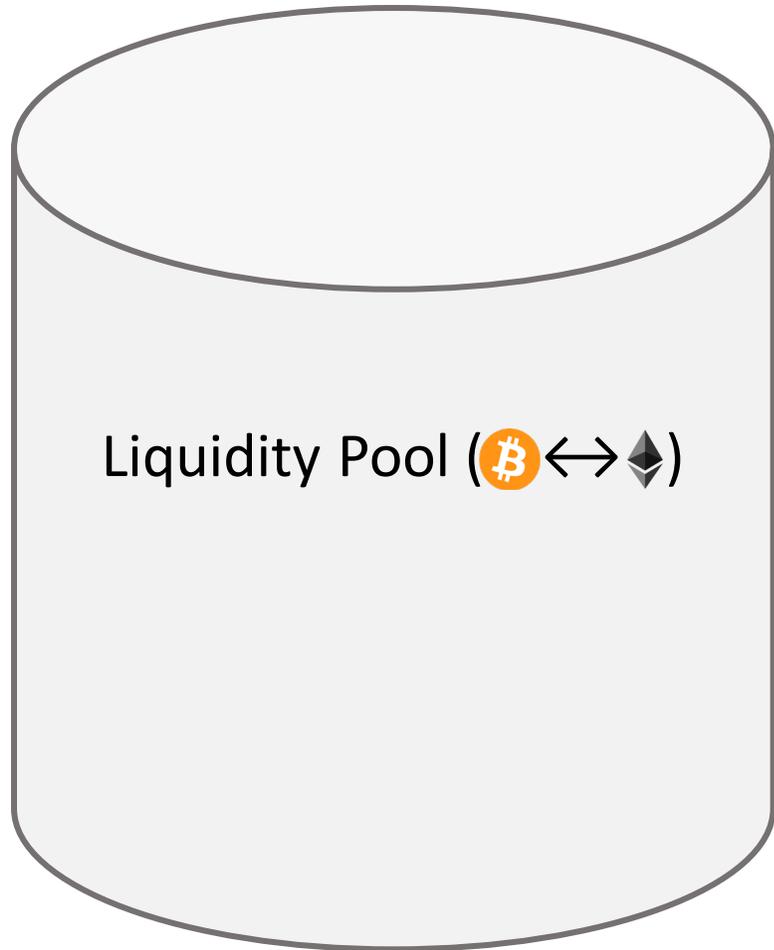
	<b>Centralized Exchange</b>	<b>Decentralized Exchange</b>
execution	operates through an intermediary organization for clearing transactions	operates through automated smart contracts without an intermediary
data storage	server	blockchain
market making	order book	automated market maker
spread	bid-ask spread	(expected) slippage
crypto products	some cryptocurrencies and a few crypto derivatives	almost all cryptocurrencies and a few crypto derivatives

# 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)

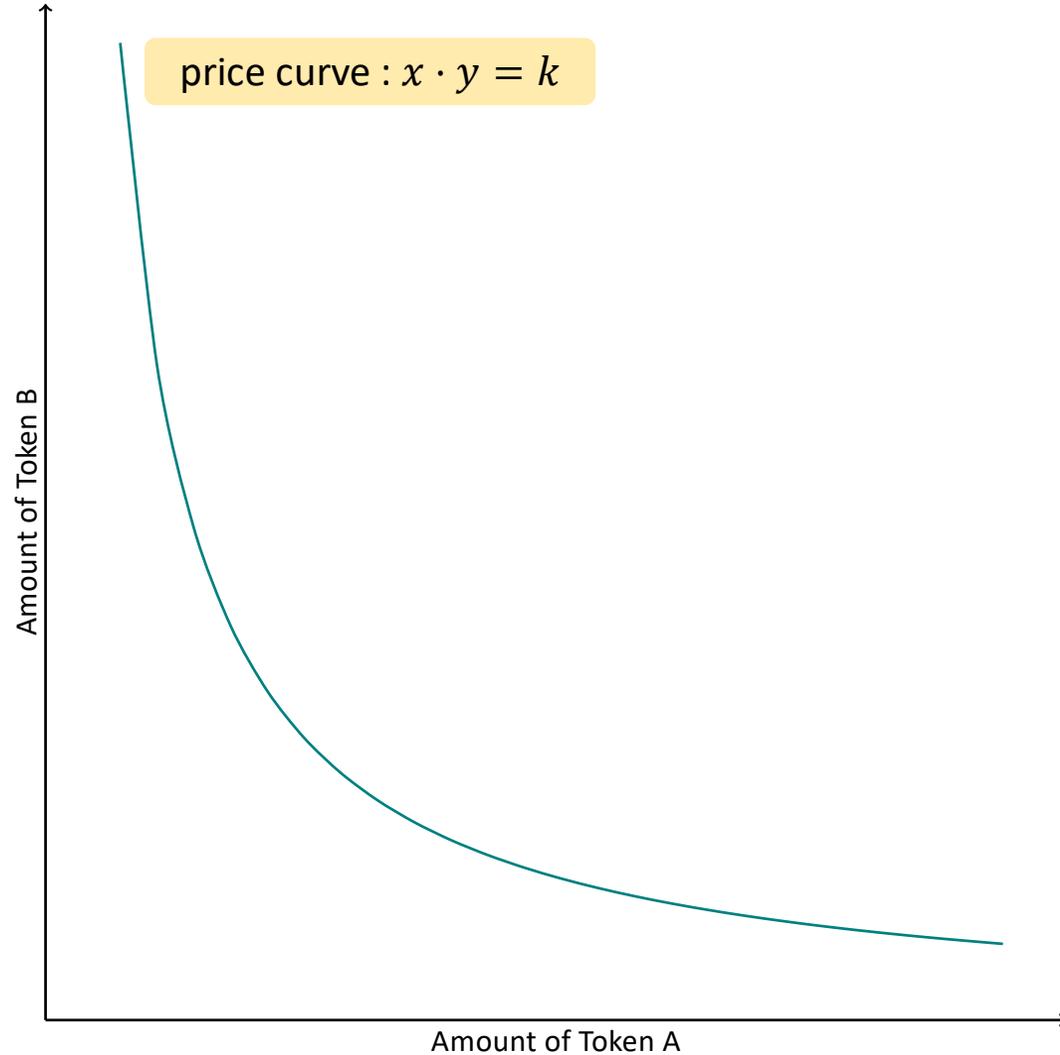


liquidity pool for every token pair

liquidity providers deposit reserves in pools

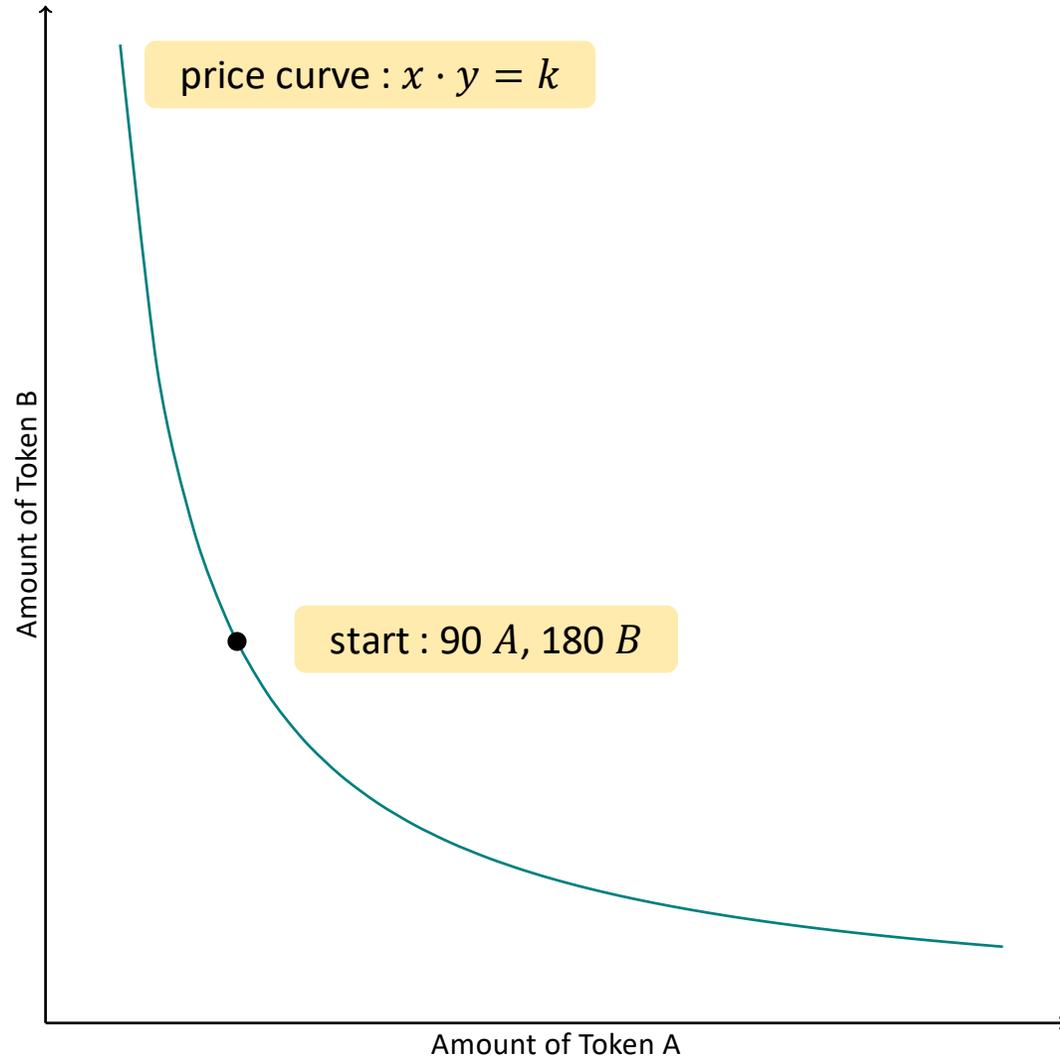
pool holds reserves for both tokens

# Constant product market makers (CPMMs)



trading along price curve

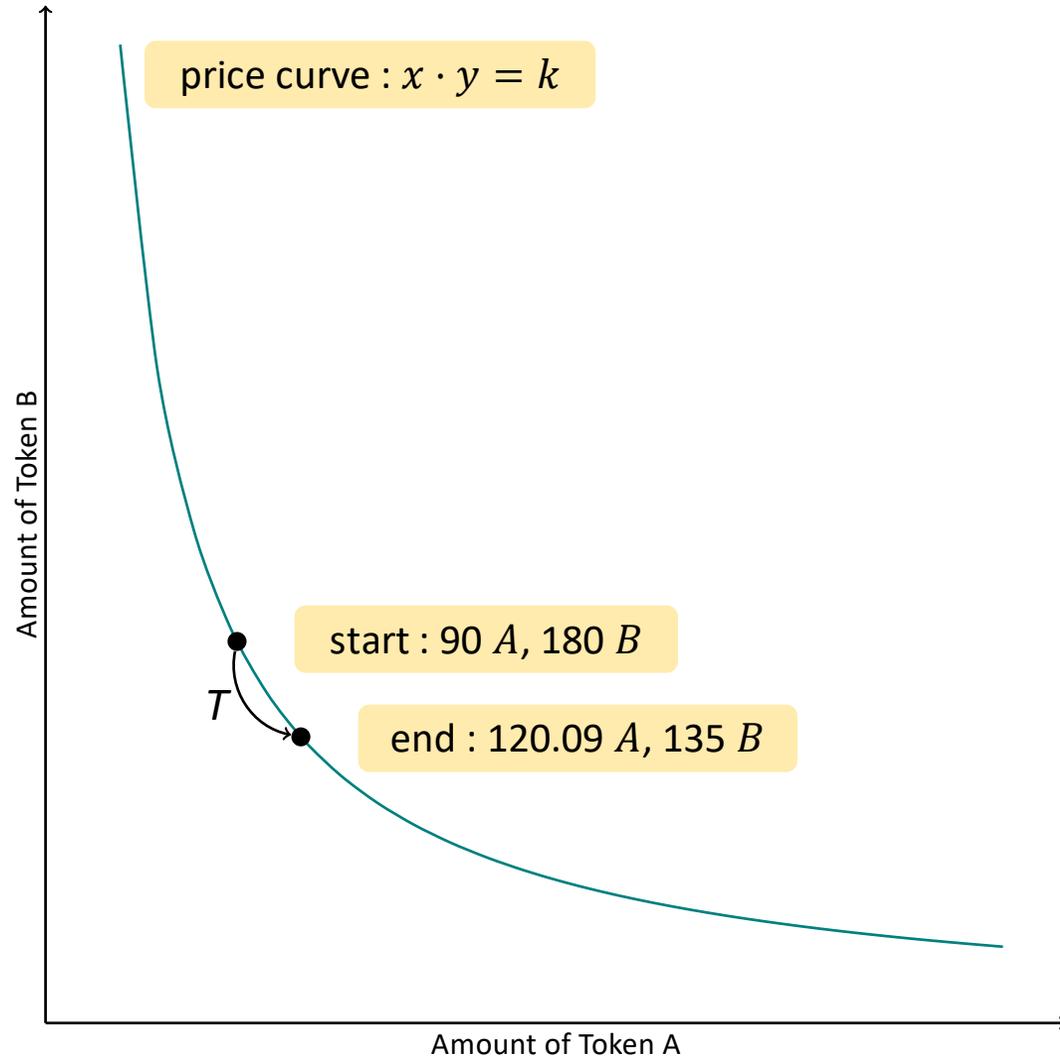
# Constant product market makers (CPMMs)



trading along price curve

$T$ : trade A  $\rightarrow$  B

# Constant product market makers (CPMMs)



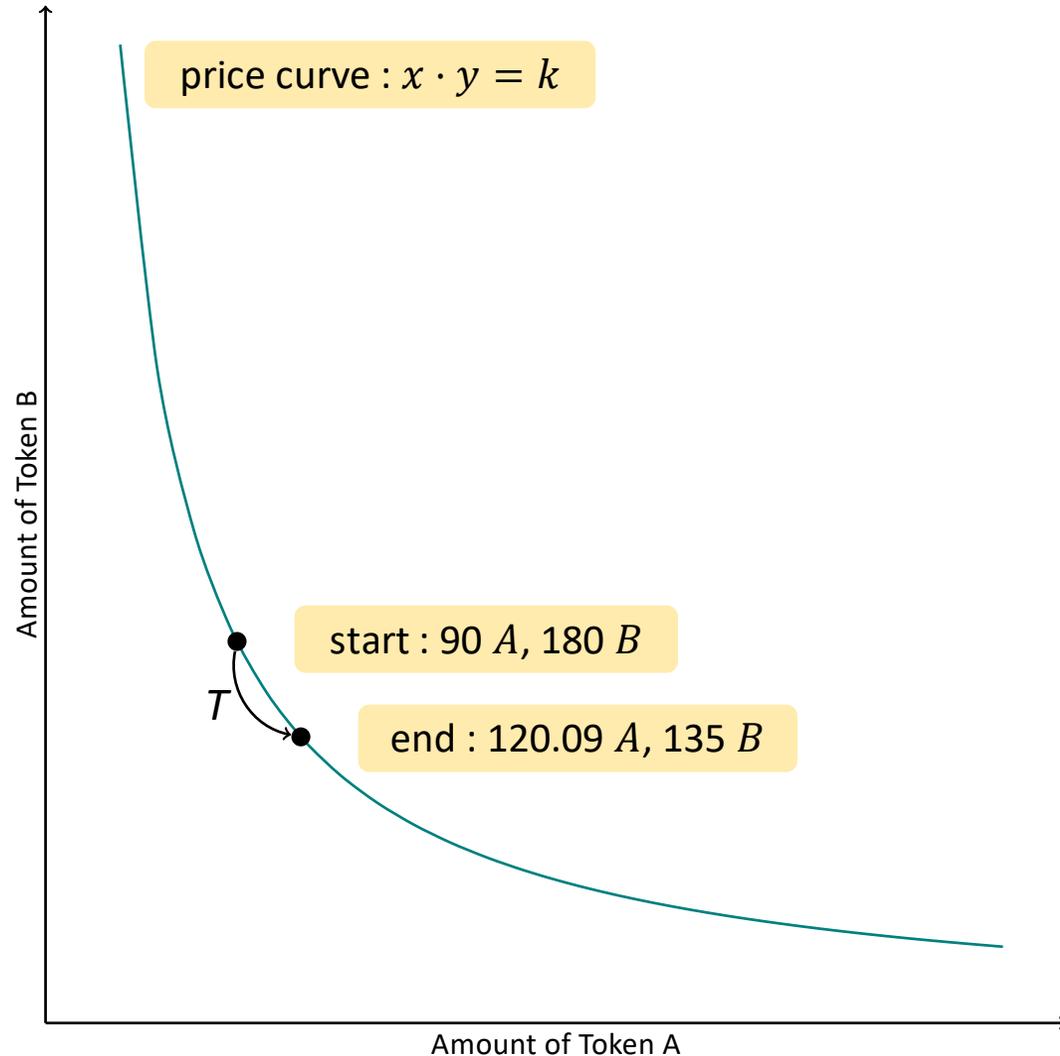
trading along price curve

$T$ : trade A  $\rightarrow$  B

input: 30 A + 0.3% fee

output: 45 B

# Constant product market makers (CPMMs)



trading along price curve

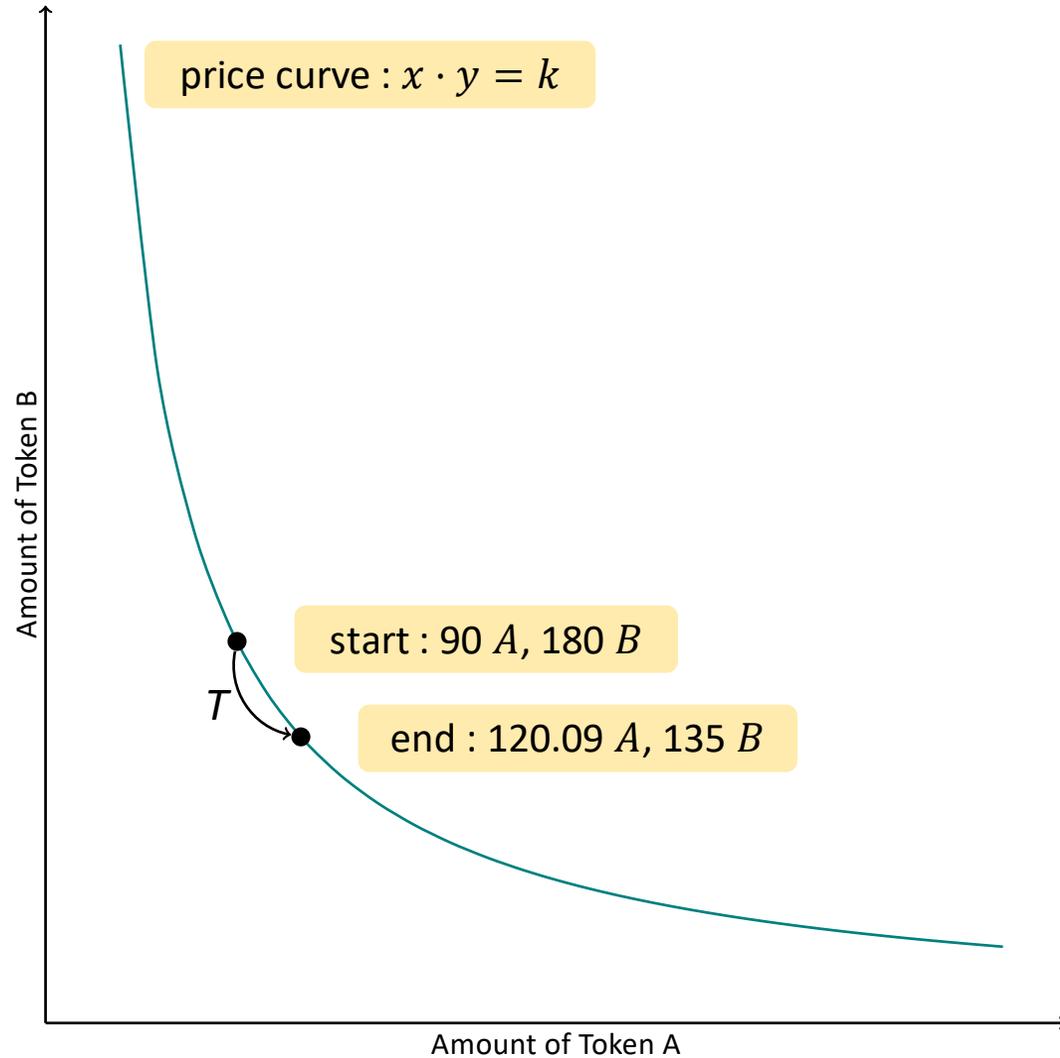
T: trade A  $\rightarrow$  B

input: 30 A + 0.3% fee

output: 45 B

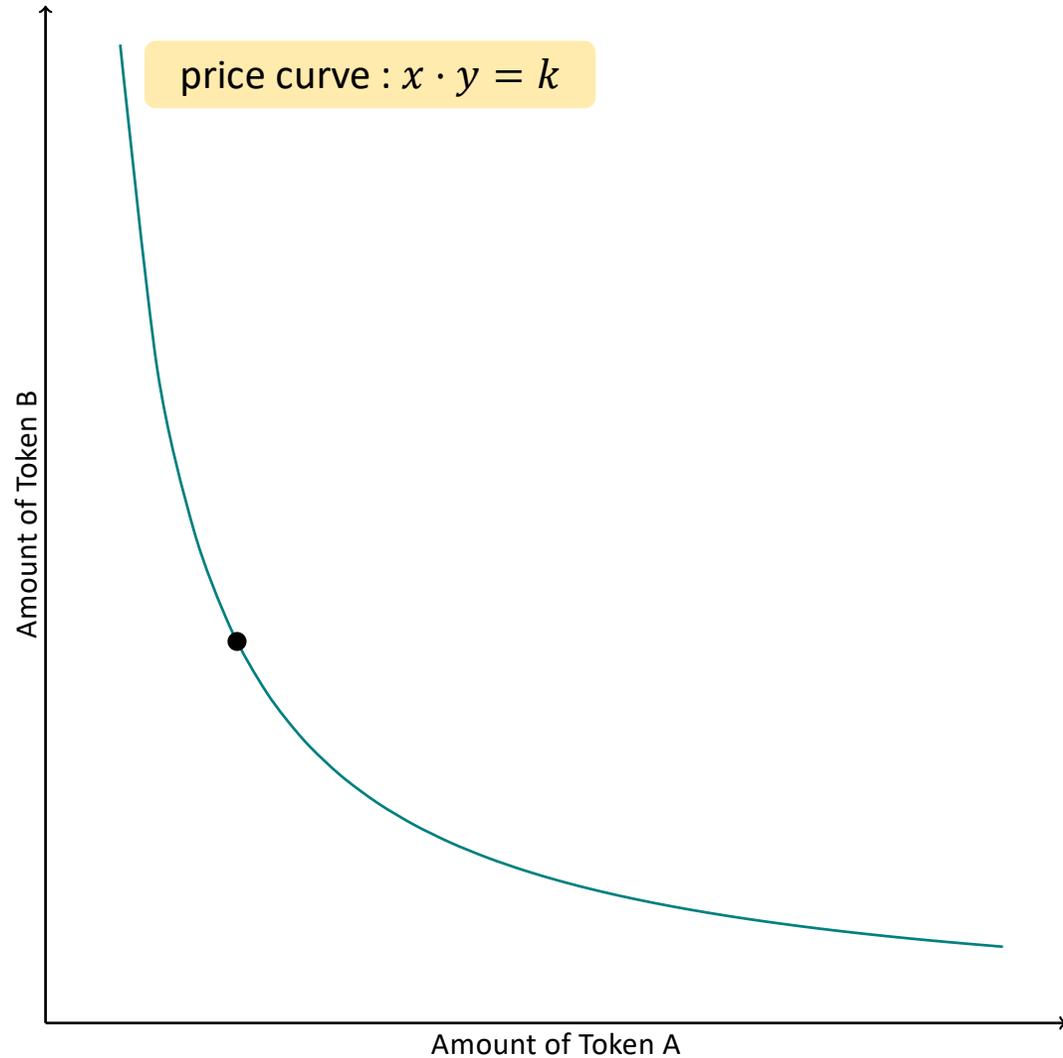
fees received by liquidity providers  
for every trade in liquidity pool

# Expected slippage



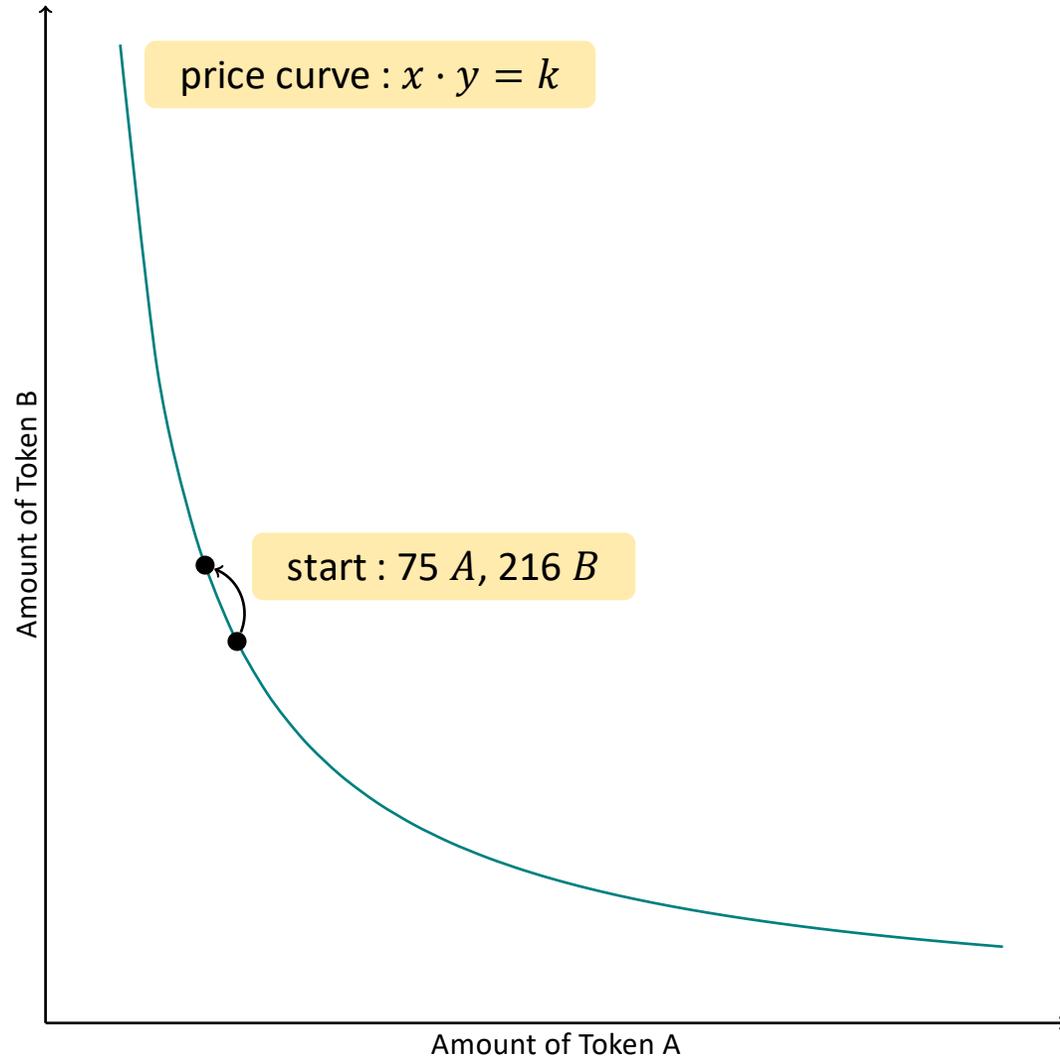
expected slippage  
expected decrease in price based on  
trading volume and available liquidity

# Unexpected slippage



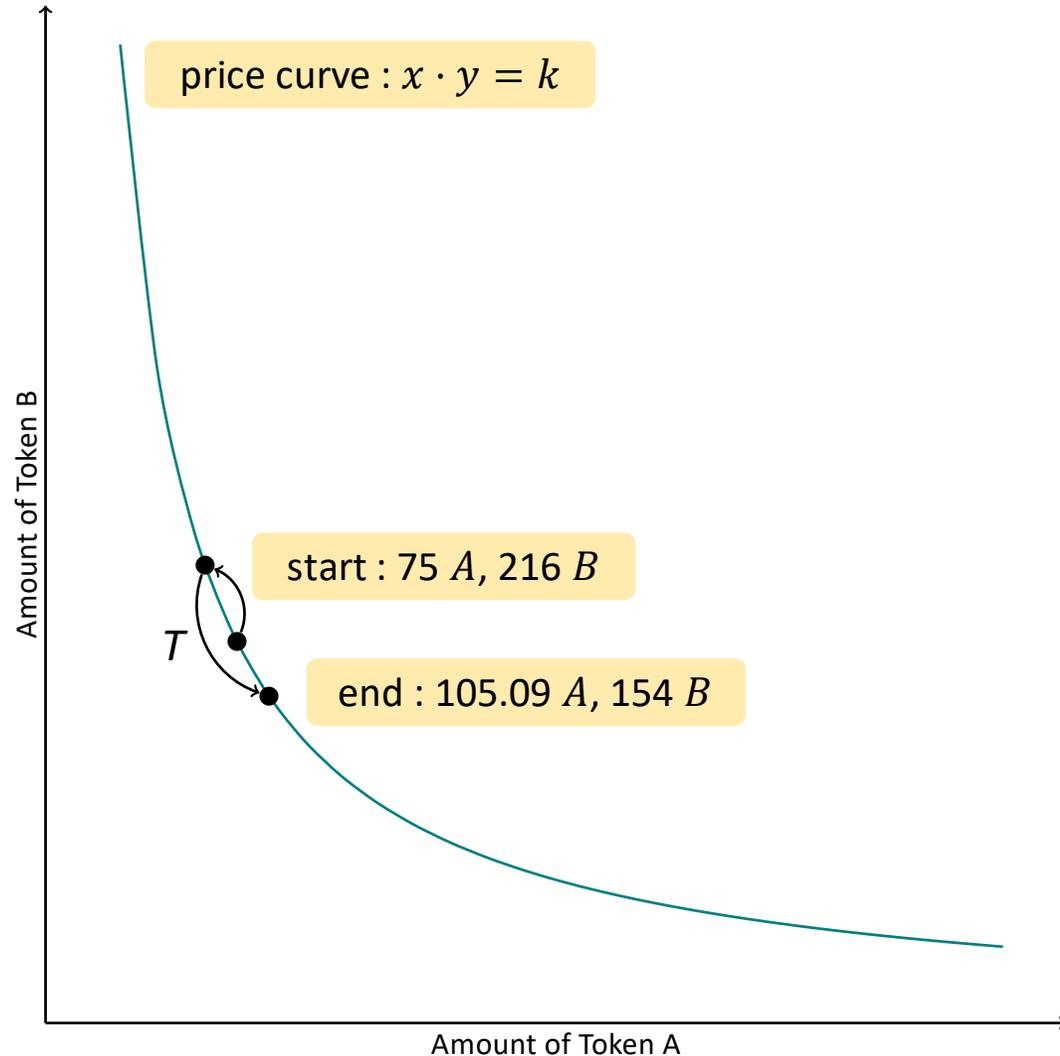
unexpected slippage  
unexpected increase or decrease in  
price based on previous trades

# Unexpected slippage



unexpected slippage  
unexpected increase or decrease in  
price based on previous trades

# Unexpected slippage



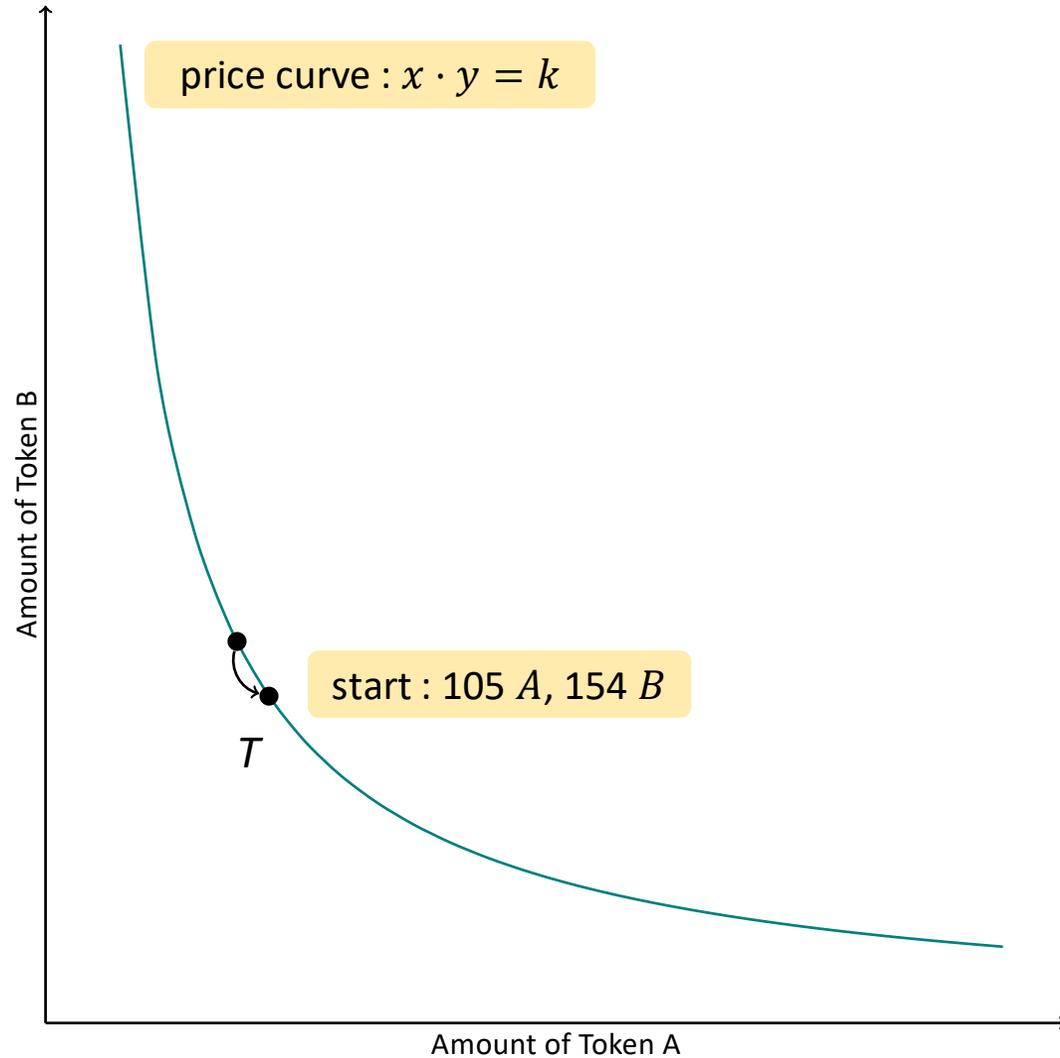
unexpected slippage  
unexpected increase or decrease in  
price based on previous trades

$T$ : trade  $A \rightarrow B$

input: 30  $A$  + 0.3% fee

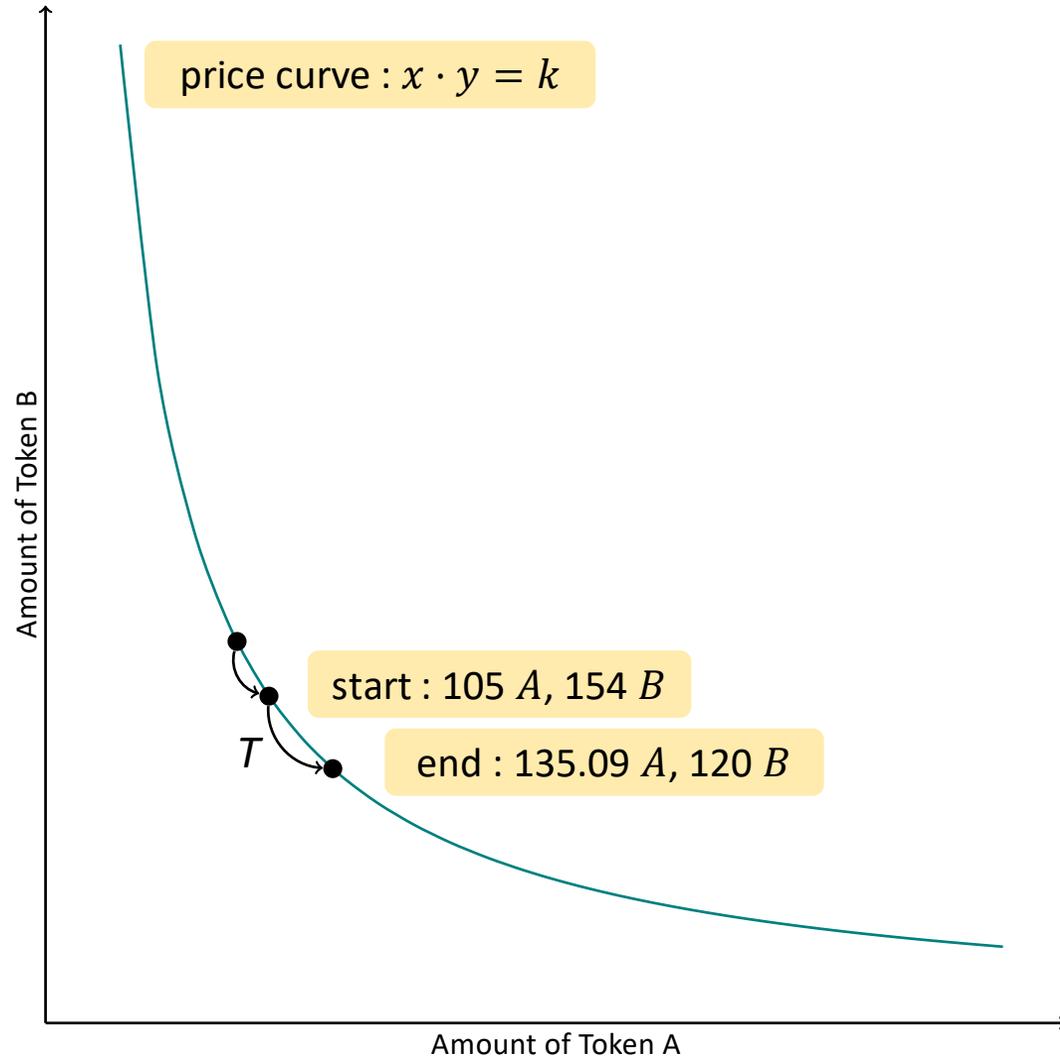
output: 62  $B$

# Unexpected slippage



unexpected slippage  
unexpected increase or decrease in  
price based on previous trades

# Unexpected slippage



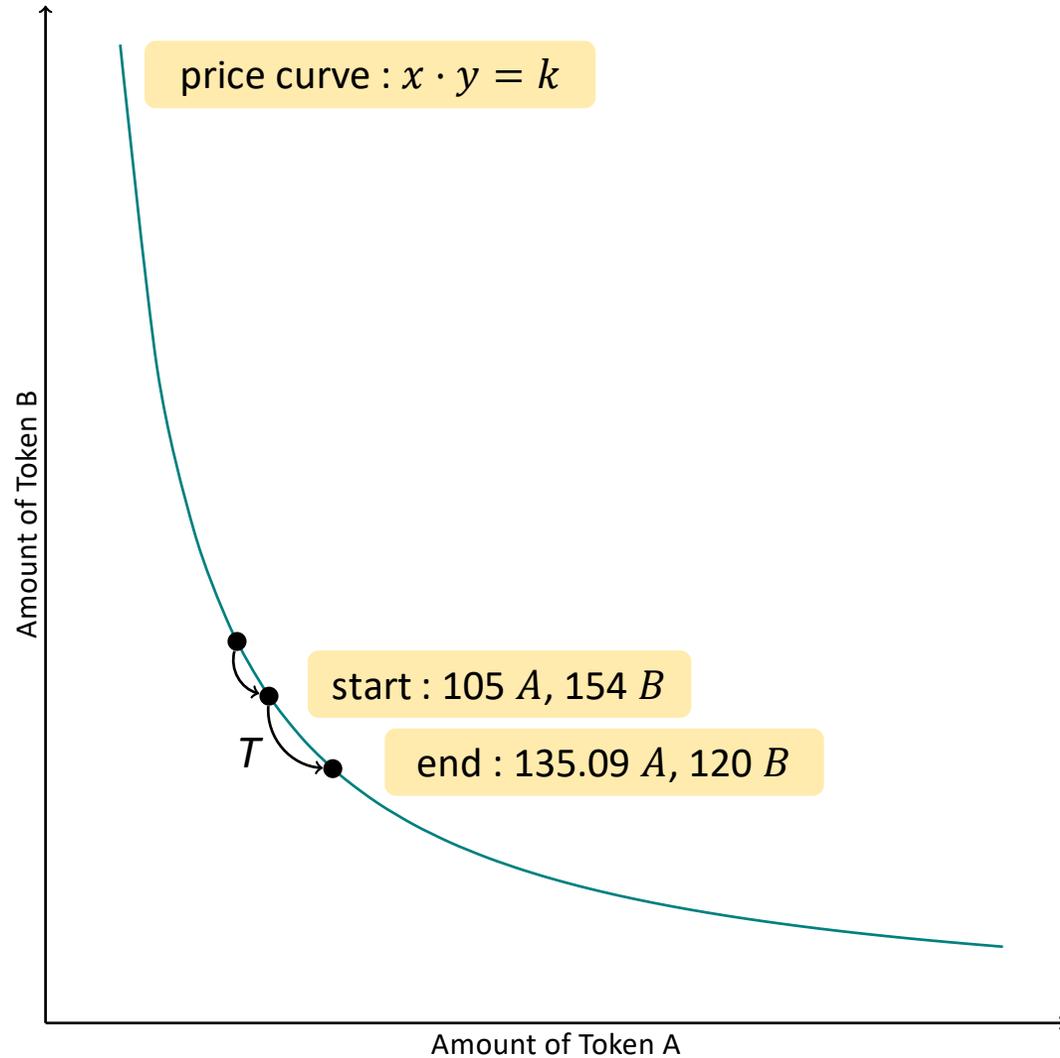
unexpected slippage  
unexpected increase or decrease in  
price based on previous trades

$T$ : trade A  $\rightarrow$  B

input: 30 A + 0.3% fee

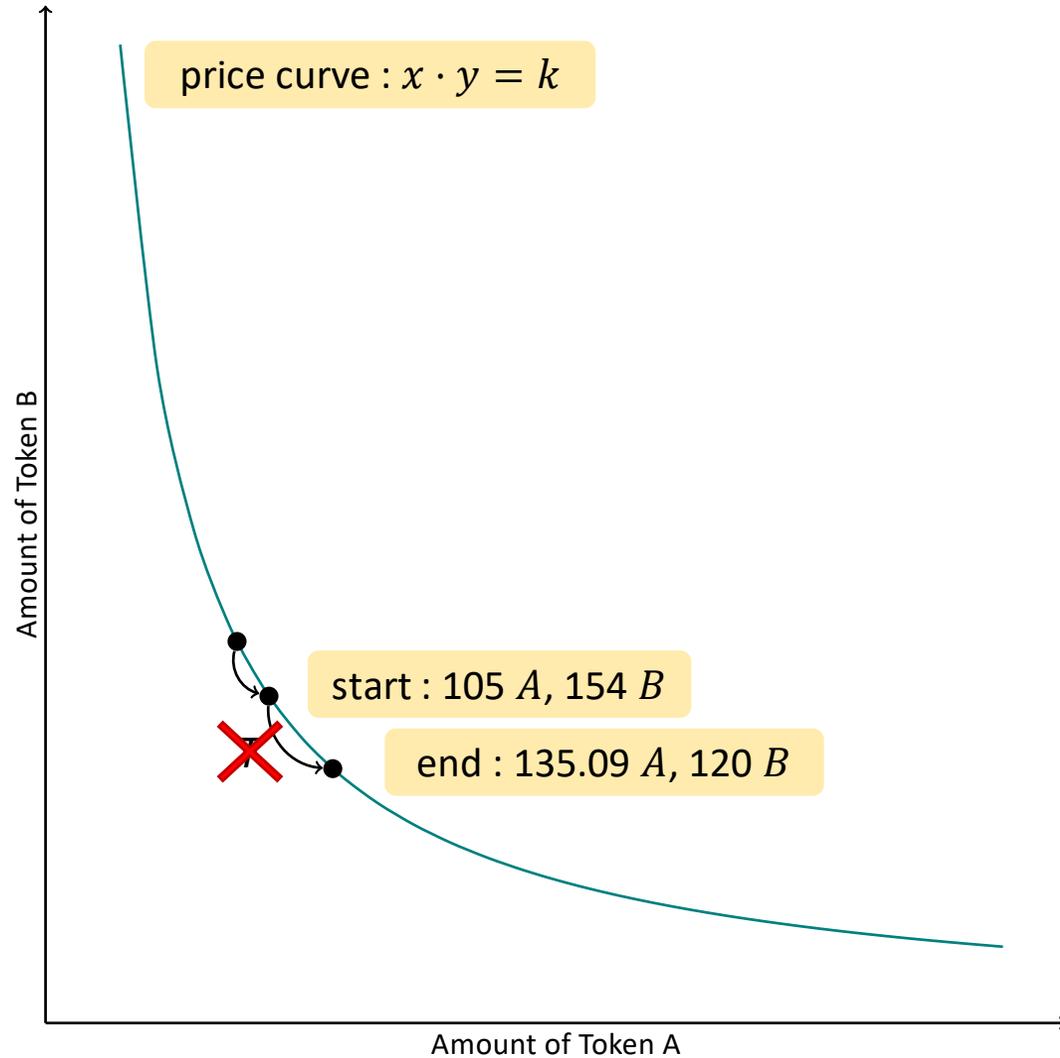
output: 34 B

# Unexpected slippage



slippage tolerance specifies maximum acceptable price movement

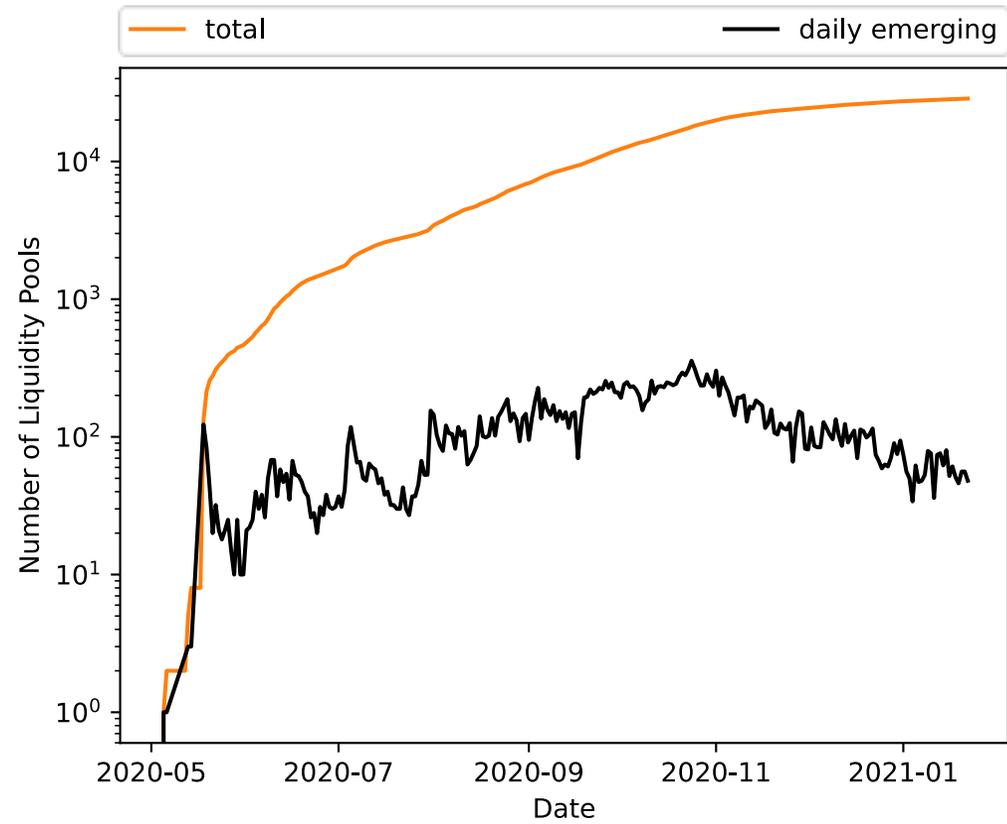
# Unexpected slippage



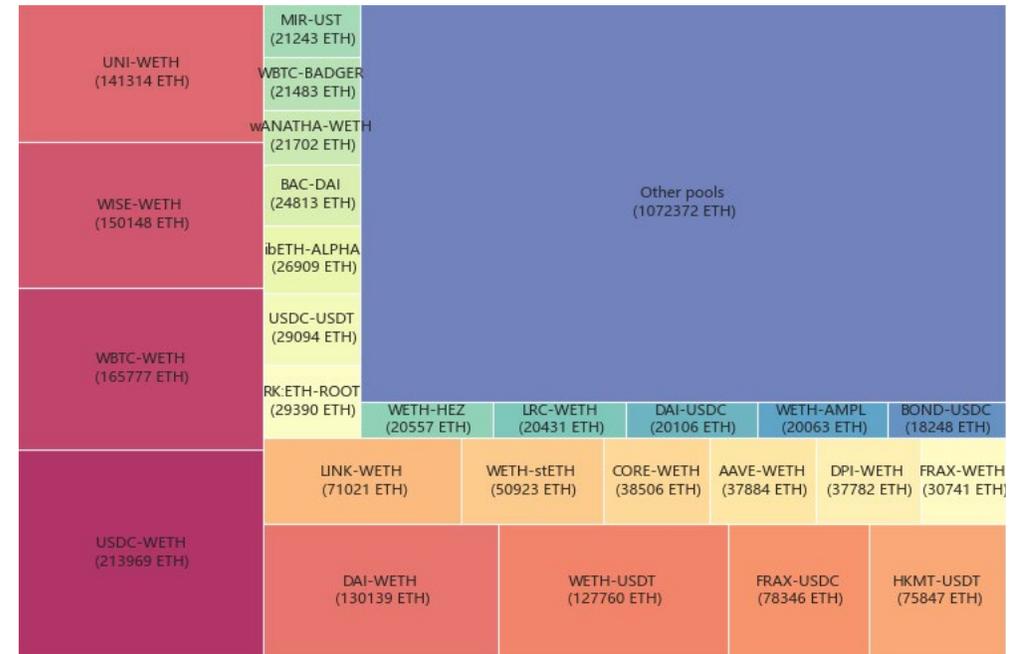
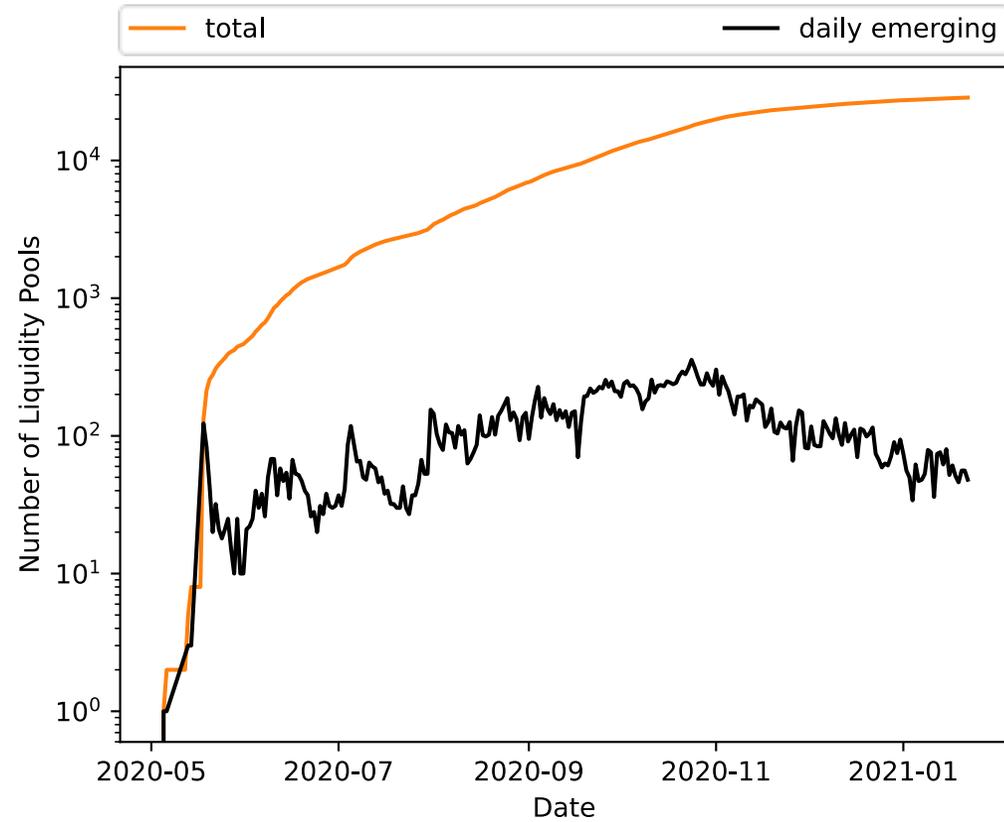
slippage tolerance specifies maximum acceptable price movement

trade fails if slippage tolerance exceeded

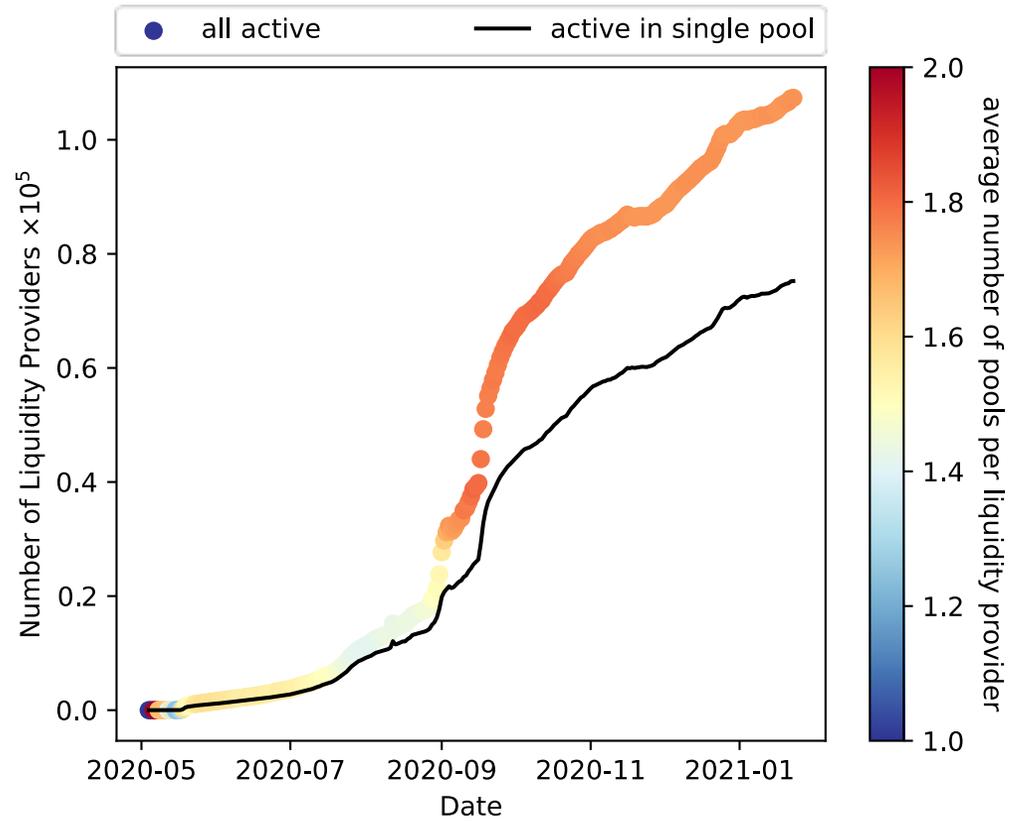
# Liquidity pools



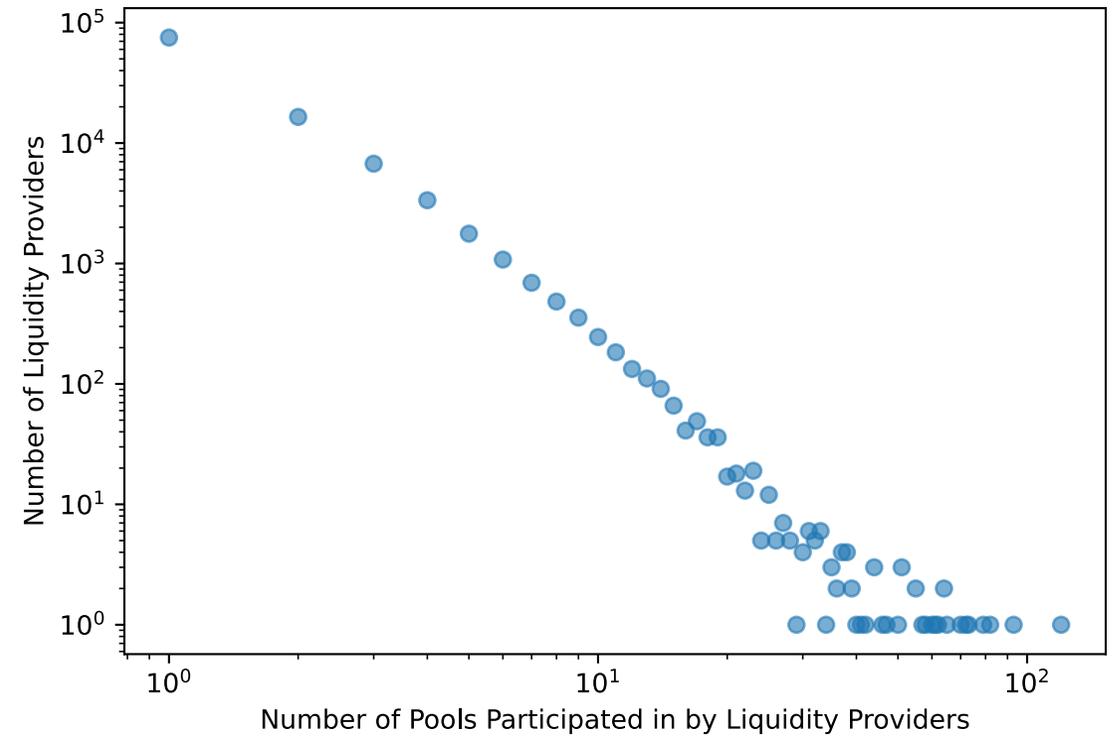
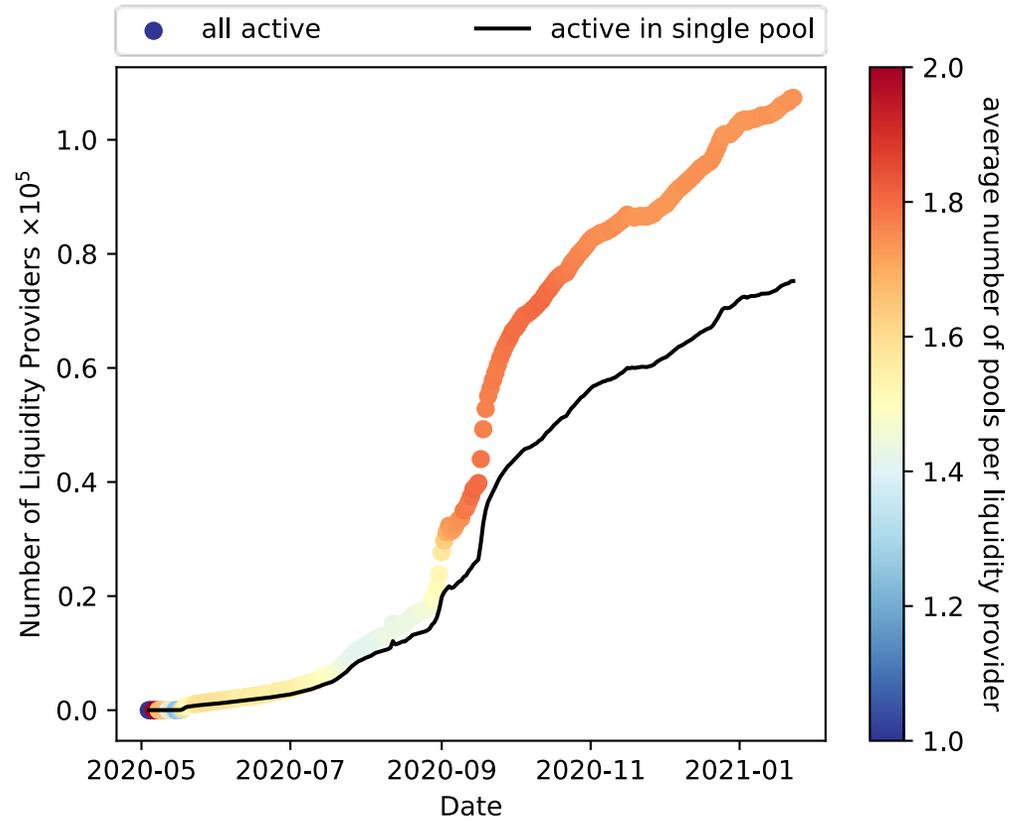
# Liquidity pools



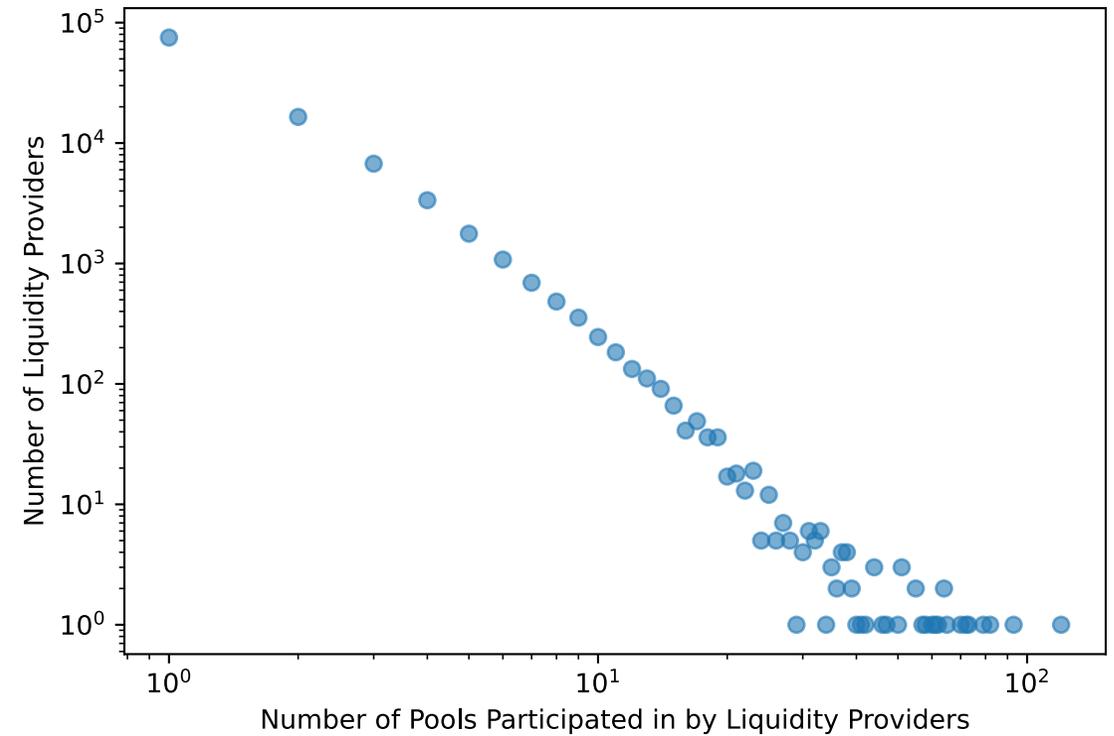
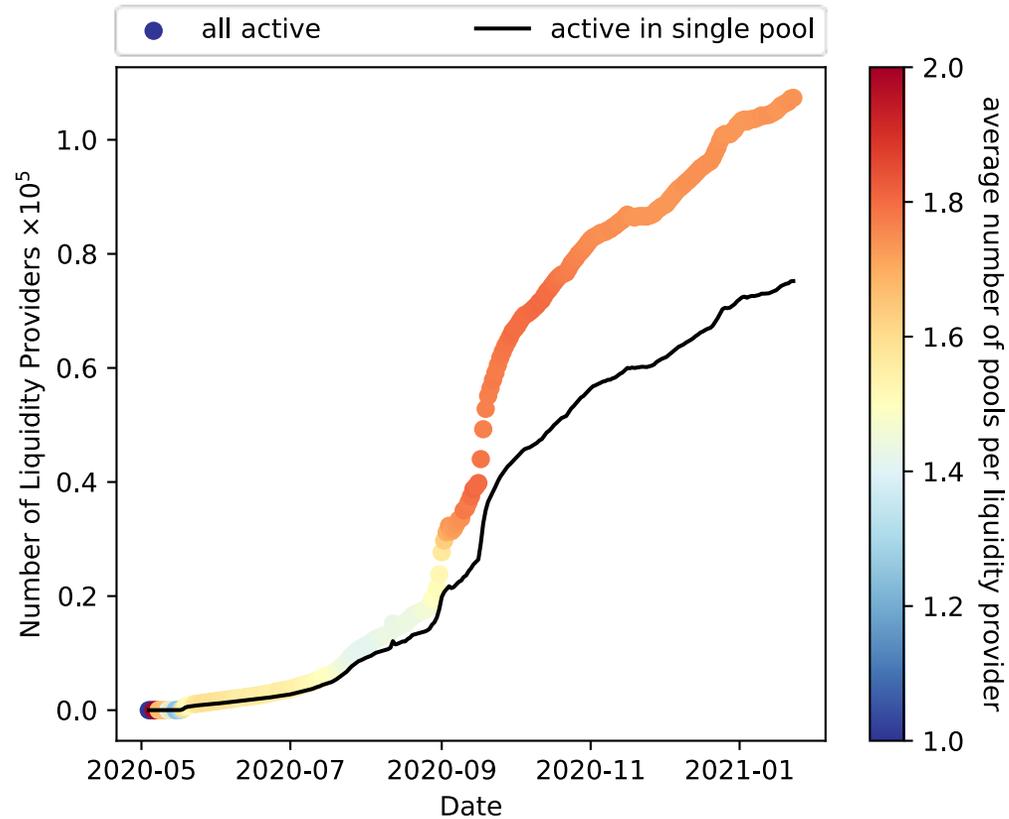
# Liquidity providers



# Liquidity providers



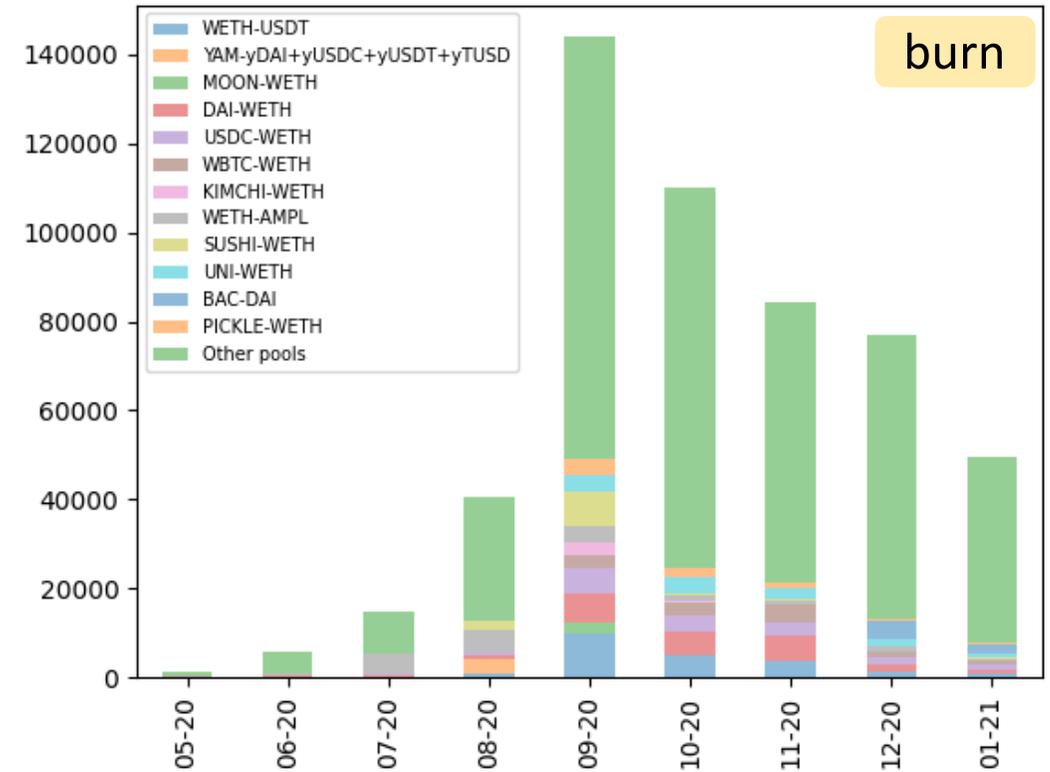
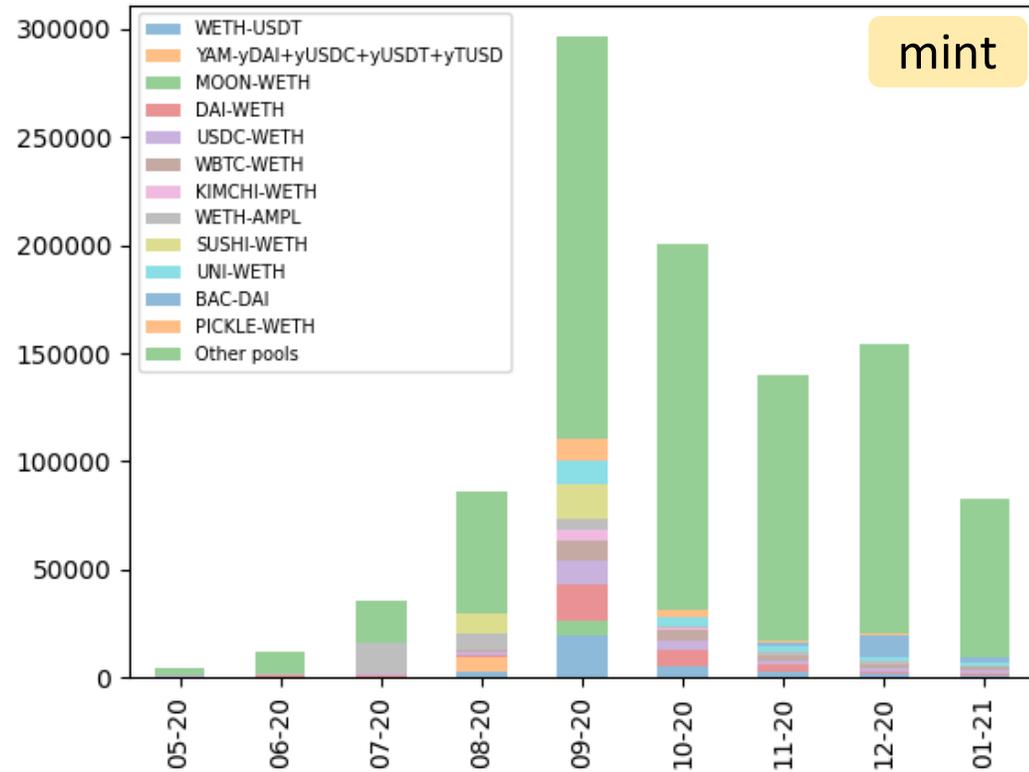
# Liquidity providers



most liquidity providers only participate in single pool

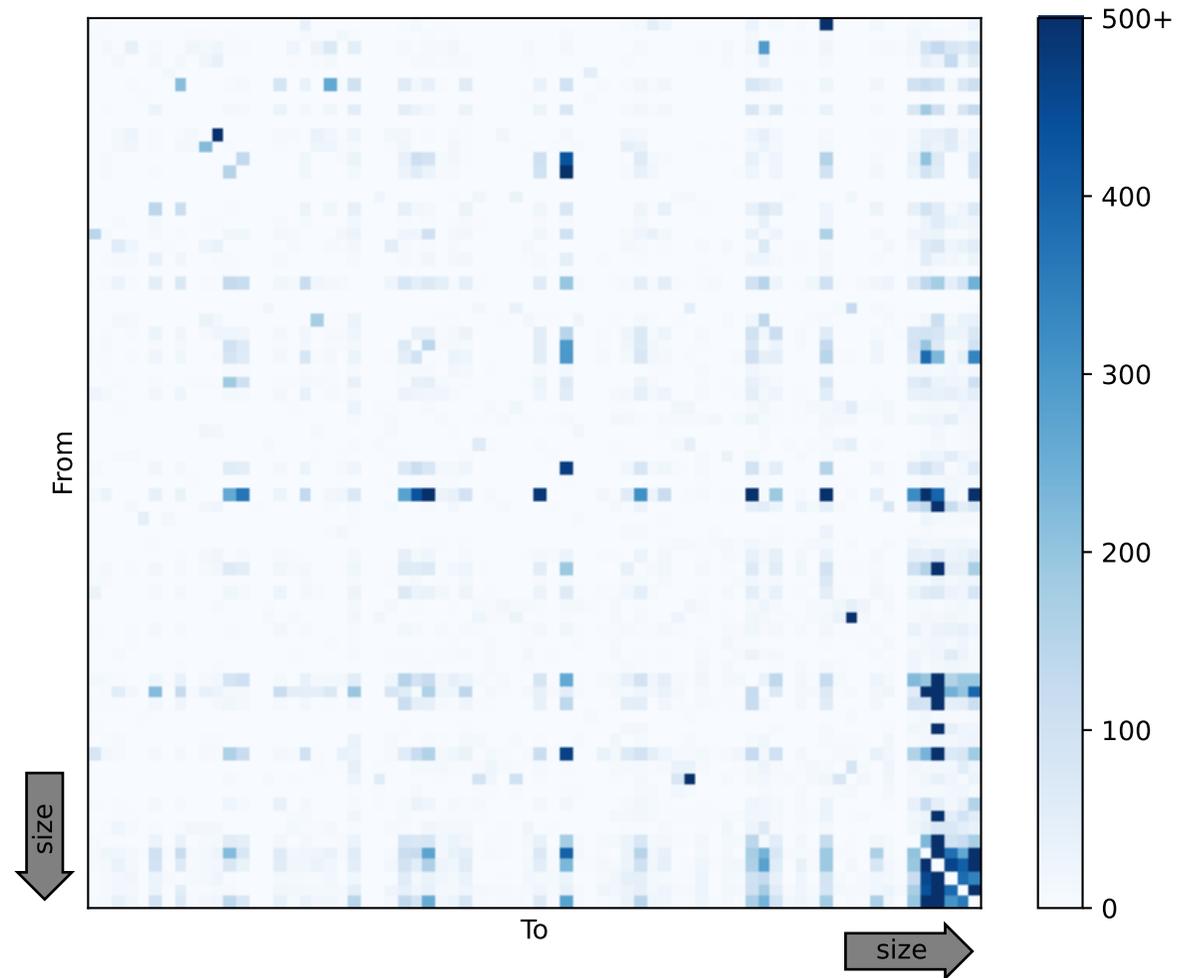


# Liquidity movements

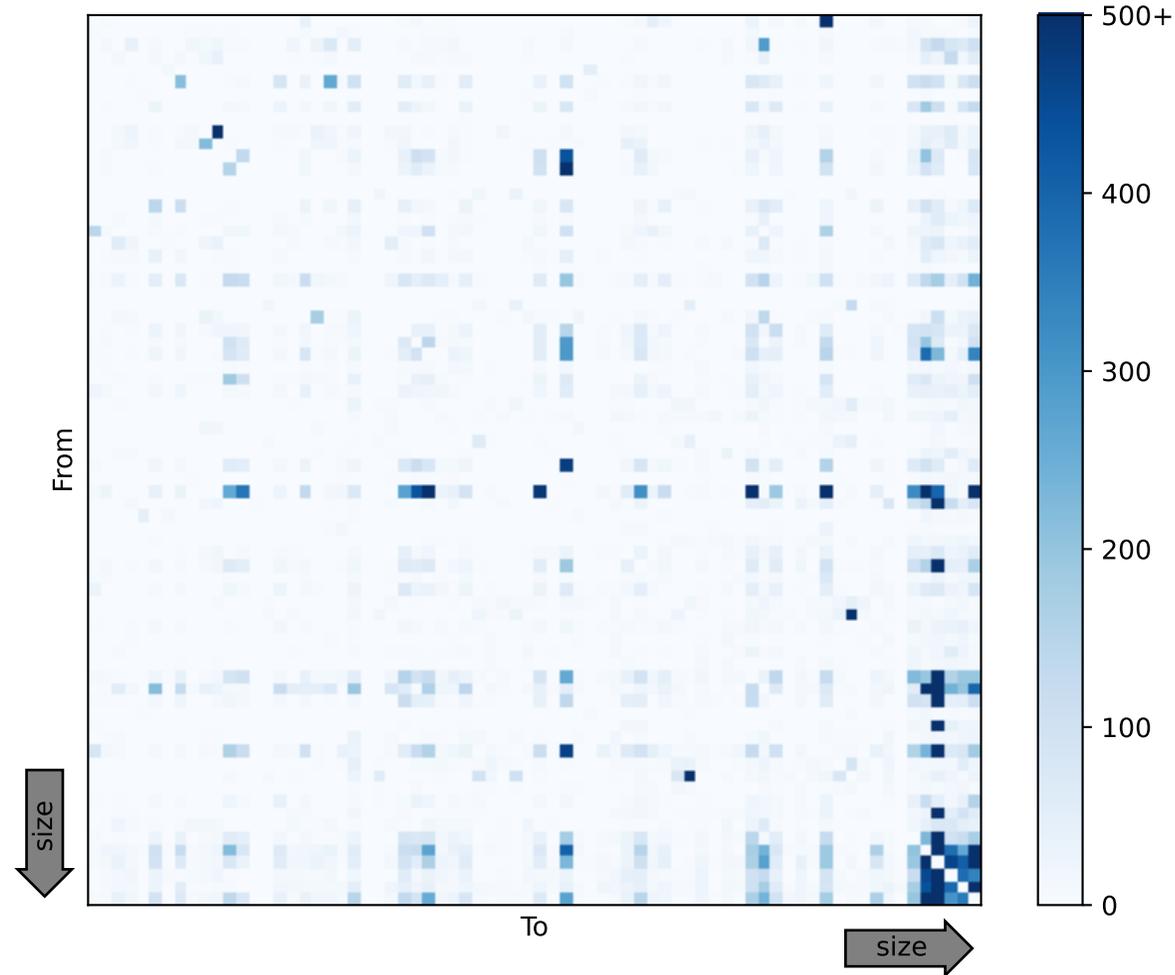


mint and burn events are symmetric

# Liquidity provider movements between pools

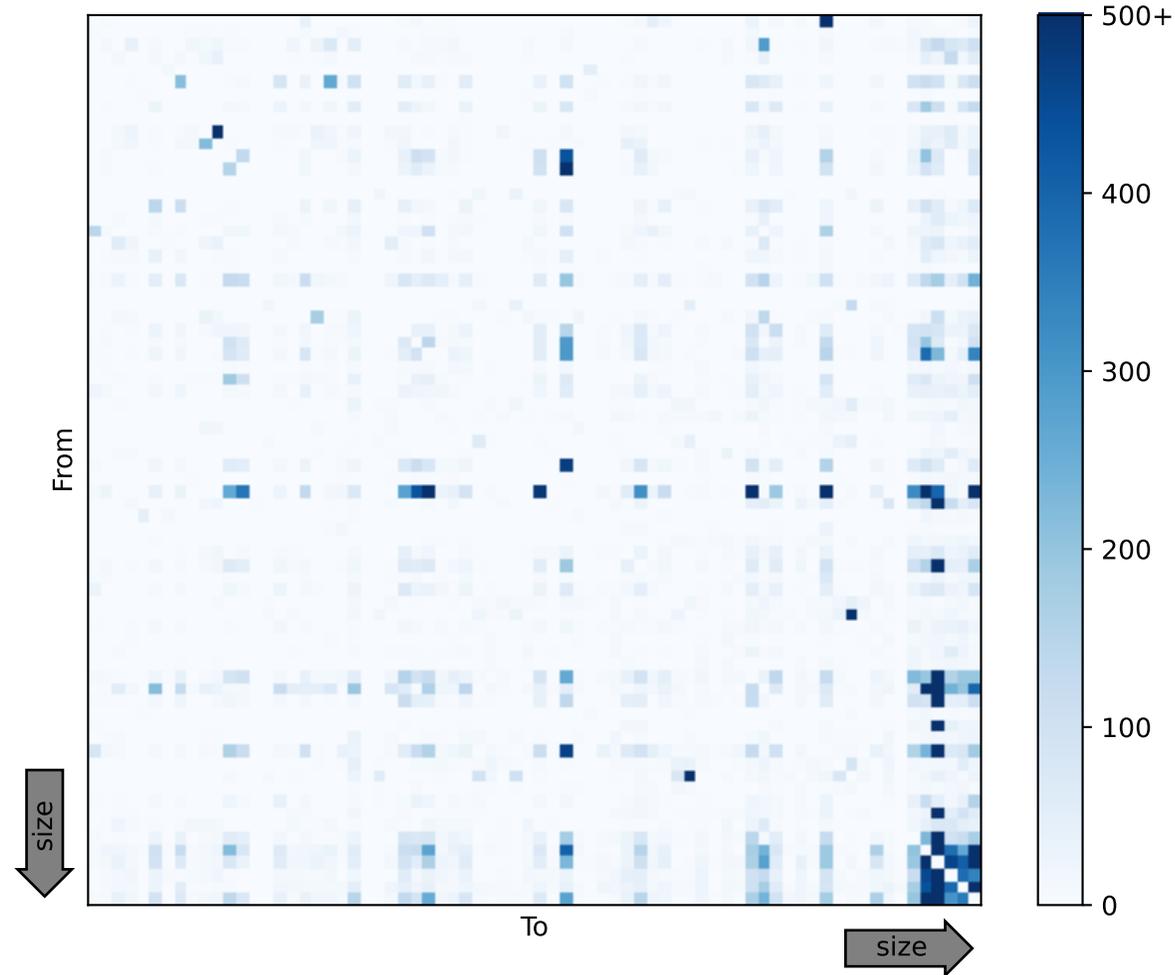


# Liquidity provider movements between pools



liquidity movements are rare

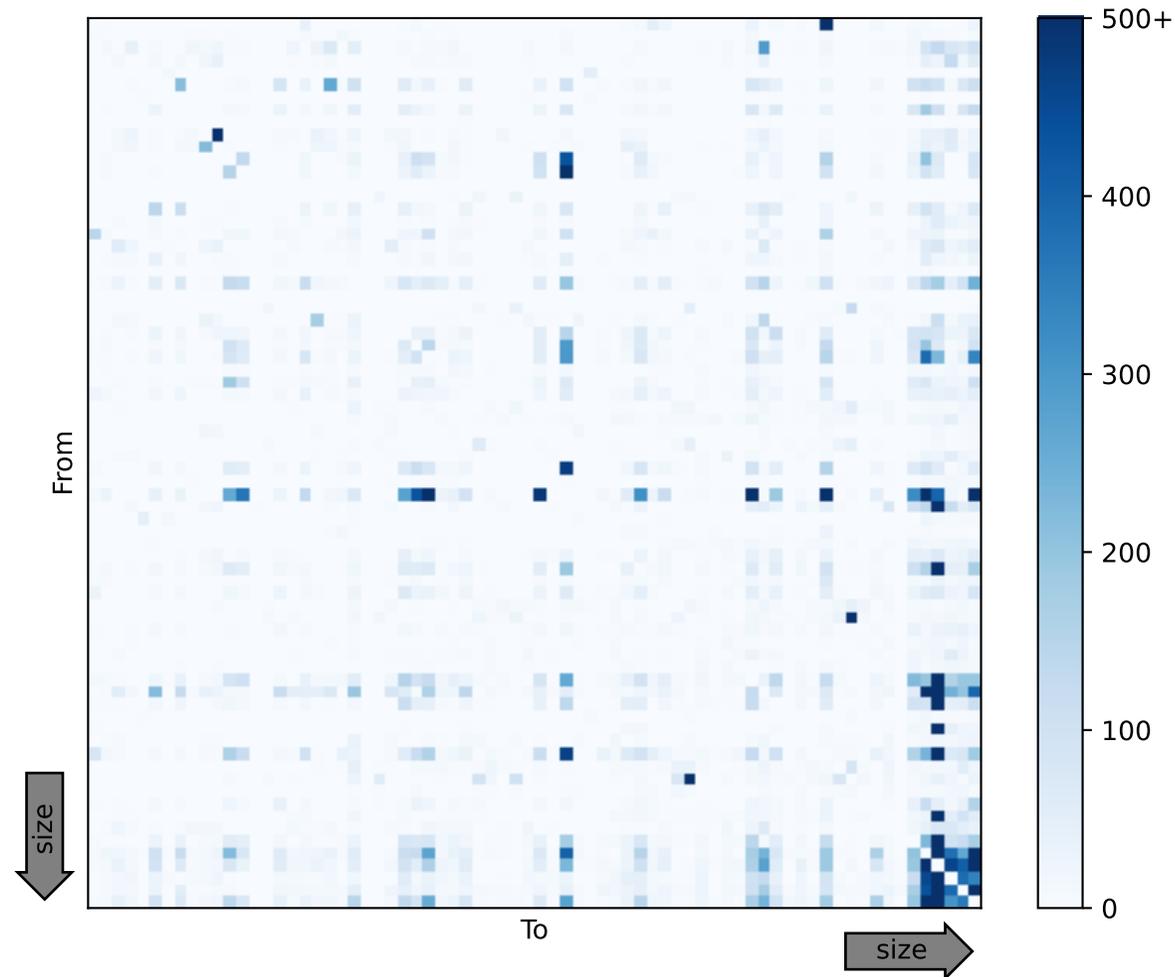
# Liquidity provider movements between pools



liquidity movements are rare

liquidity movements are symmetric

# Liquidity provider movements between pools

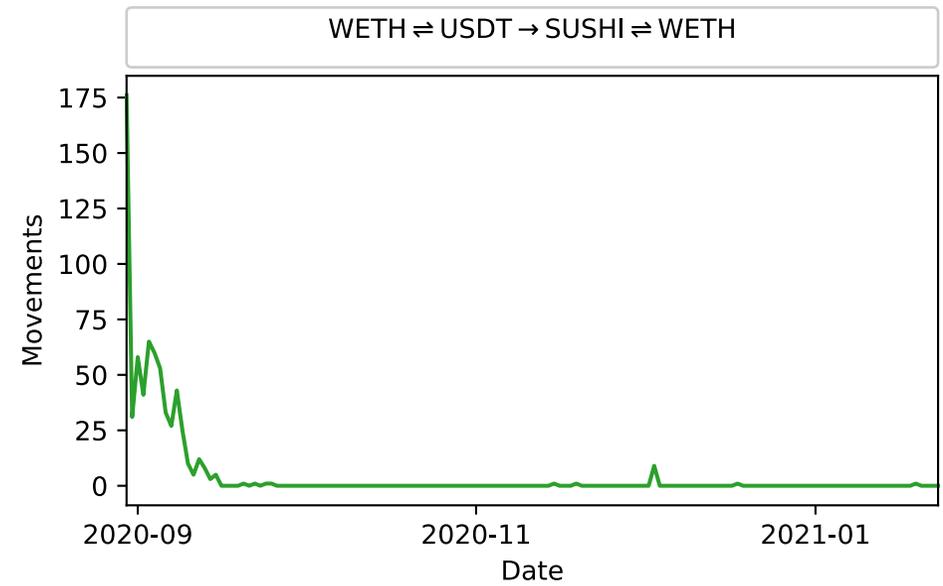
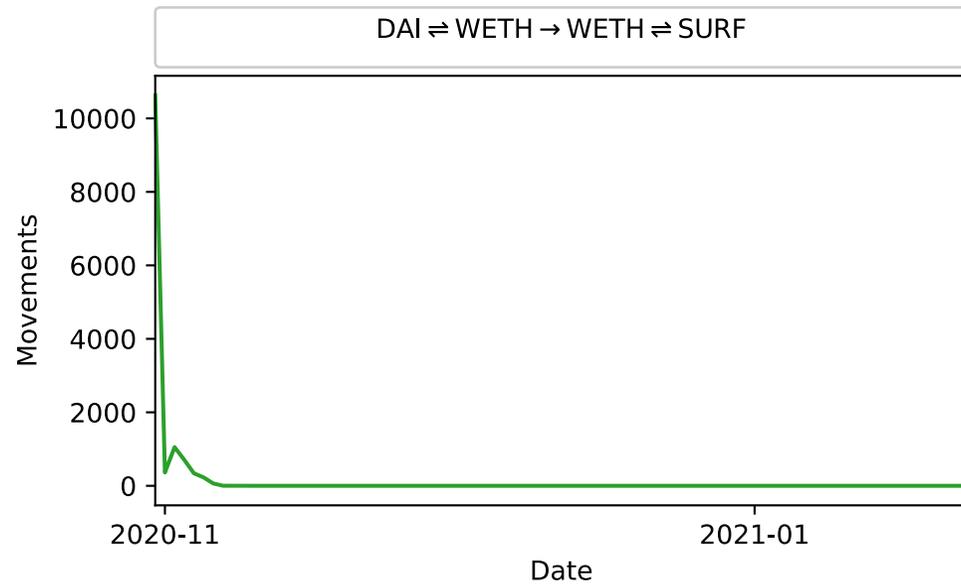


liquidity movements are rare

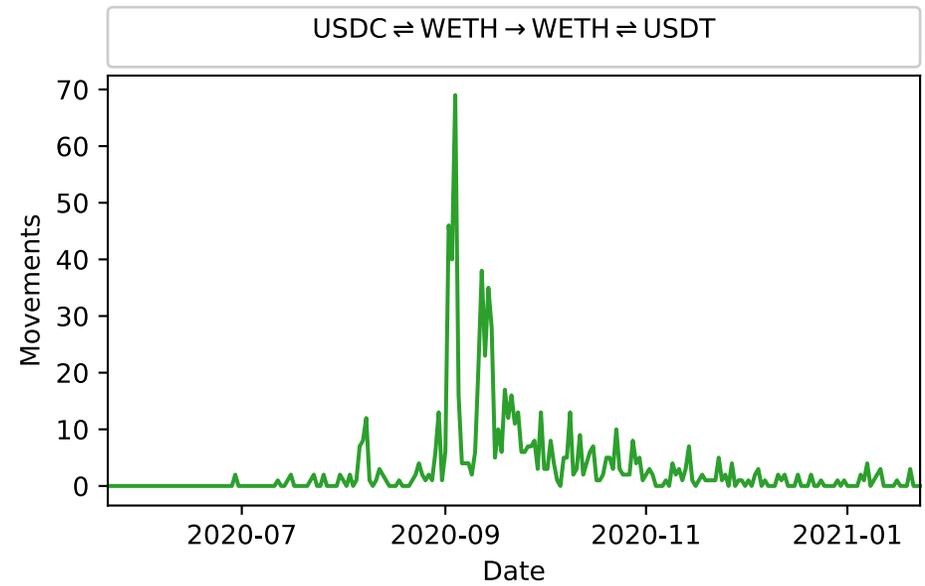
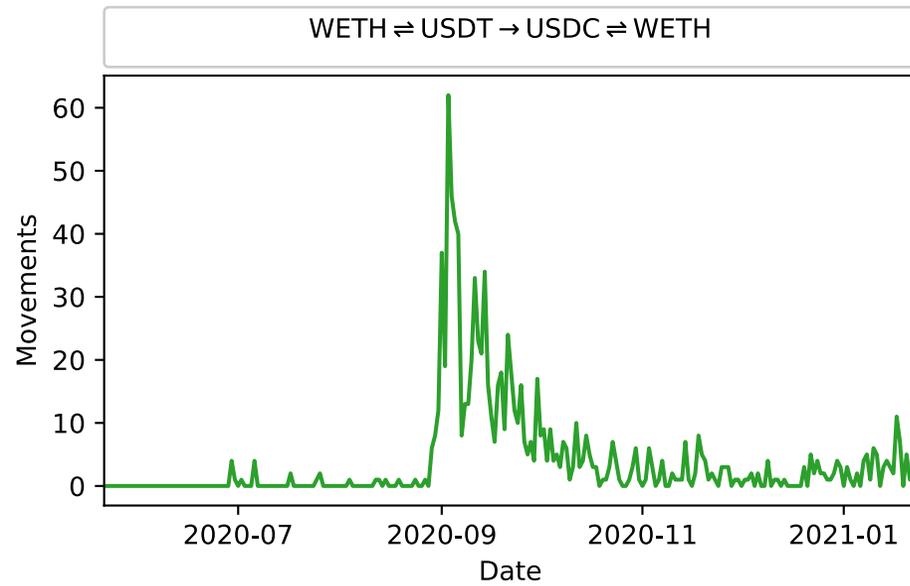
liquidity movements are symmetric

liquidity movement high among six largest pools

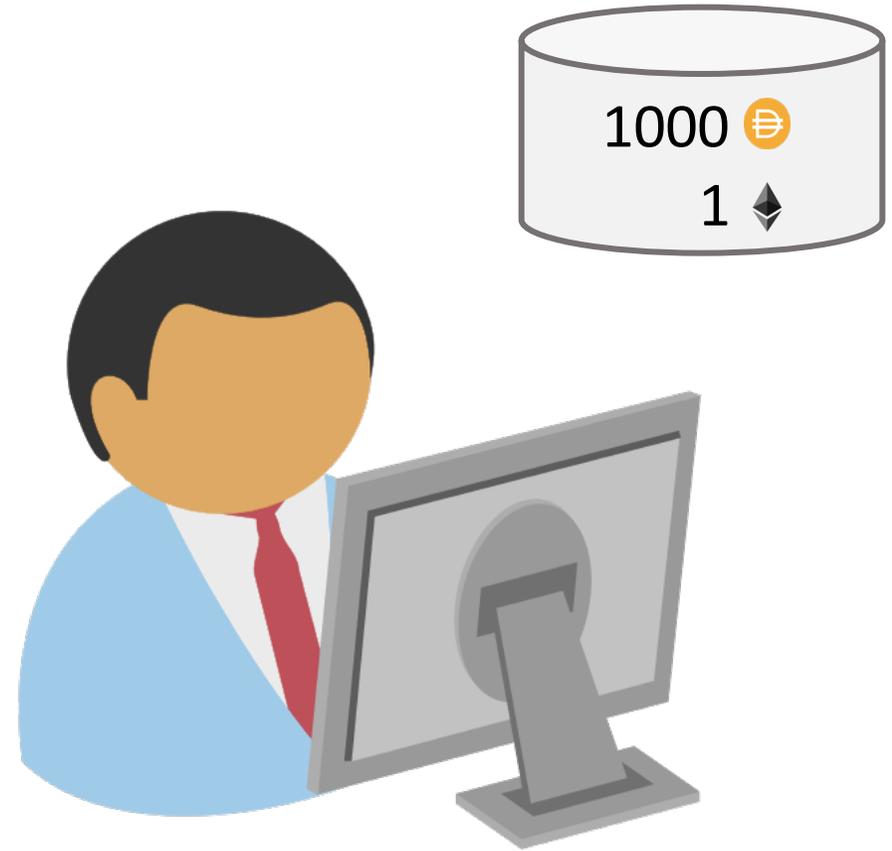
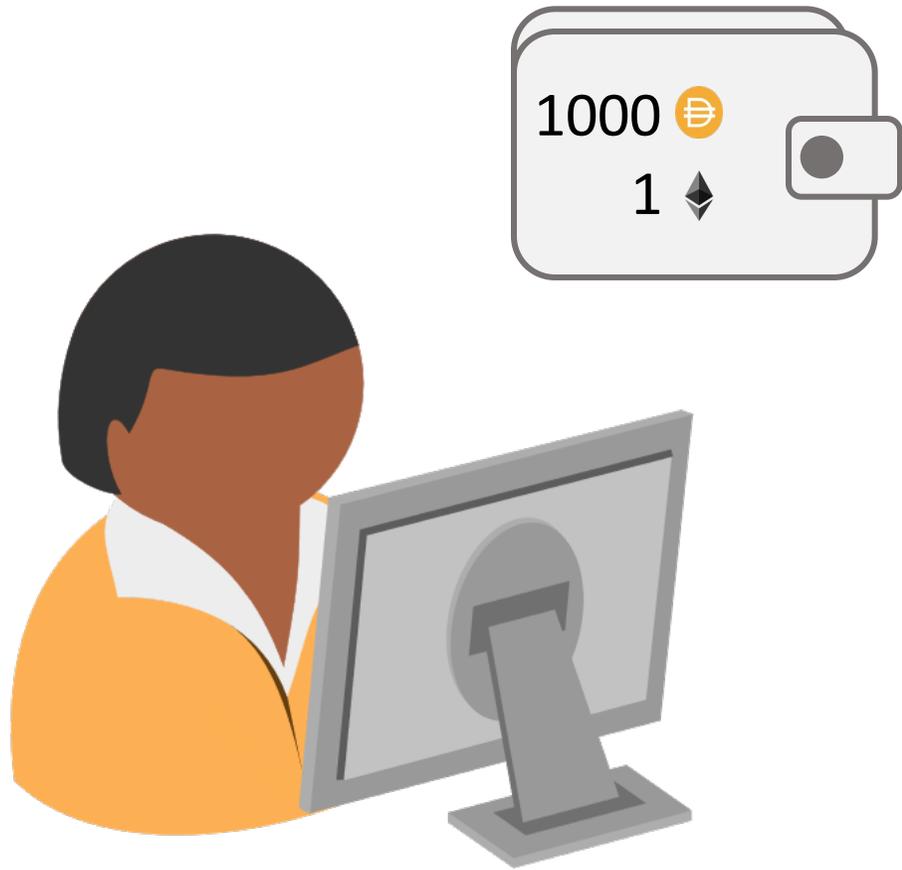
# Liquidity provider movements between pools



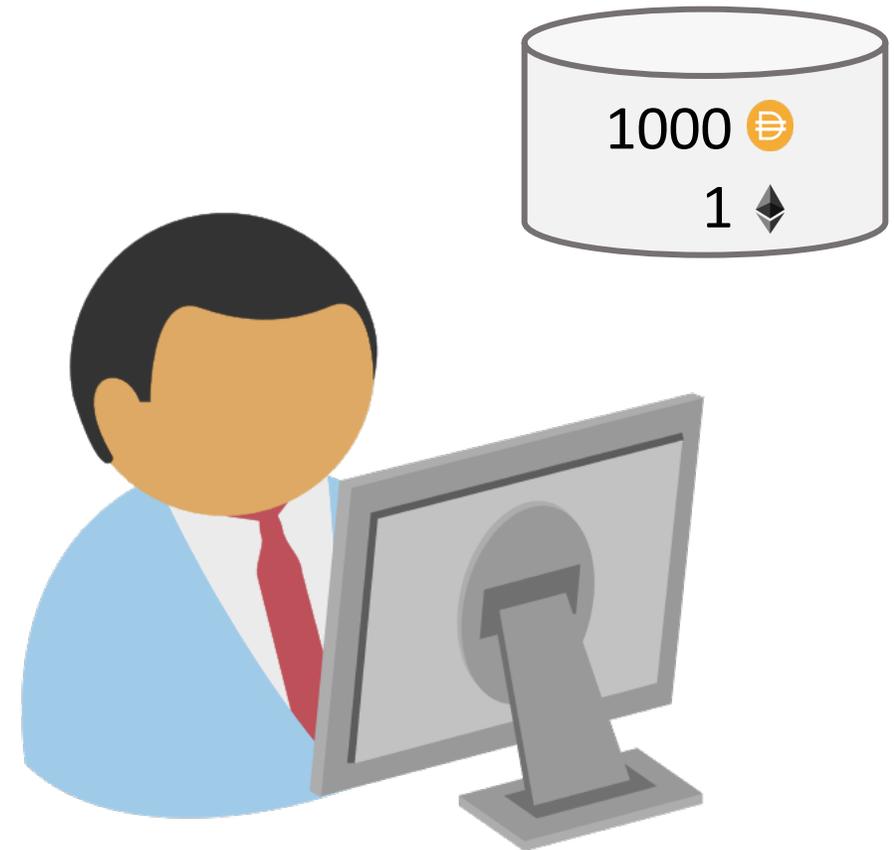
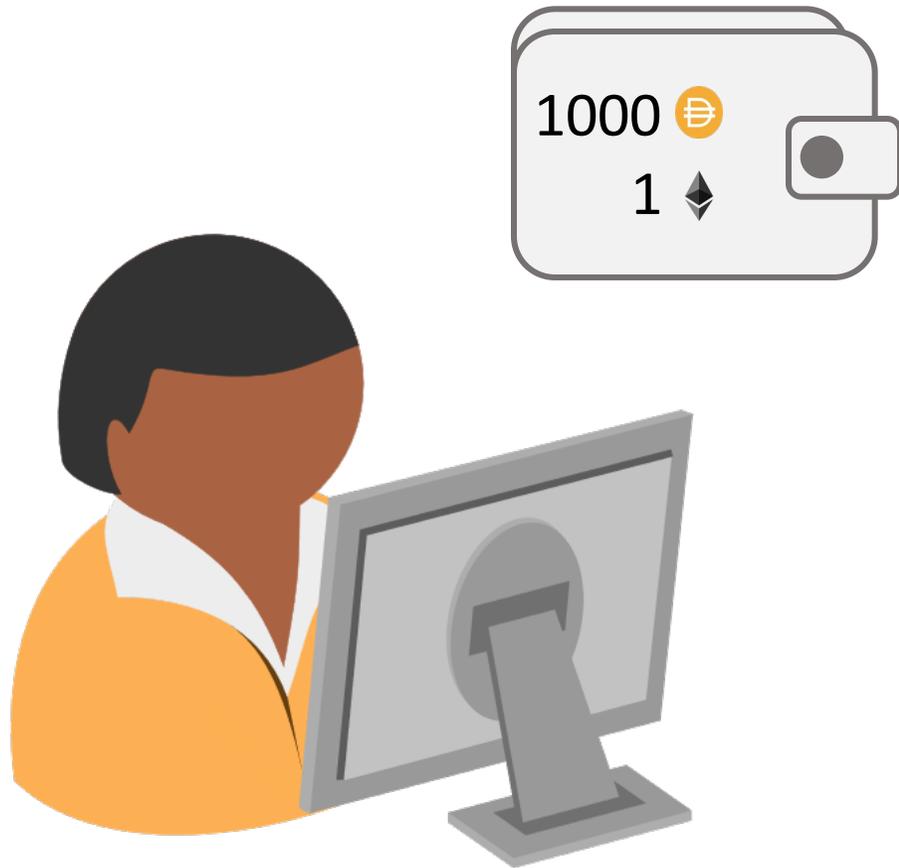
# Liquidity provider movements between pools



# Returns and risks

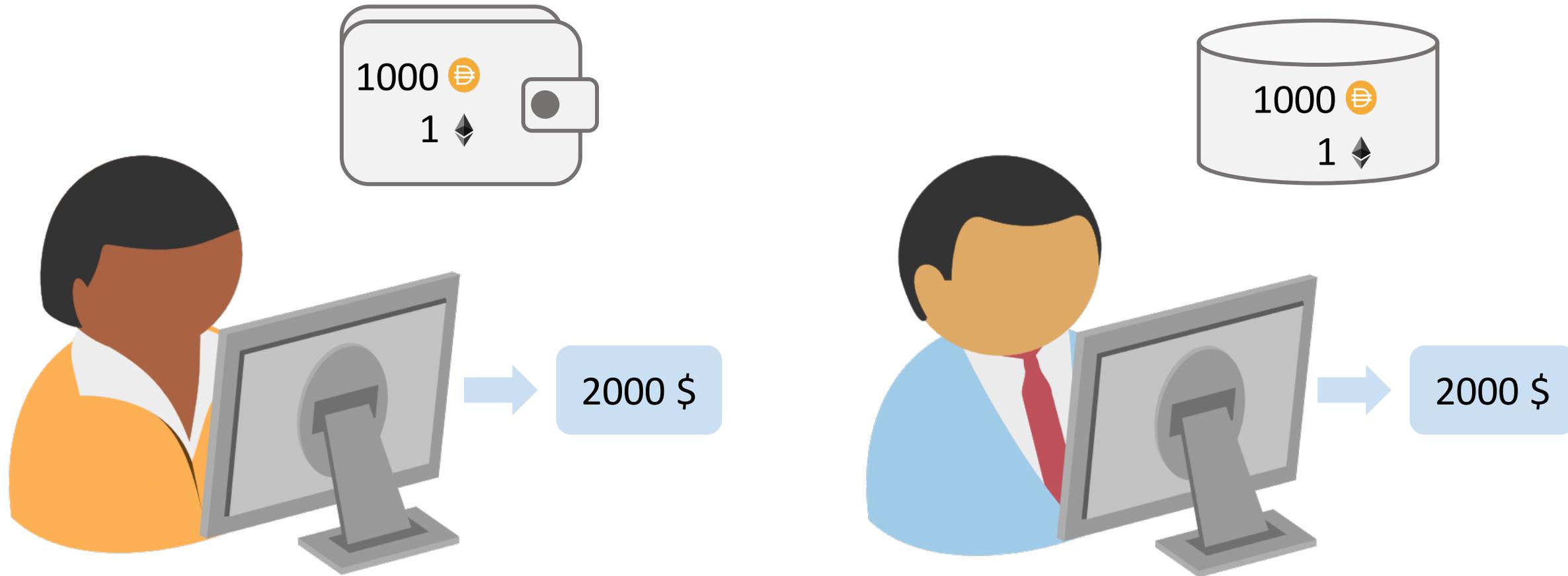


# Returns and risks



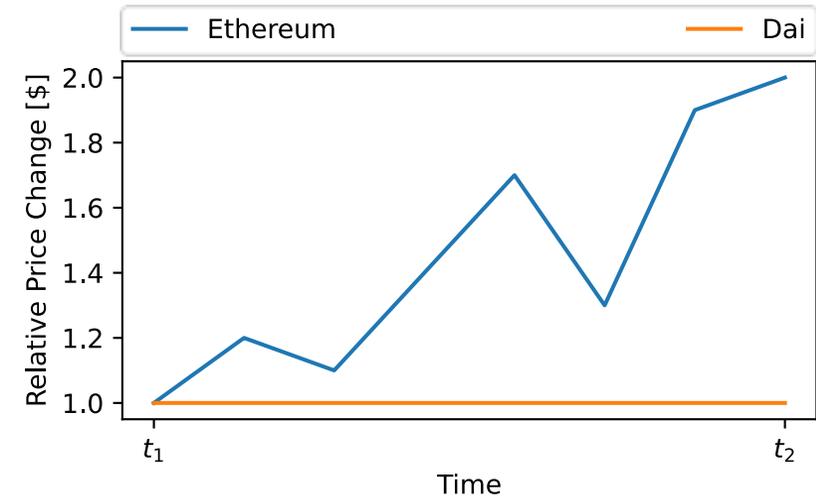
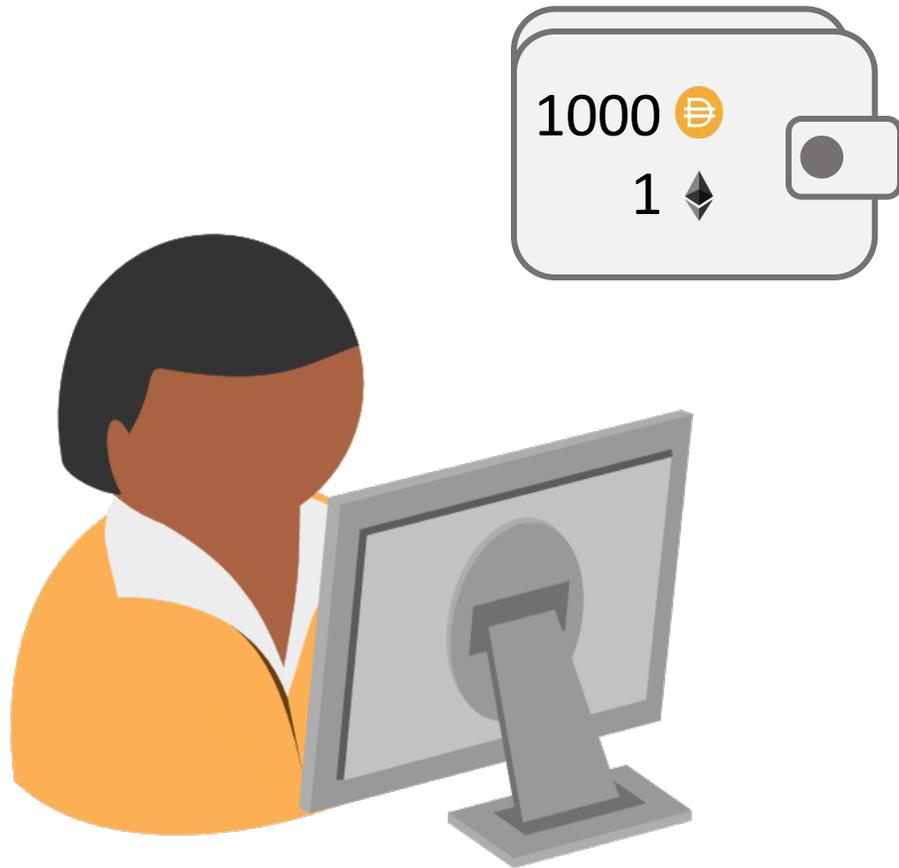
$$p(\text{₿})_{t_1} = 1 \quad p(\text{⬥})_{t_1} = 1000$$

# Returns and risks



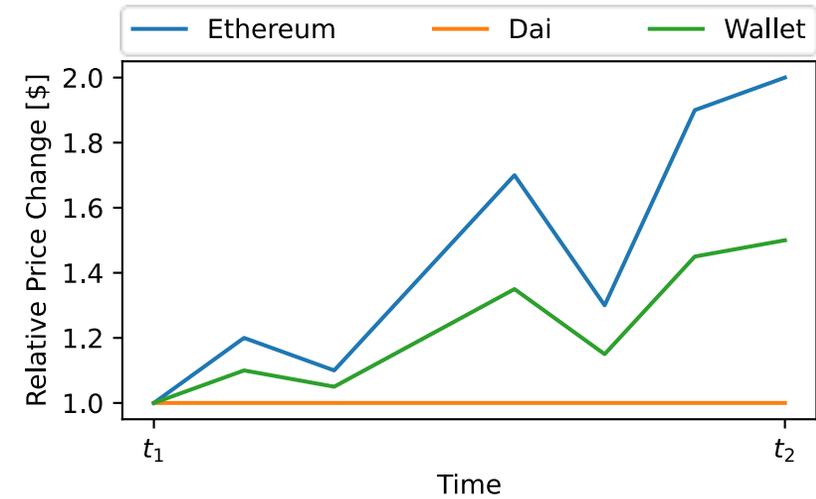
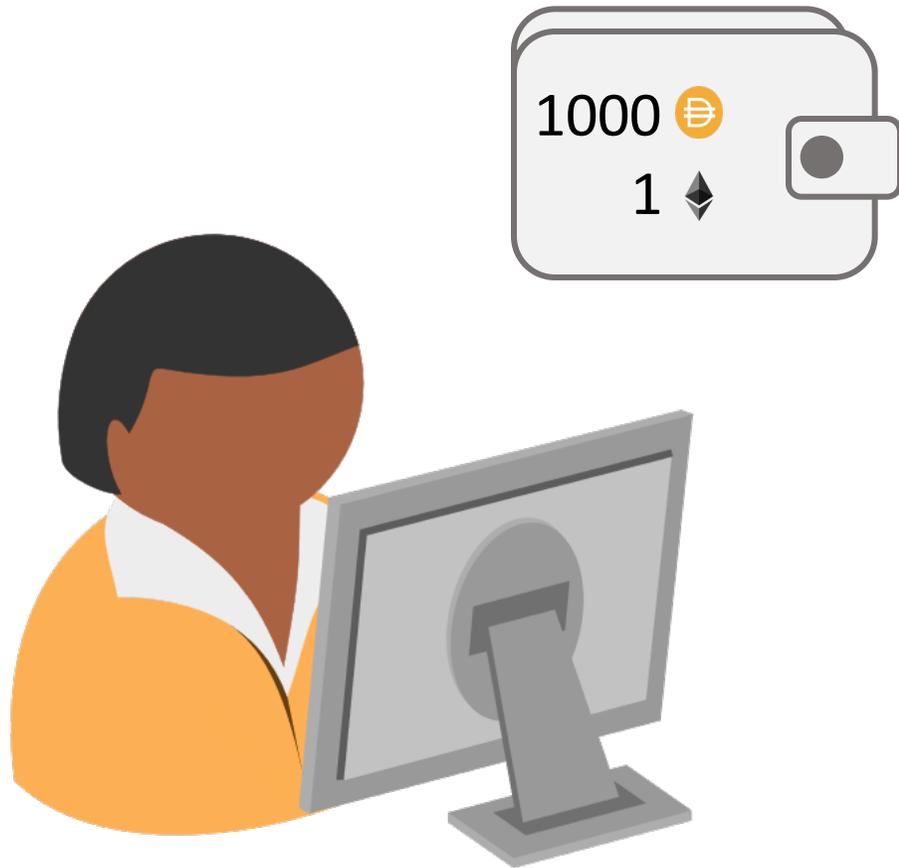
$$p(\text{₿})_{t_1} = 1 \quad p(\text{⬥})_{t_1} = 1000$$

# Returns and risks



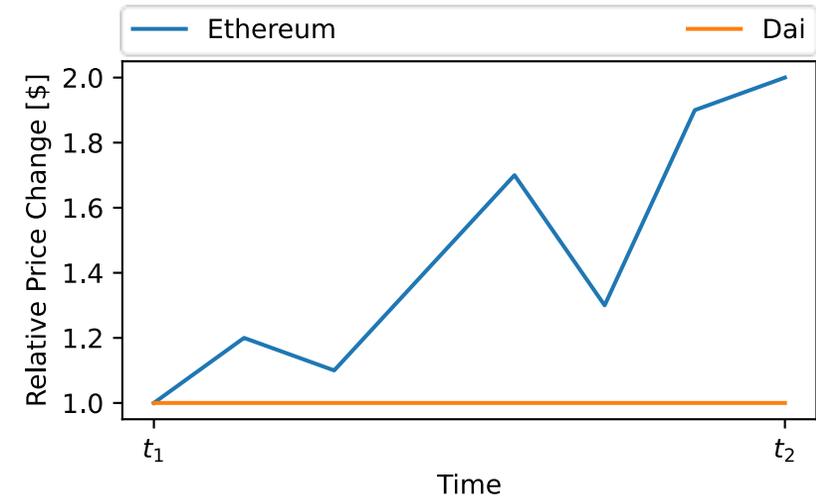
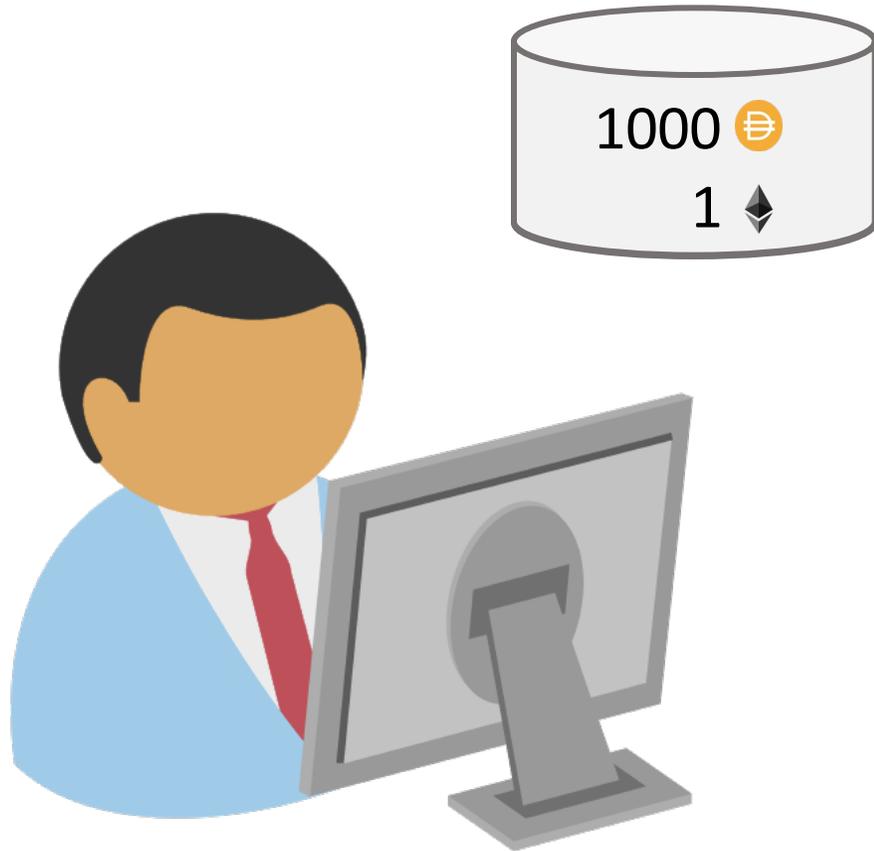
Alice holds her assets and hopes for the crypto price to increase

# Returns and risks



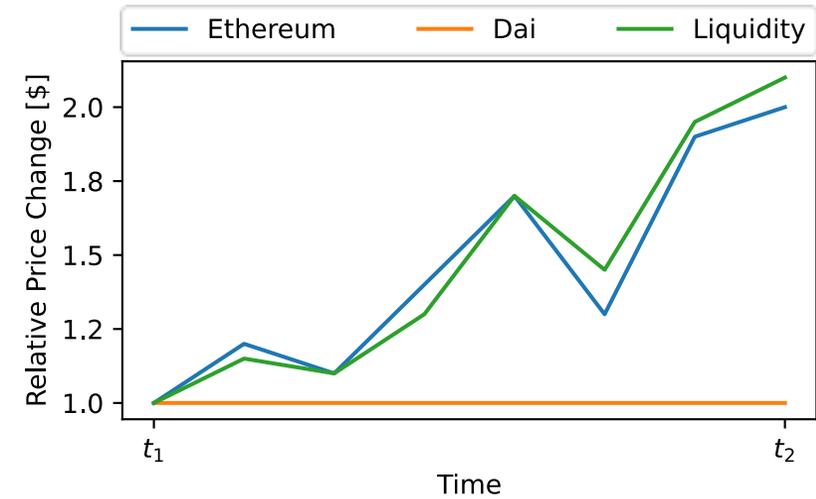
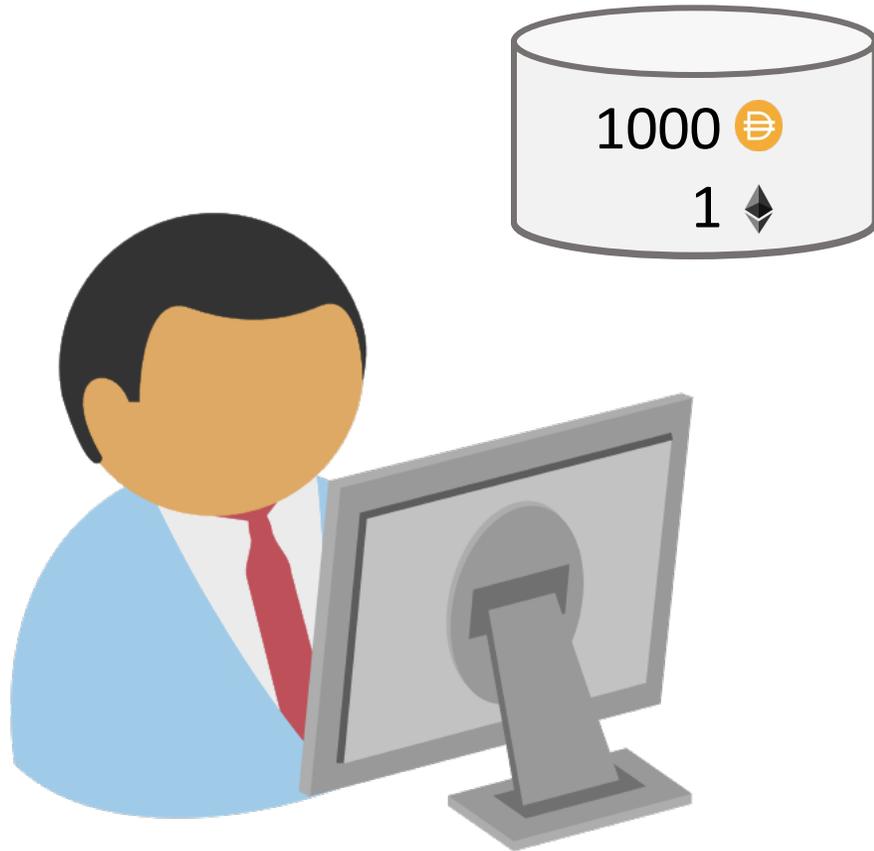
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# Returns and risks



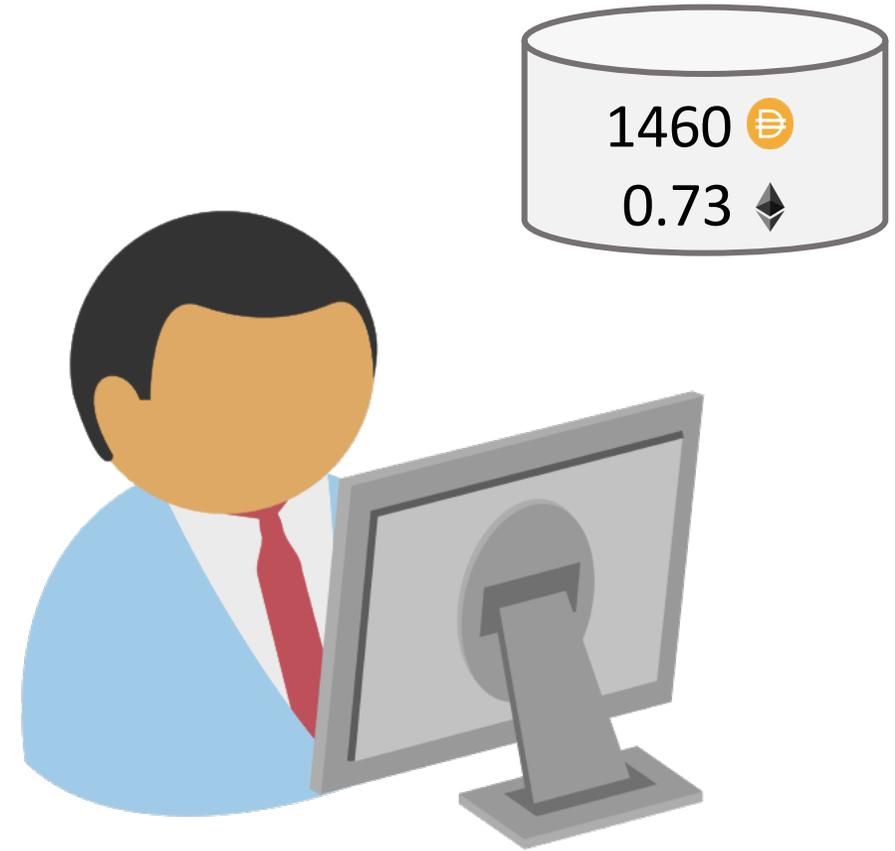
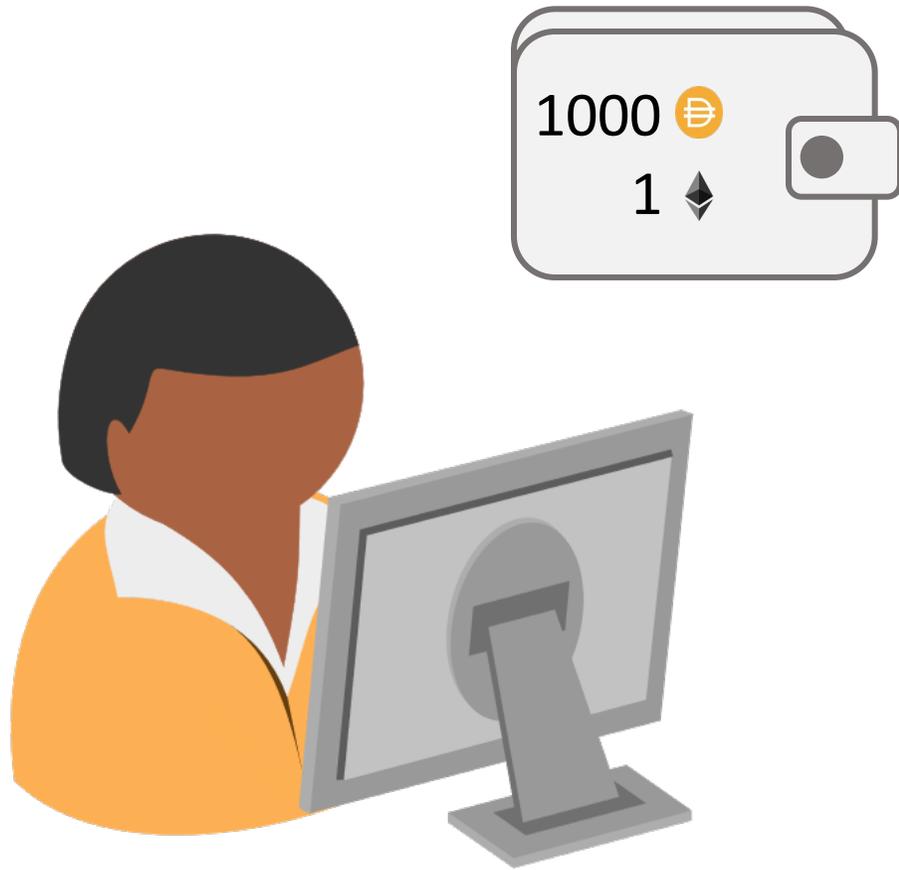
Bob invests his assets in the DAI ↔ WETH liquidity pool

# Returns and risks

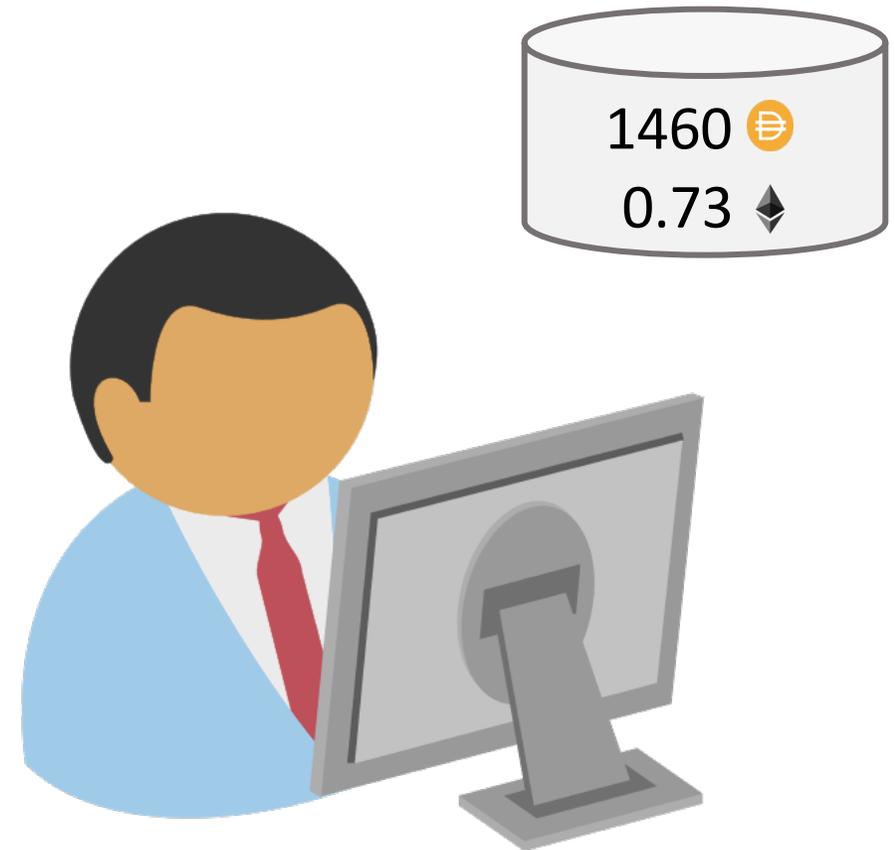
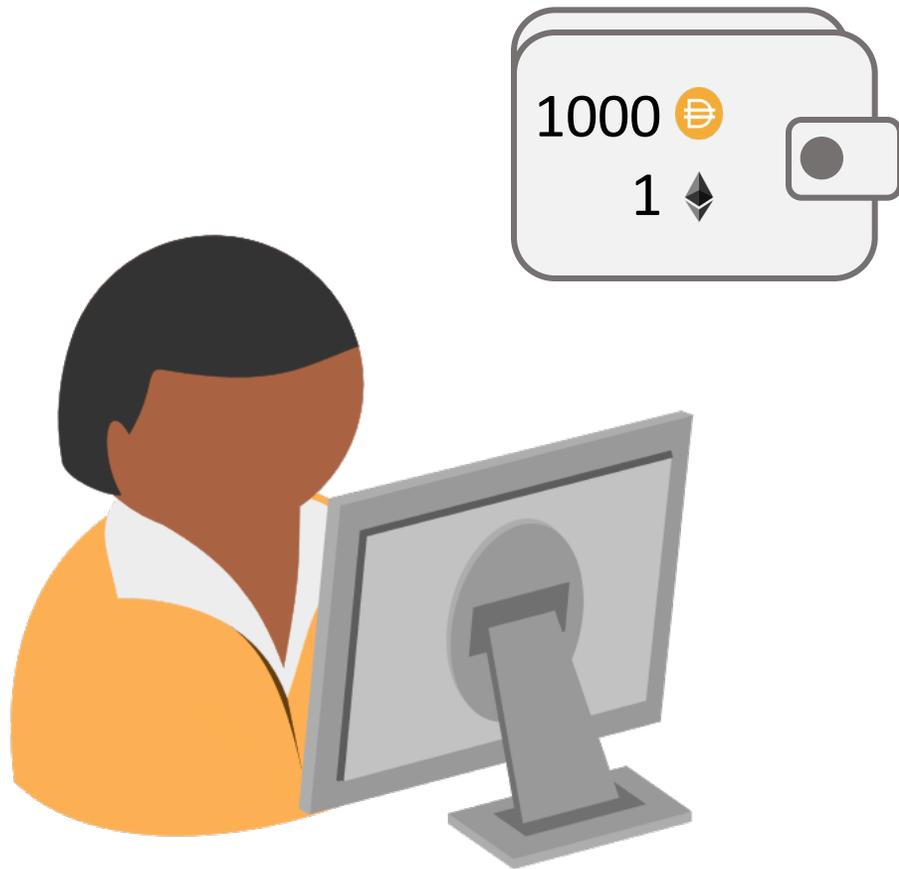


Bob invests his assets in the DAI ↔ WETH liquidity pool

# Returns and risks

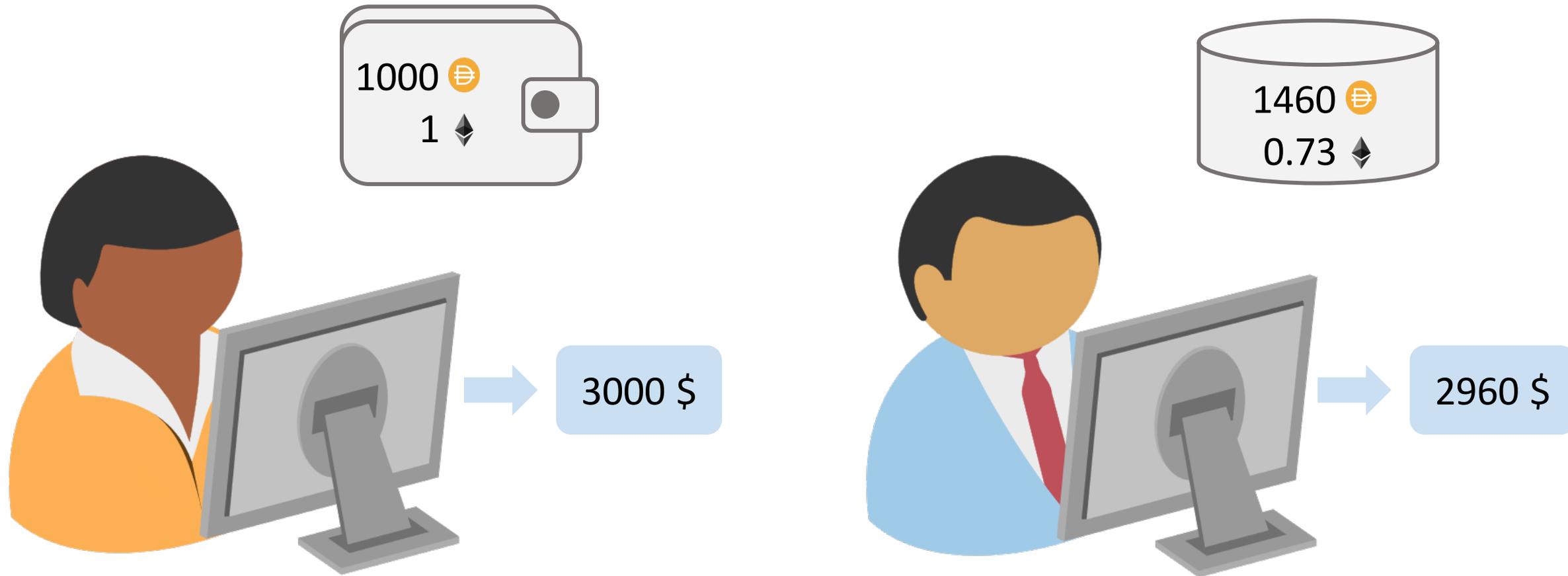


# Returns and risks



$$p(₿)_{t_2} = 1 \quad p(⬥)_{t_2} = 2000$$

# Returns and risks



$$p(\text{₿})_{t_2} = 1 \quad p(\text{⬥})_{t_2} = 2000$$

# Return



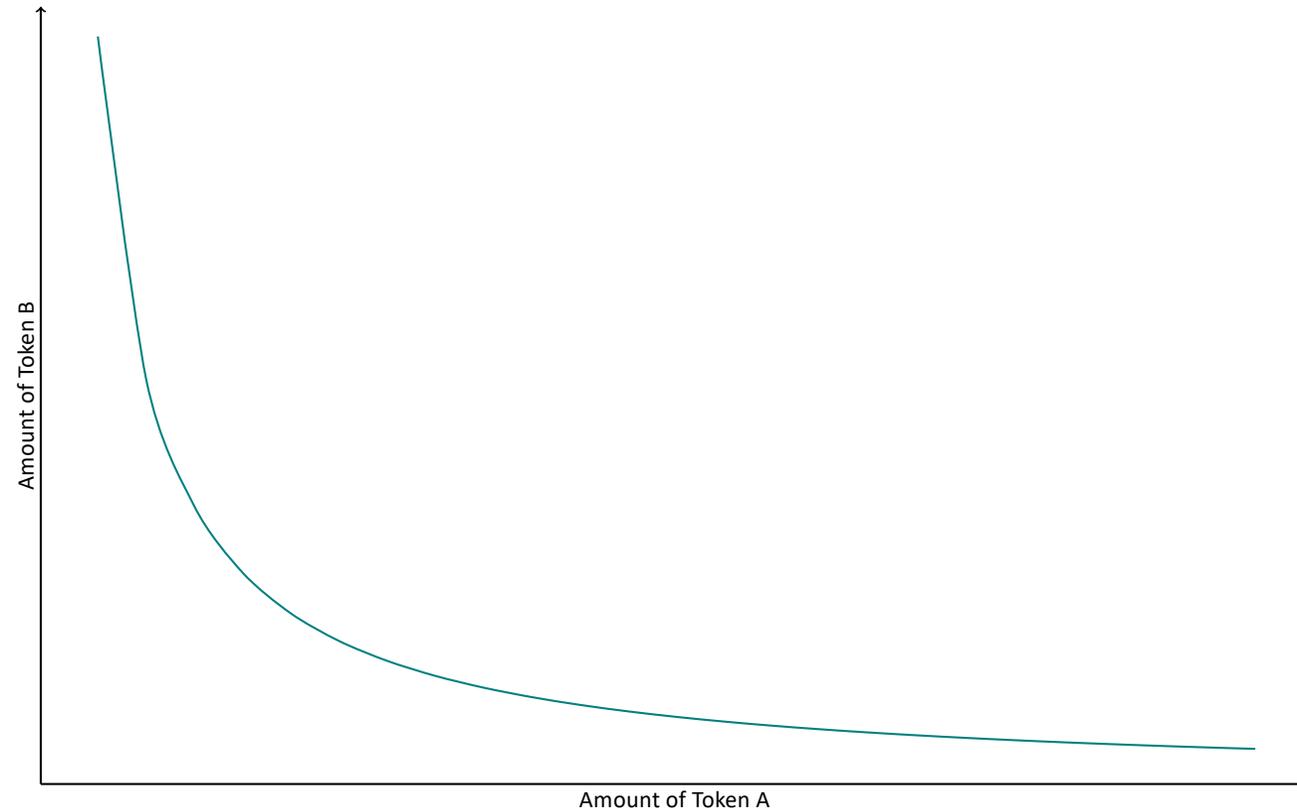
**return:** compares the value of the liquidity to holding the assets from the initial injection

# Return



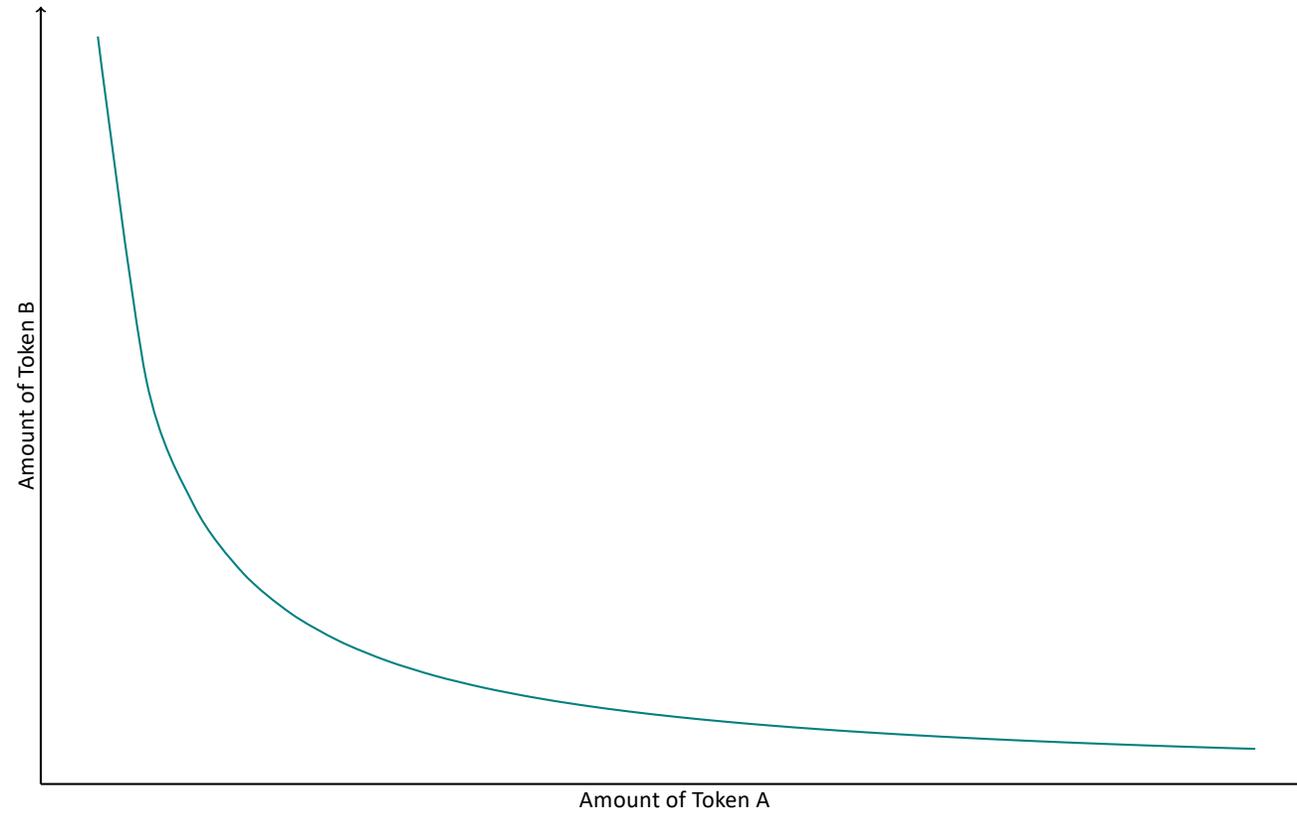
$$return_{t_1 \rightarrow t_2} \approx -1\%$$

# Fees



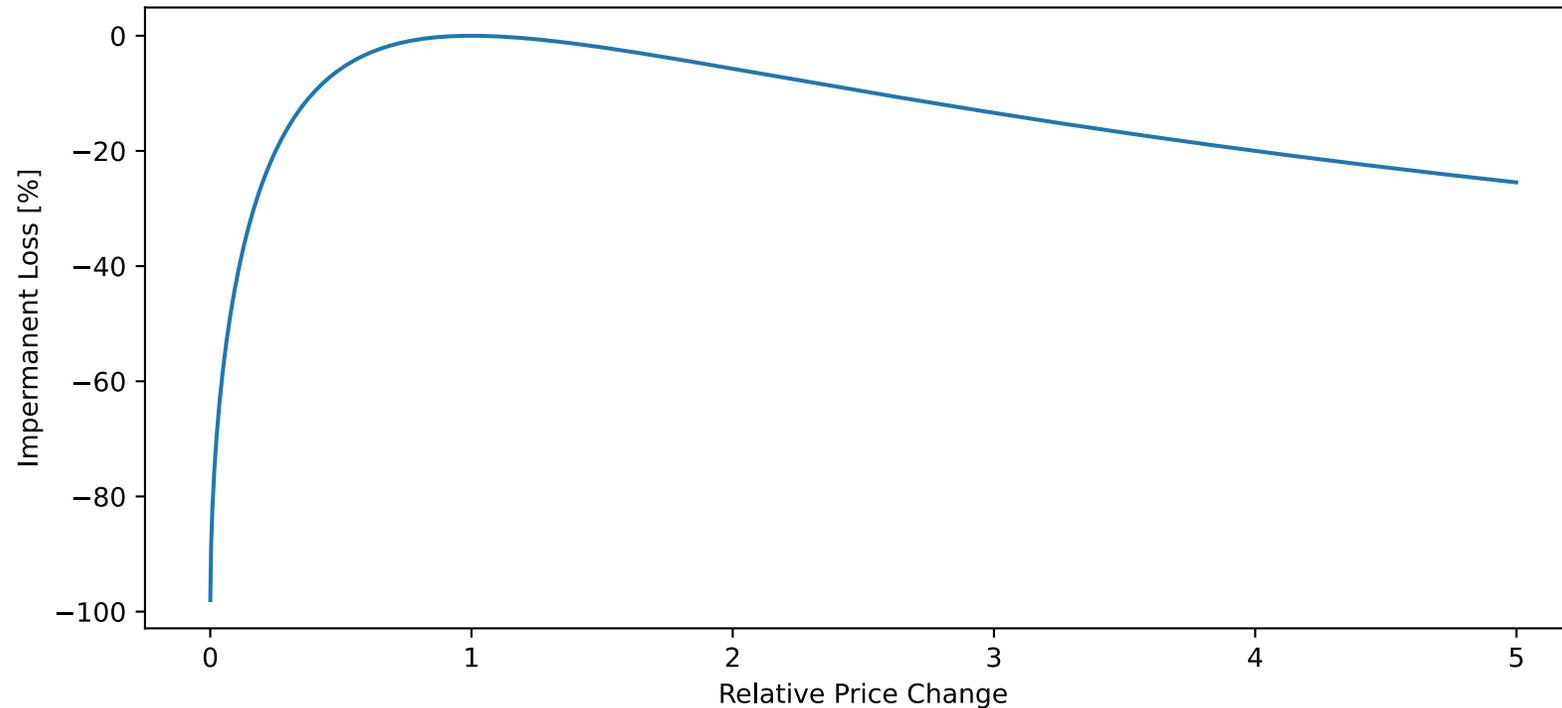
**fees:** received by liquidity providers for every trade in liquidity pool

# Fees



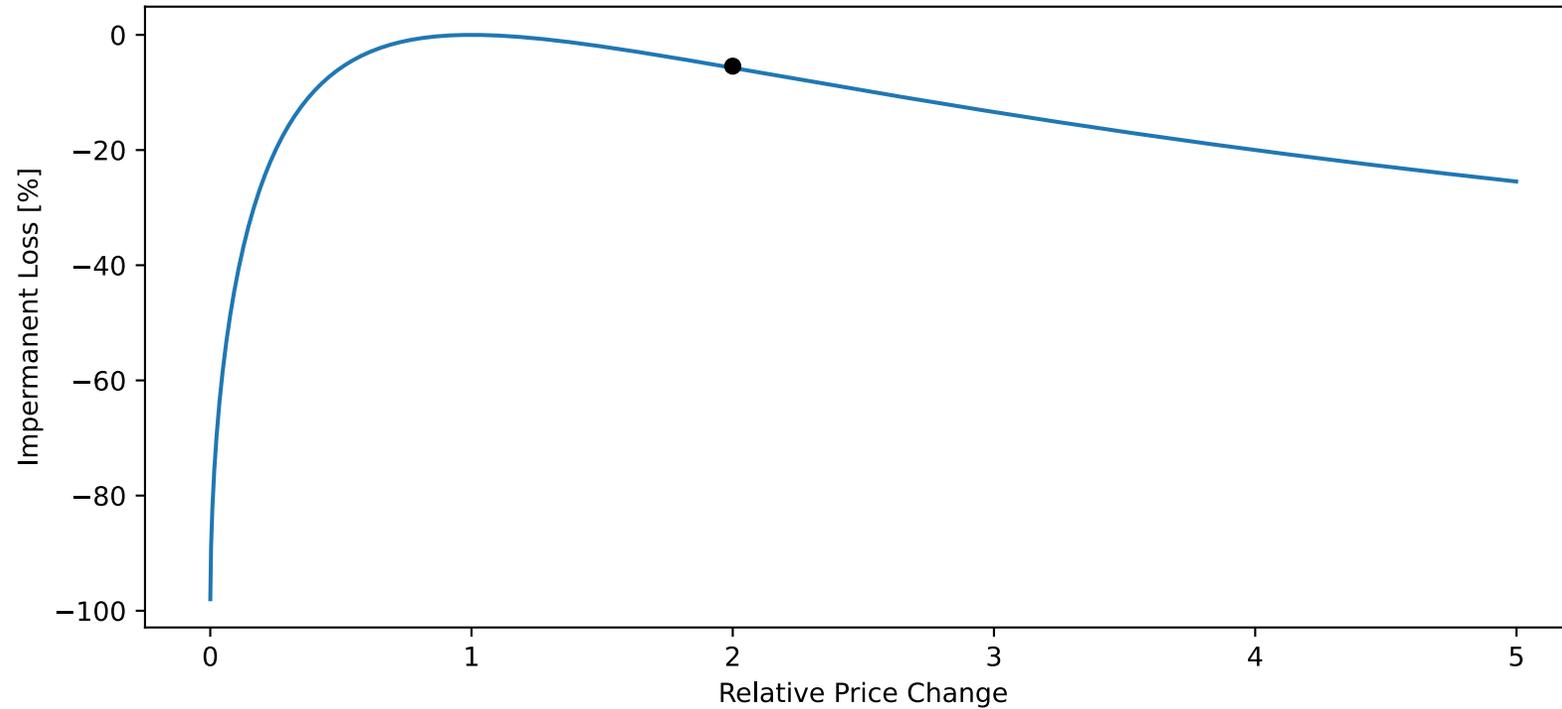
$$fees_{t_1 \rightarrow t_2} \approx 3\%$$

# Impermanent loss



**impermanent loss:** describes the risk for liquidity providers of seeing the value of their reserved tokens decrease in comparison to holding the assets

# Impermanent loss



$impermanent\ loss_{t_1 \rightarrow t_2} \approx -6\%$

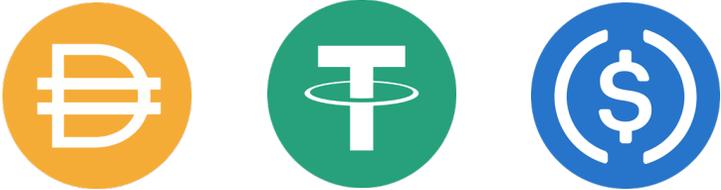
# Pair types

**stable pair:** both tokens traded in the pool  
are stable coins

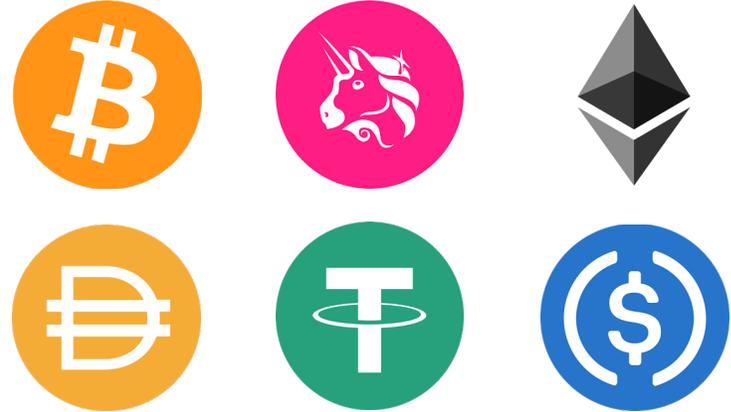


# Pair types

**stable pair:** both tokens traded in the pool are stable coins

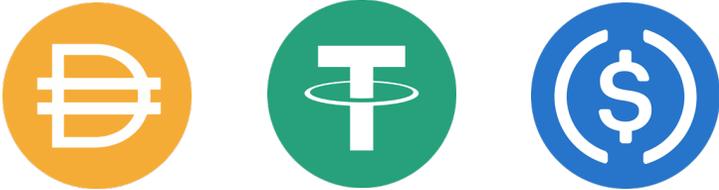


**normal pair:** both cryptocurrencies traded in the pools are established currencies, liquidity in pools is generally high



# Pair types

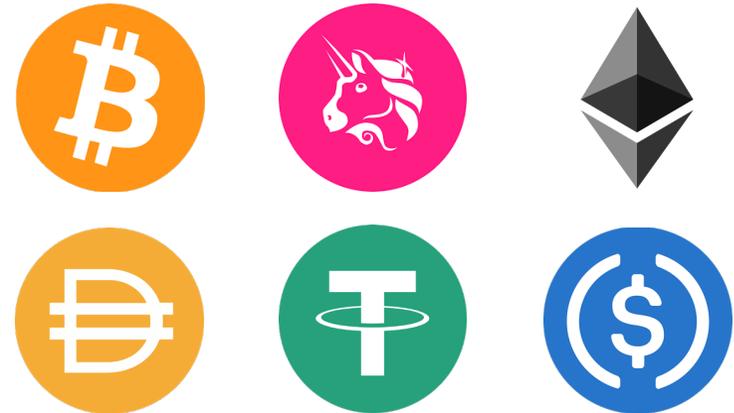
**stable pair:** both tokens traded in the pool are stable coins



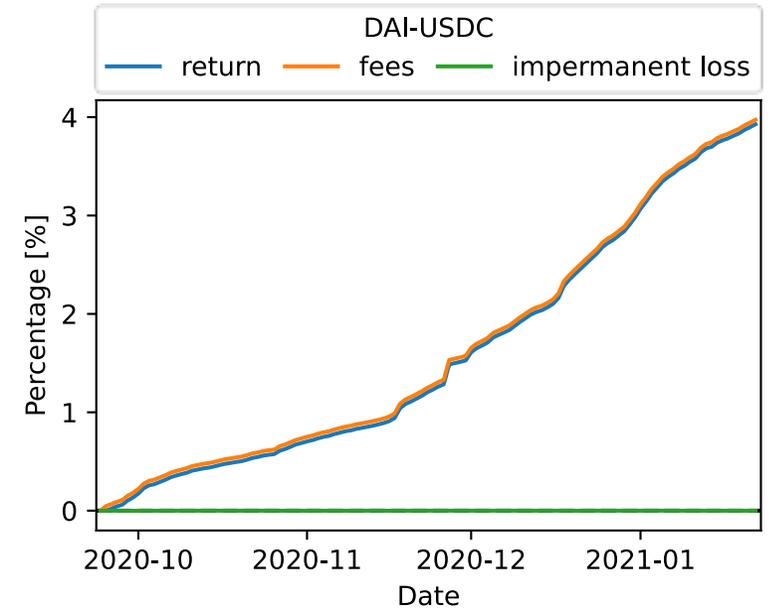
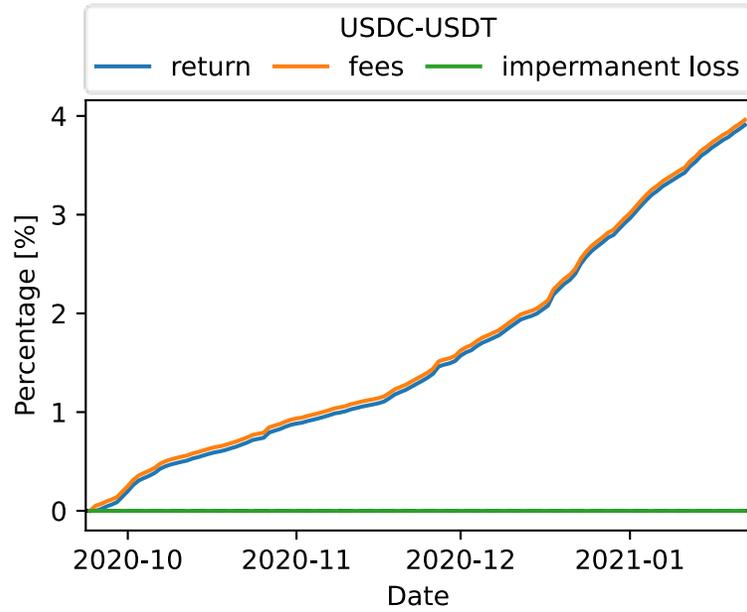
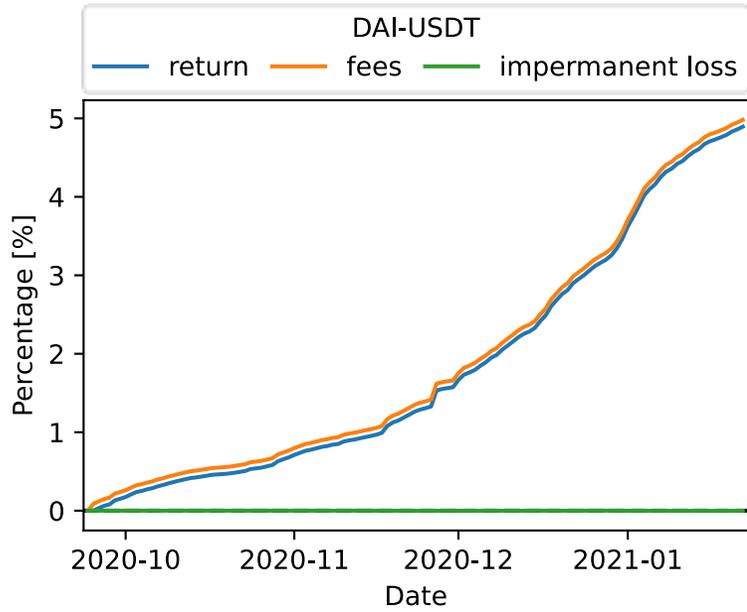
**exotic pair:** the price of at least one trading token is extremely volatile



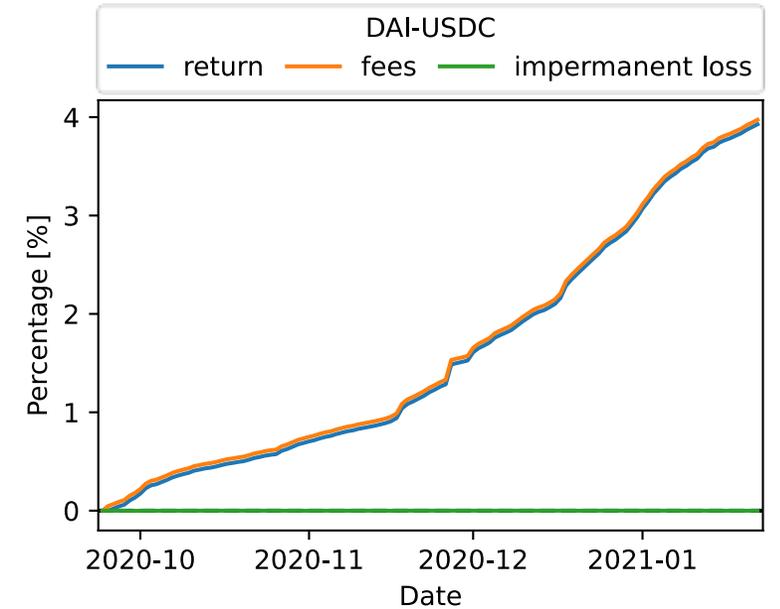
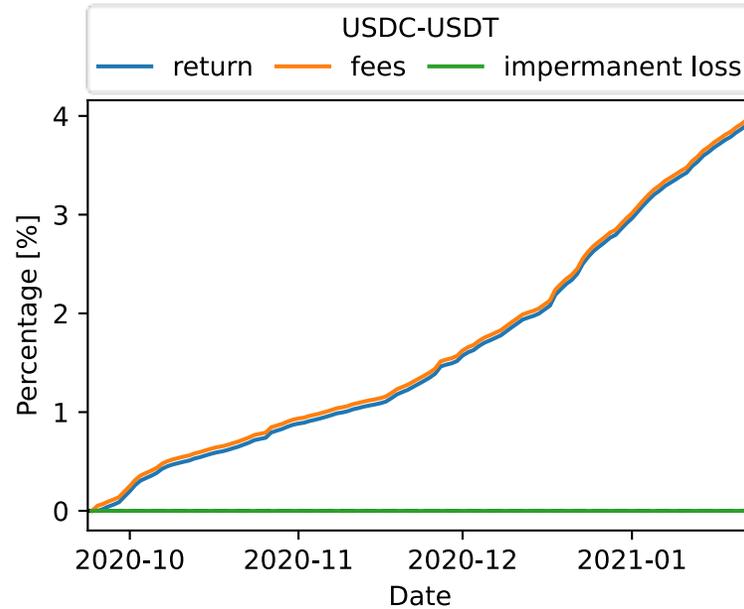
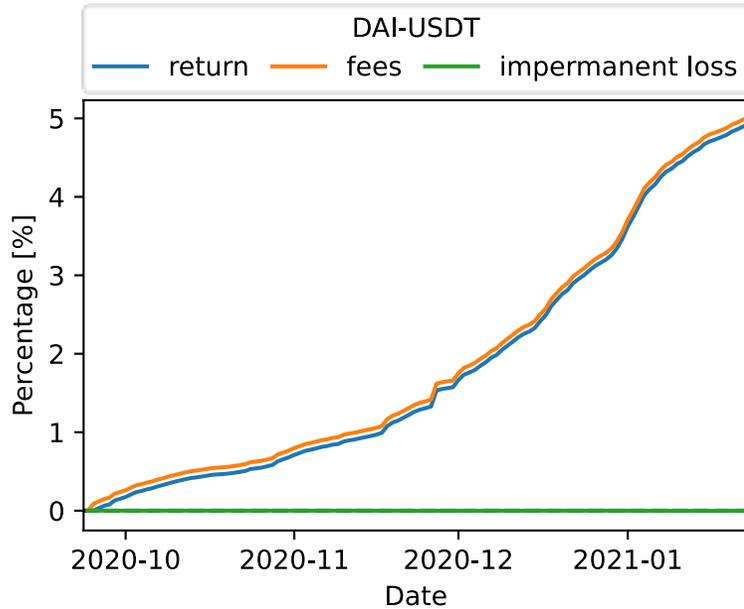
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# Stable pairs

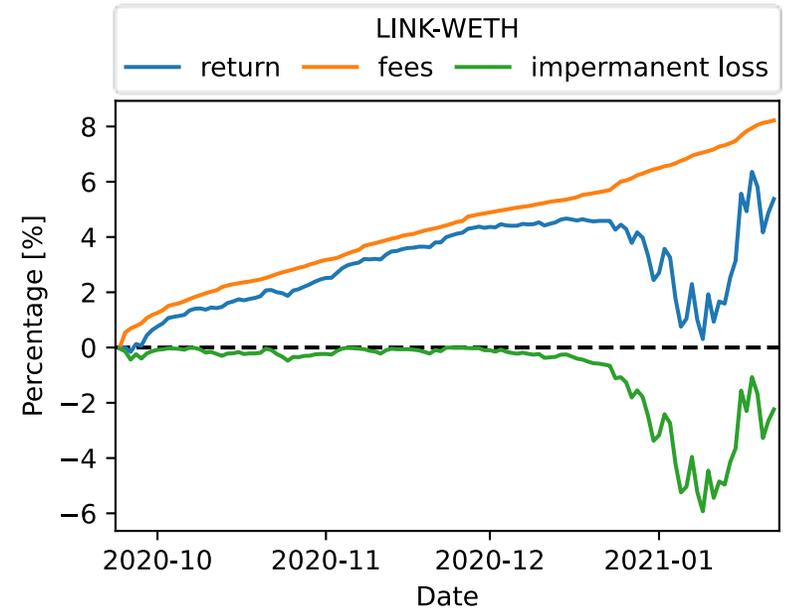
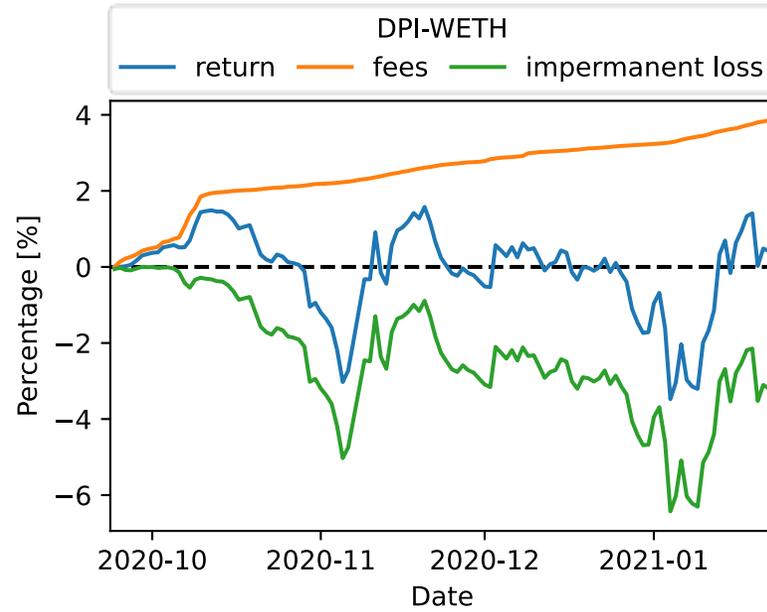
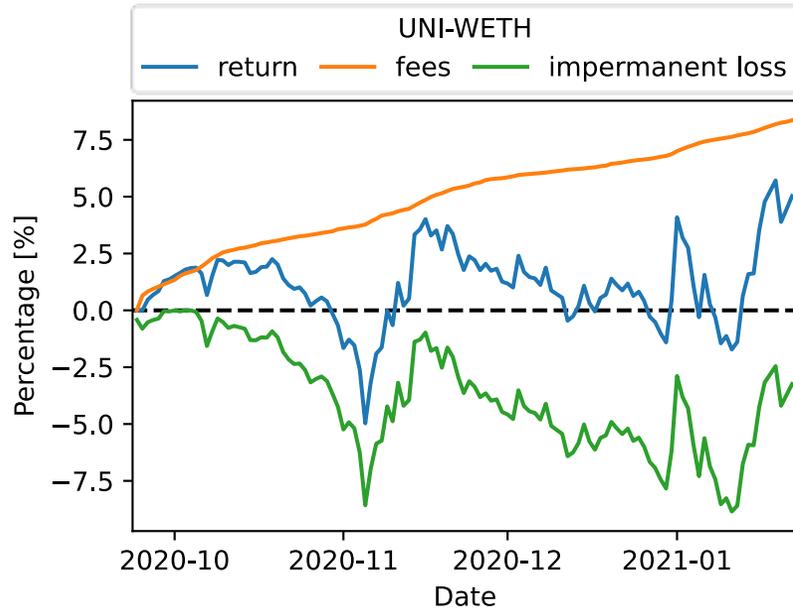


# Stable pairs

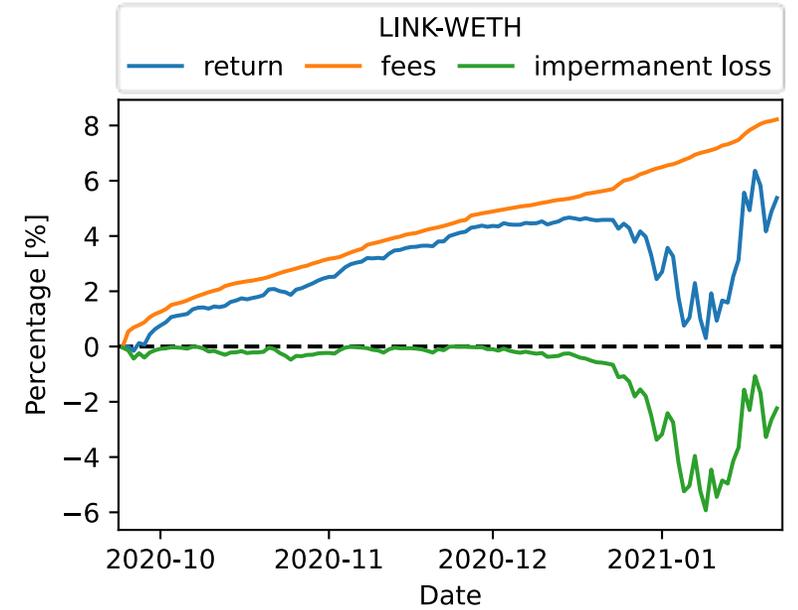
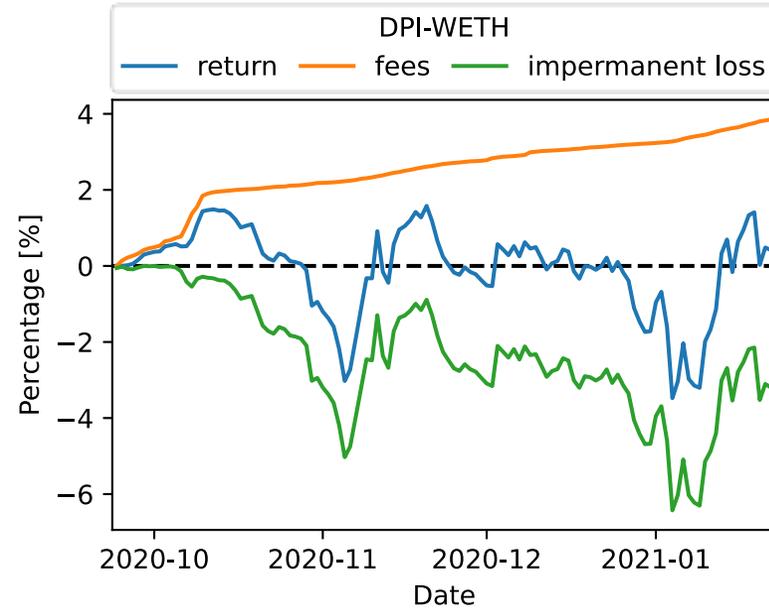
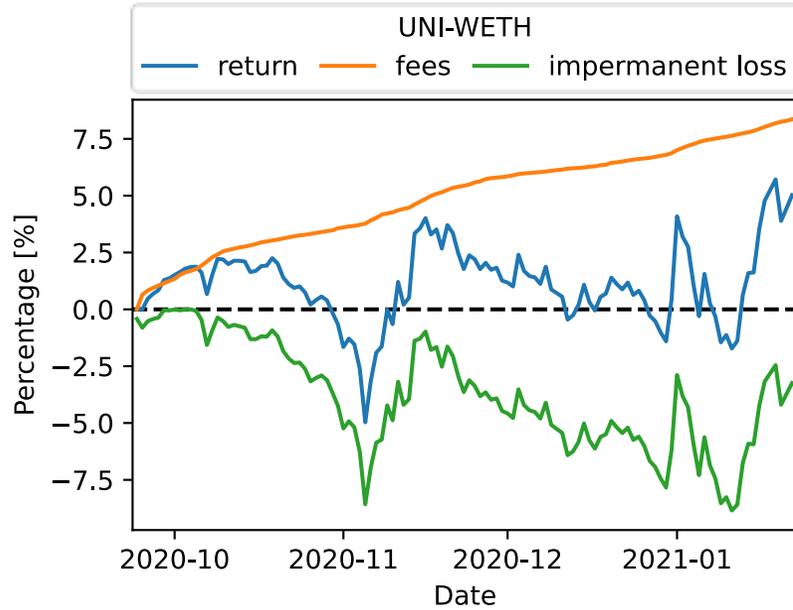


liquidity provider returns correspond to fees due to negligible impermanent loss

# Normal pairs

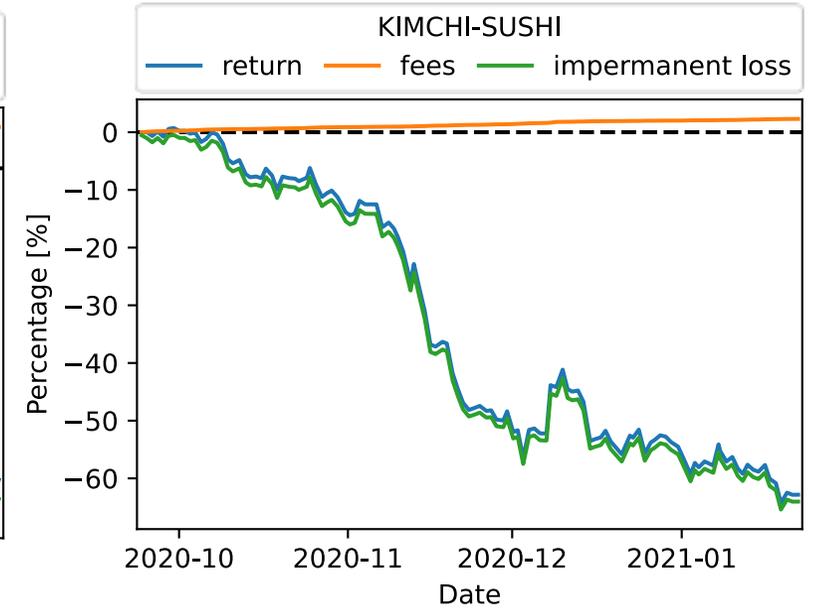
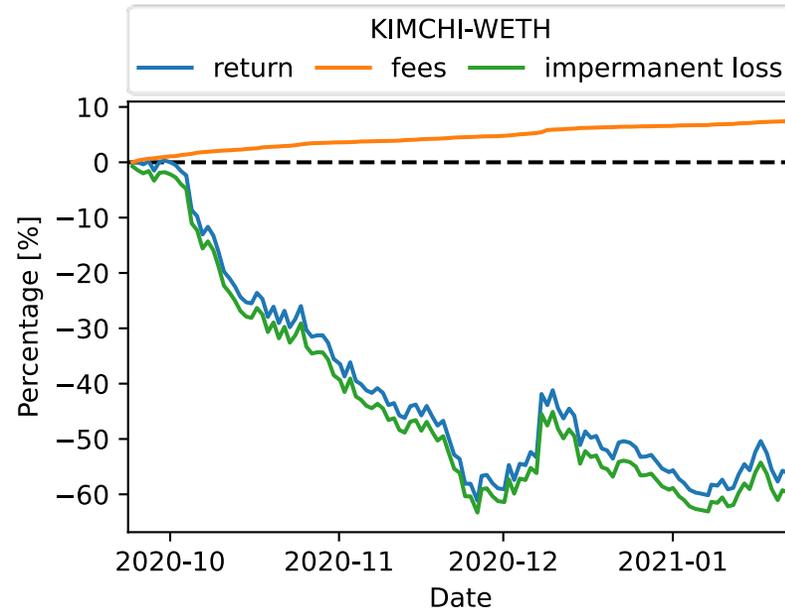
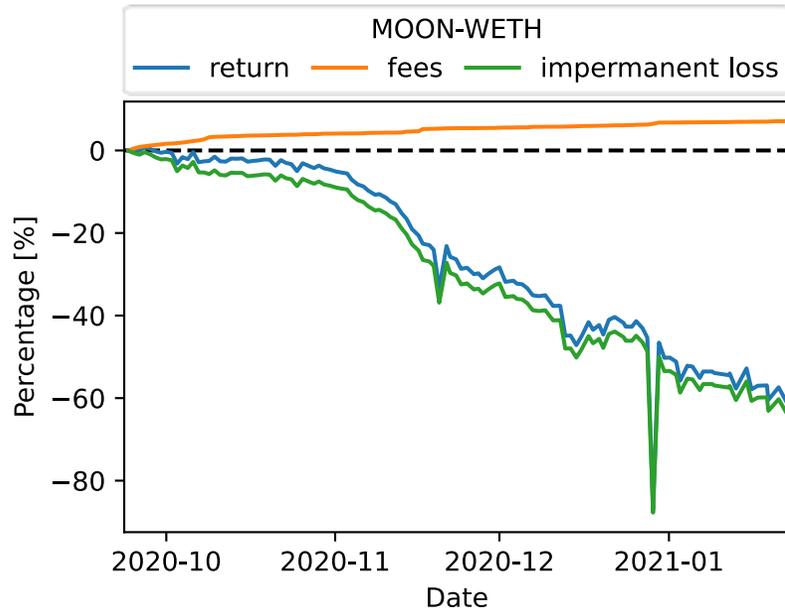


# Normal pairs

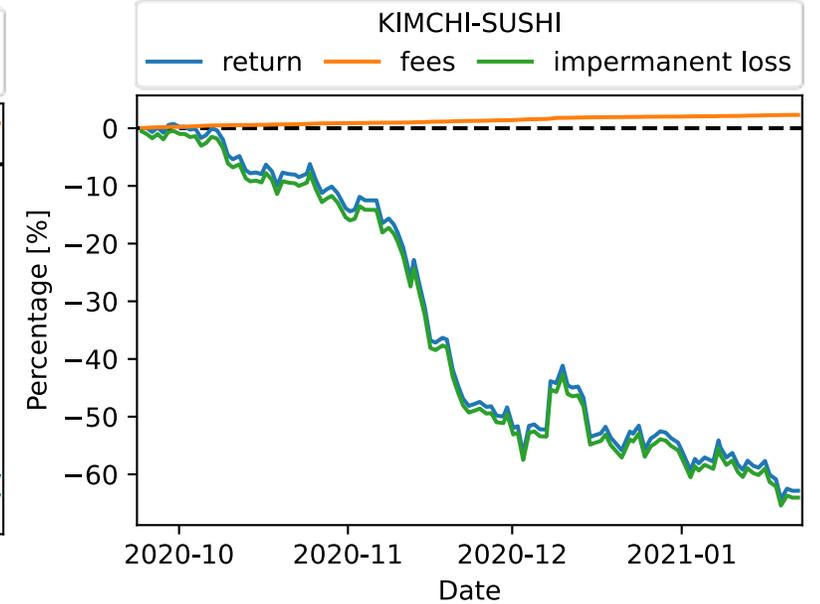
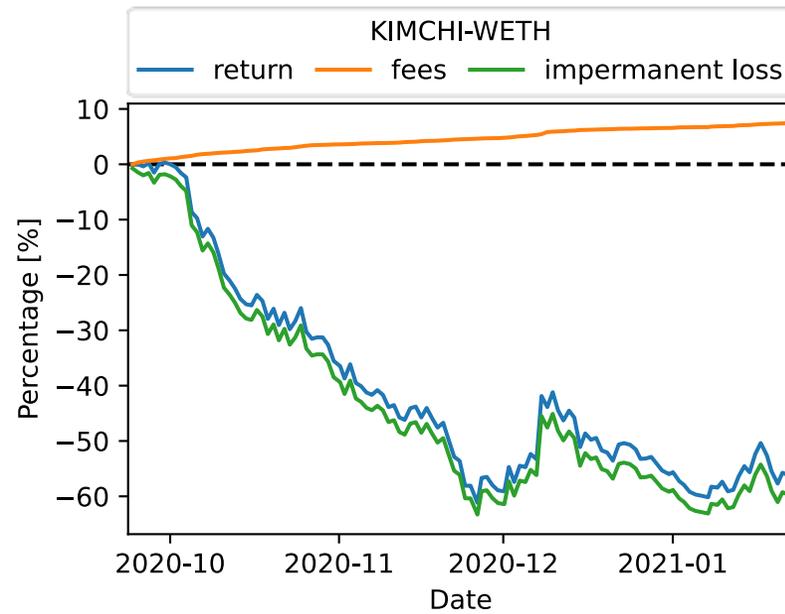
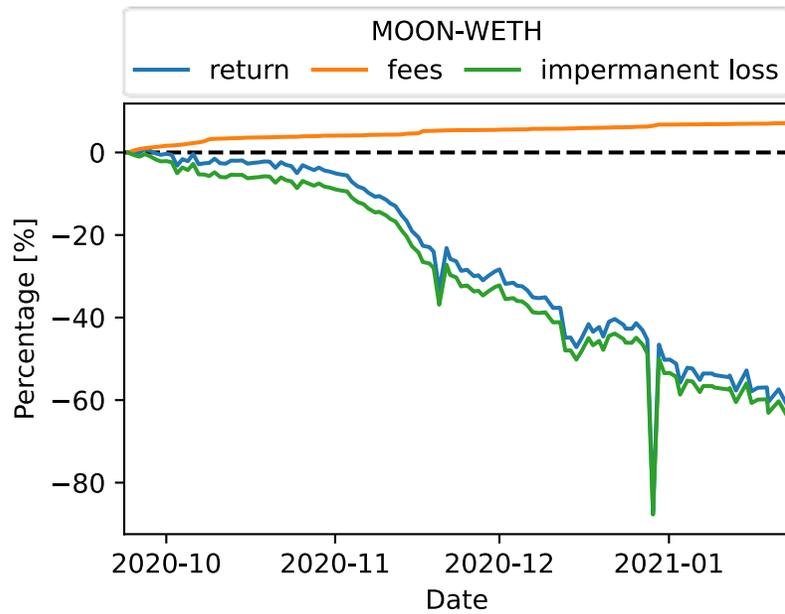


impermanent loss significantly impact on returns, but returns are generally positive

# Exotic pairs

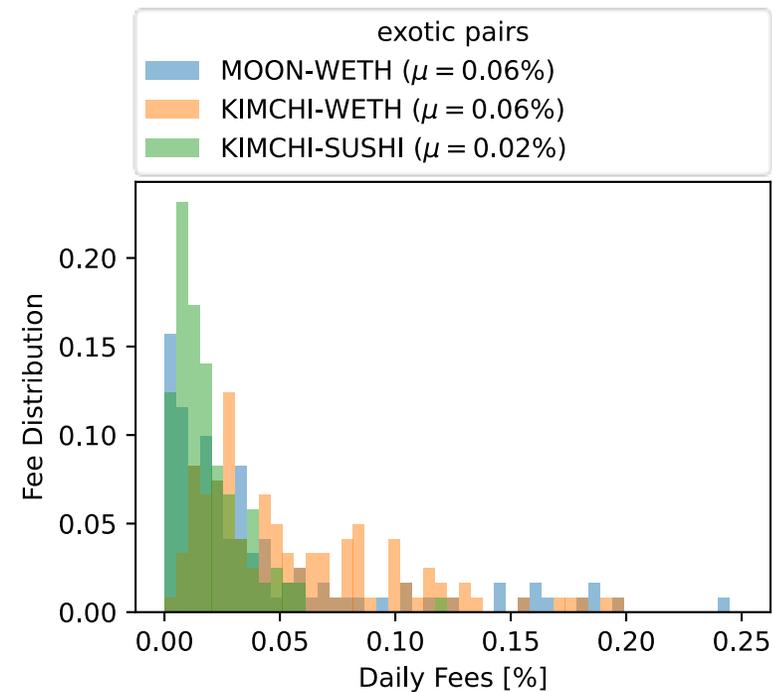
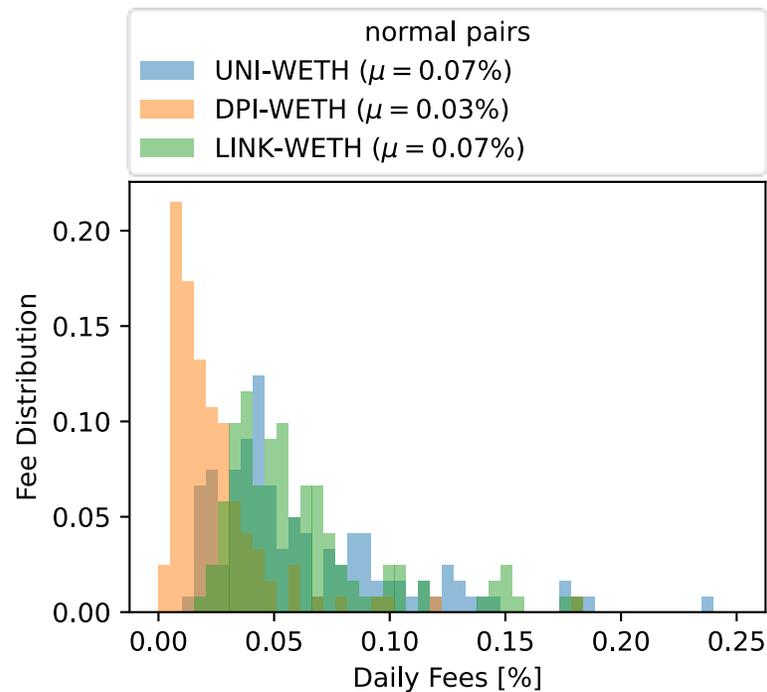
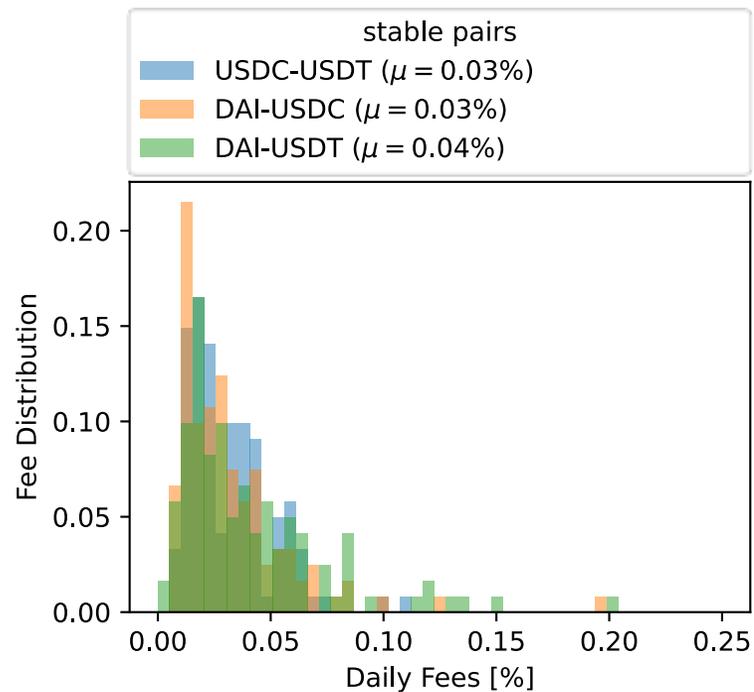


# Exotic pairs

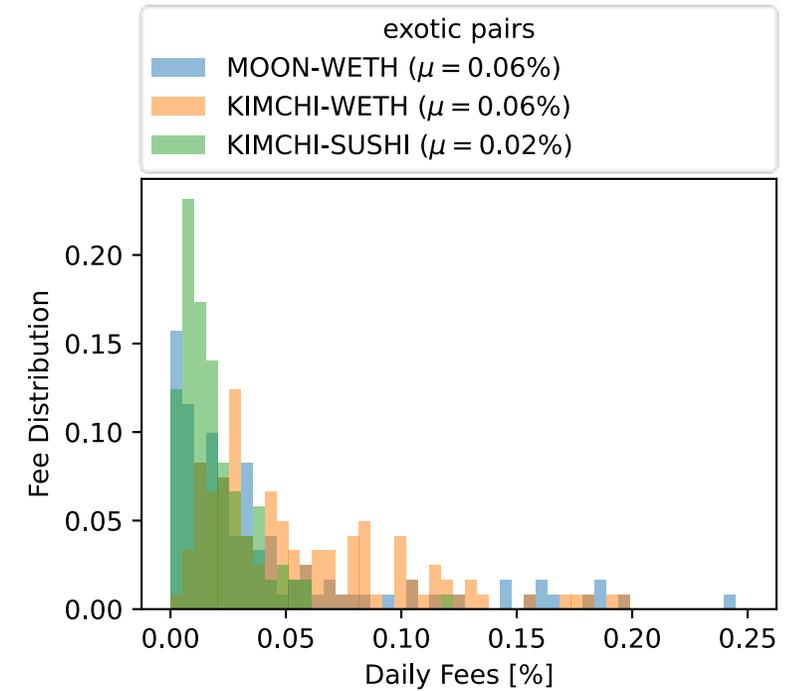
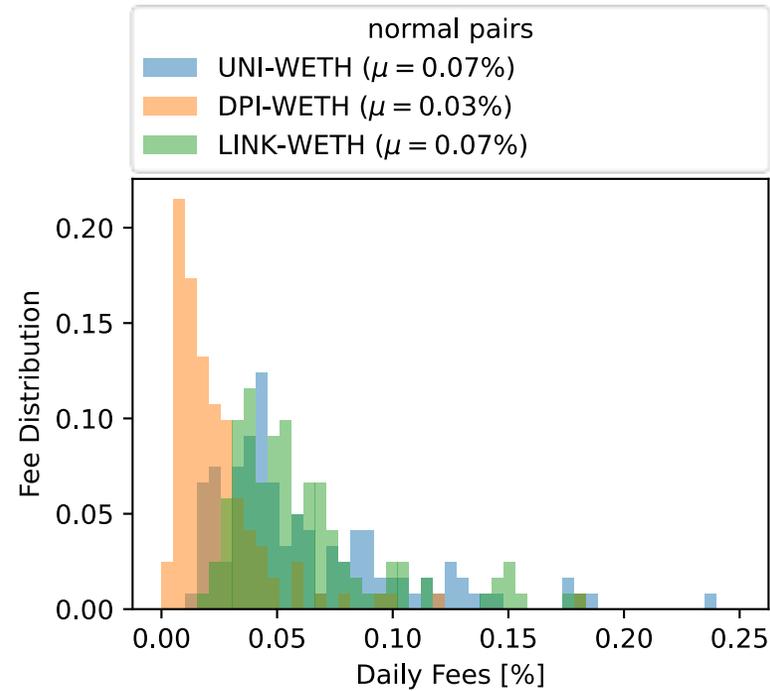
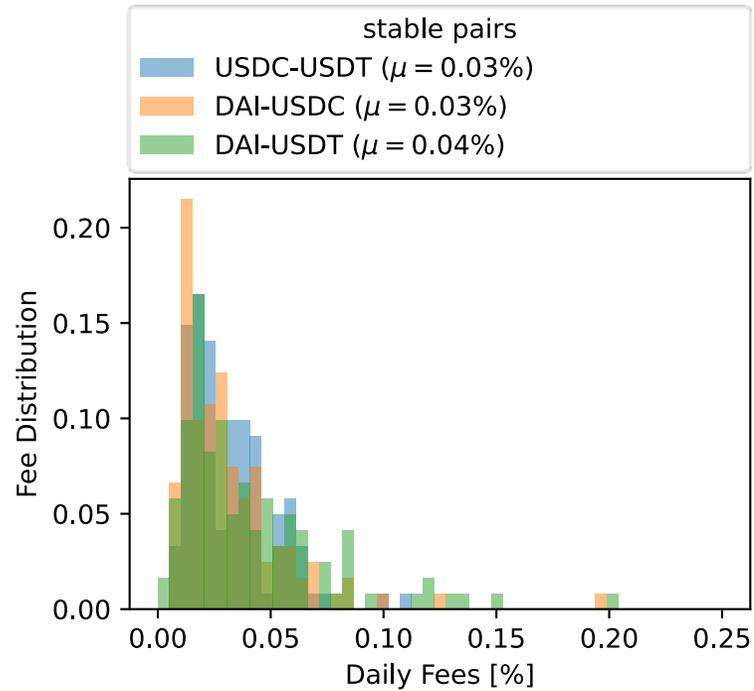


impermanent loss impacts returns to the point that they are highly negative

# Fees

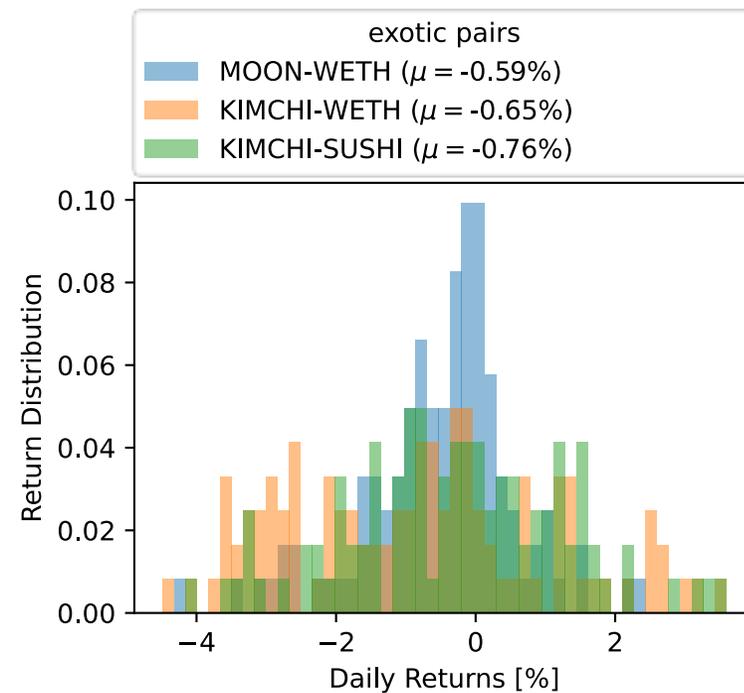
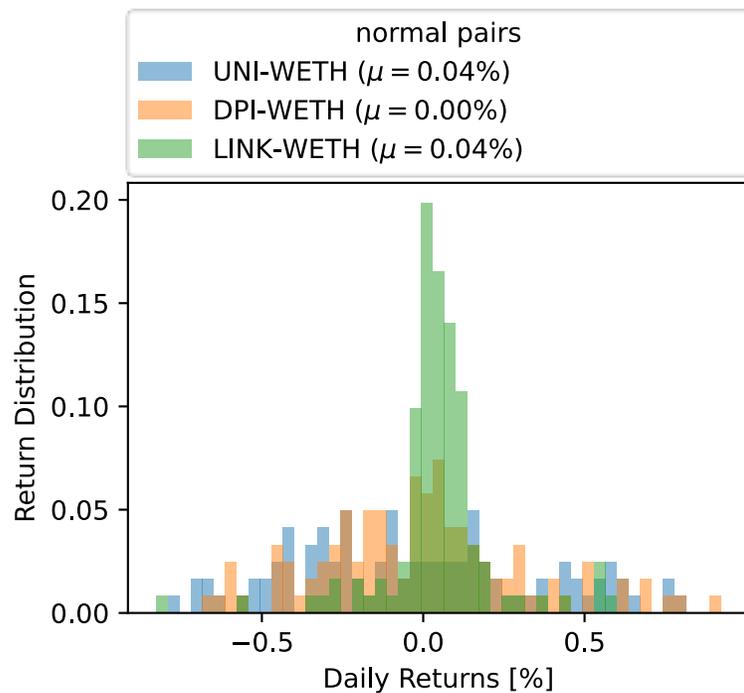
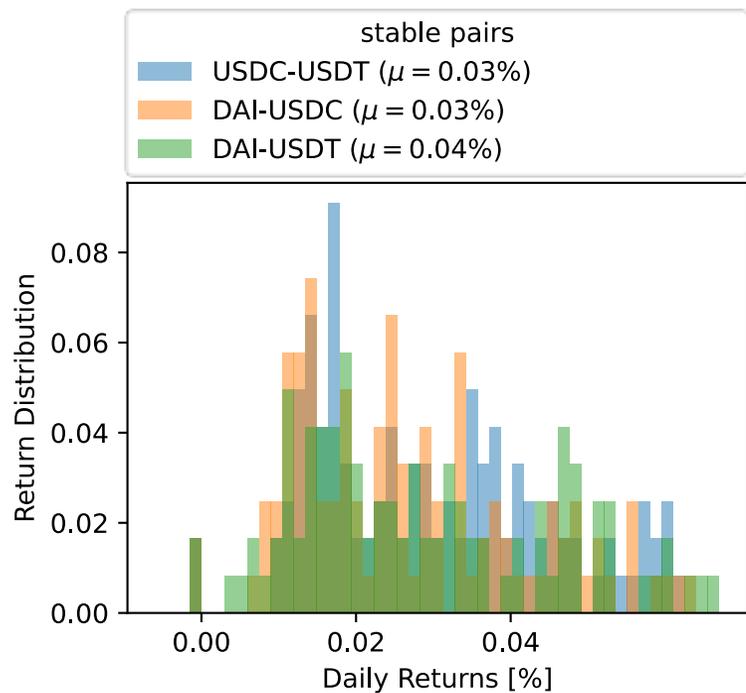


# Fees

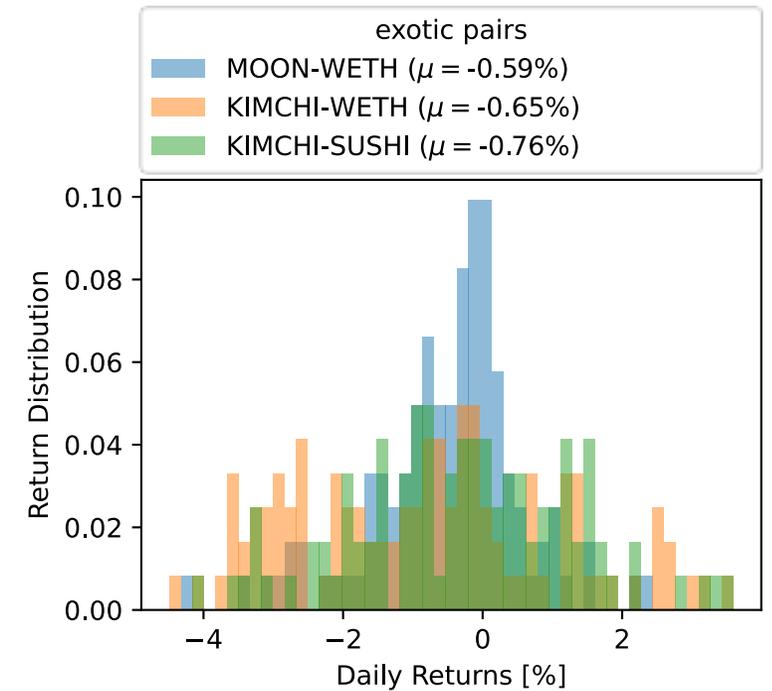
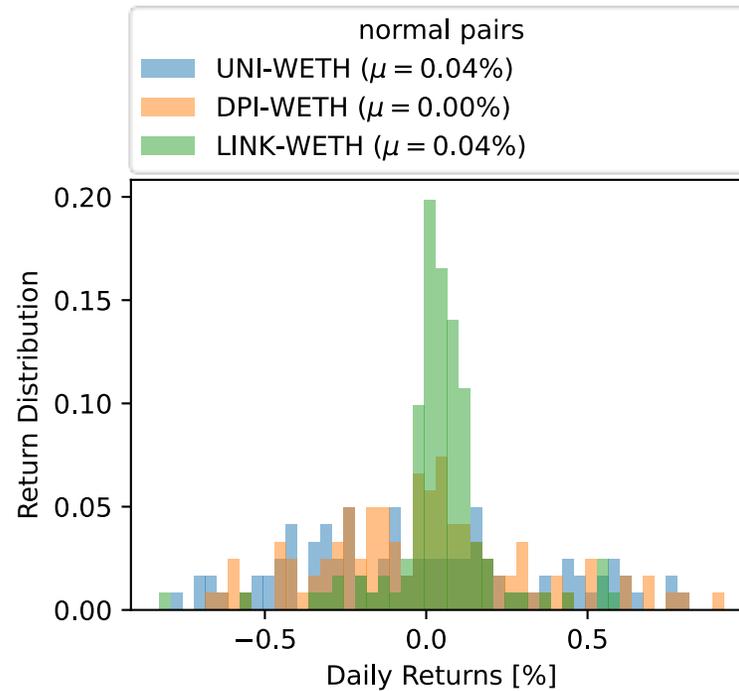
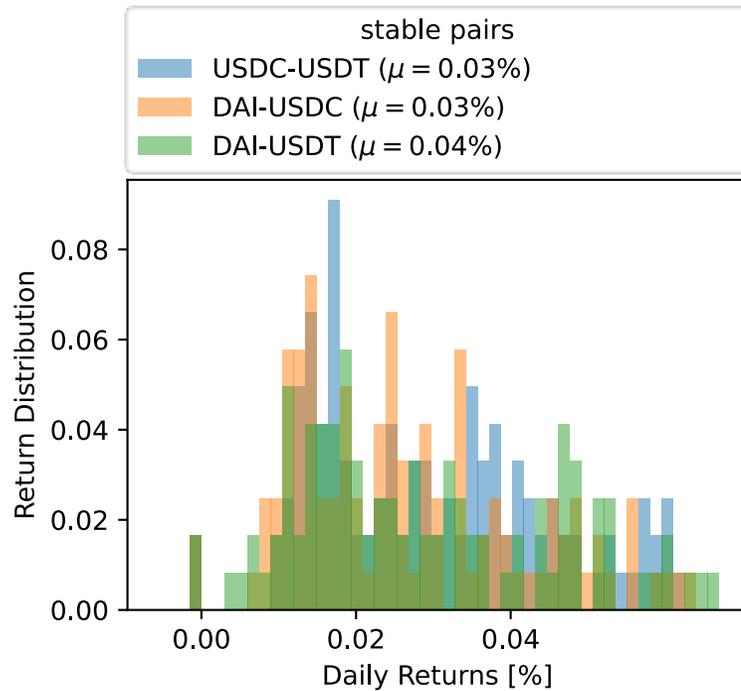


fees similar across pair types

# Return



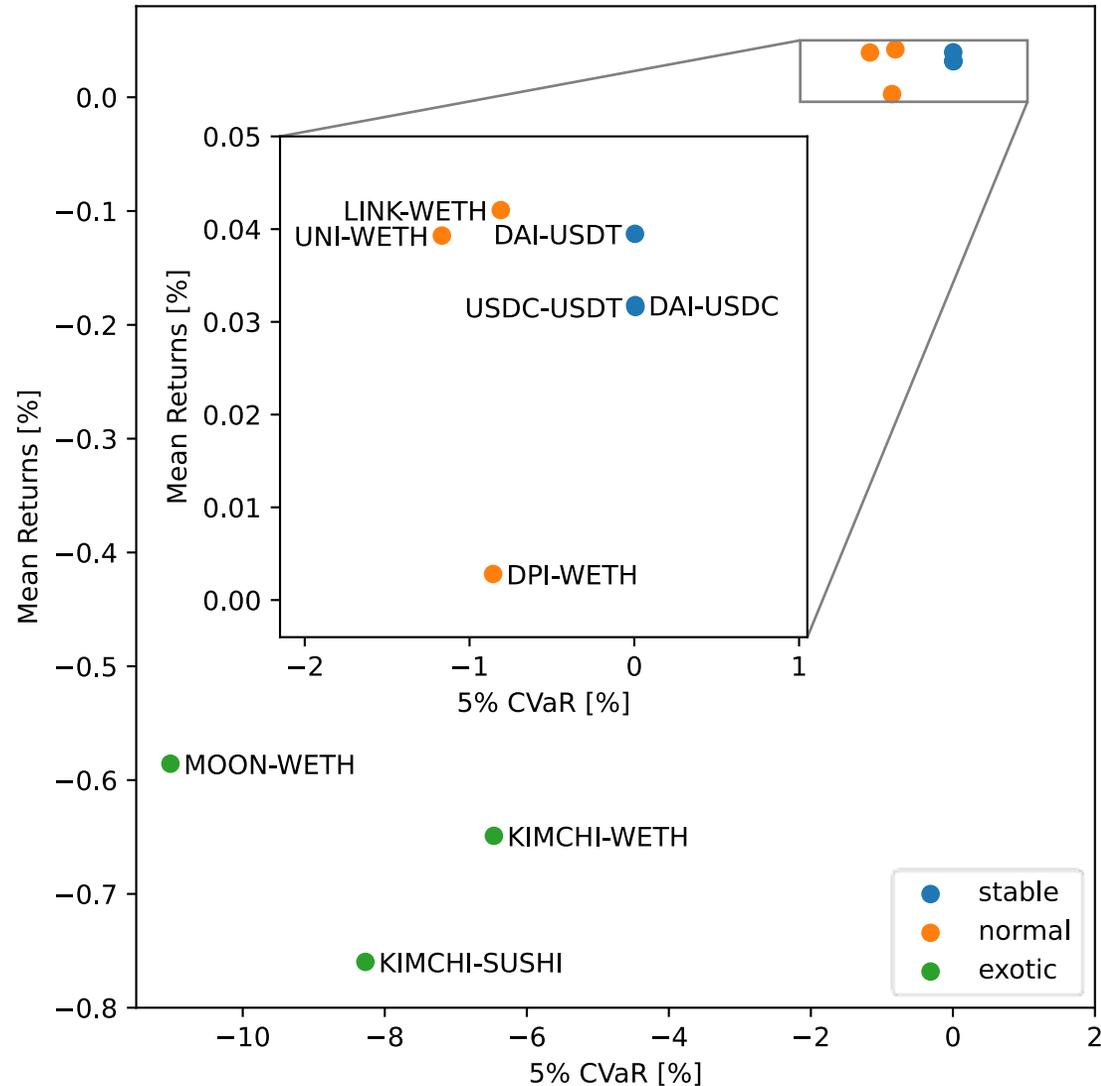
# Return



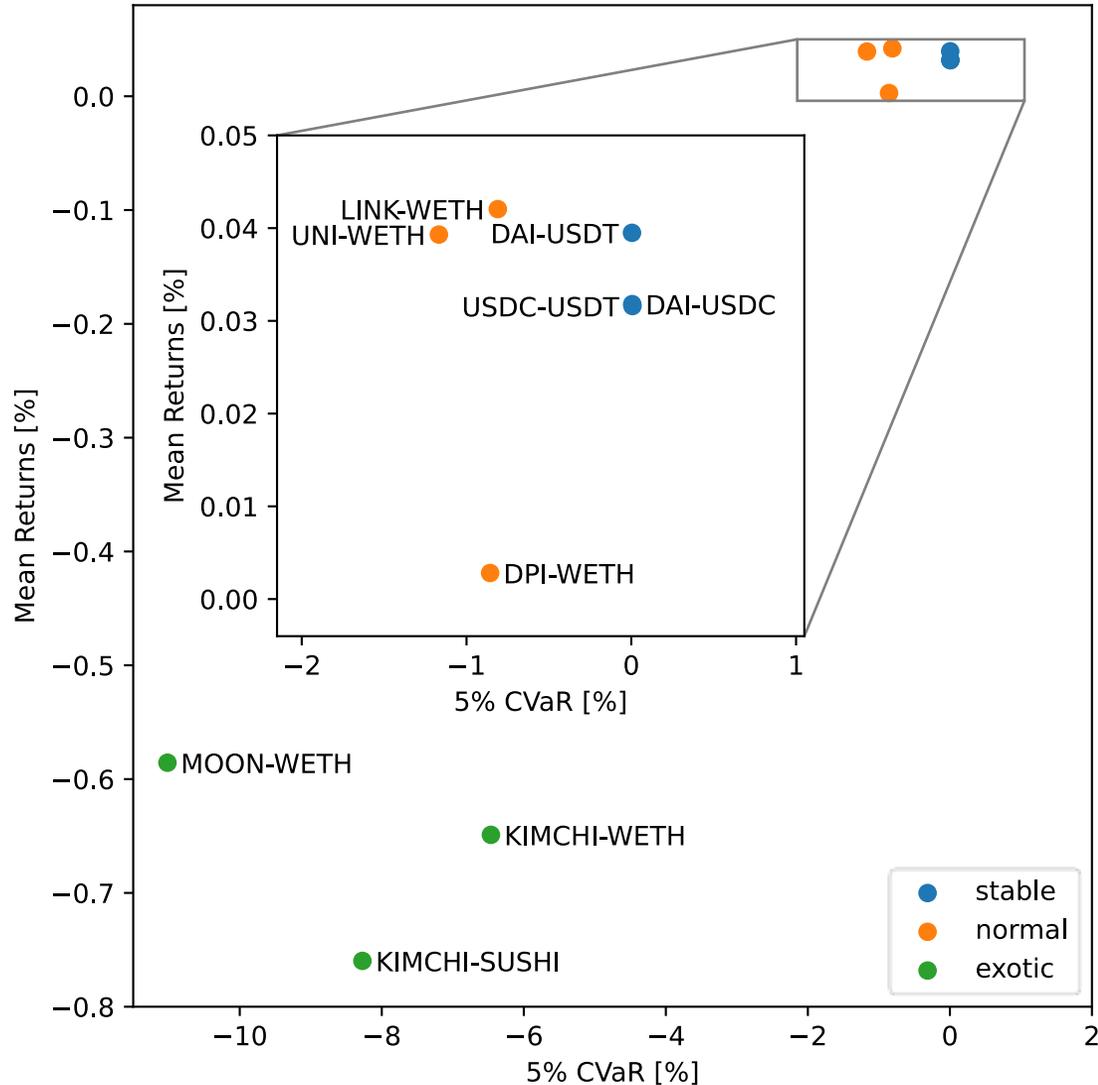
stark difference in returns across pair types

# Conditional value at risk

conditional value at risk (CVaR) quantifies tail behavior of an investment



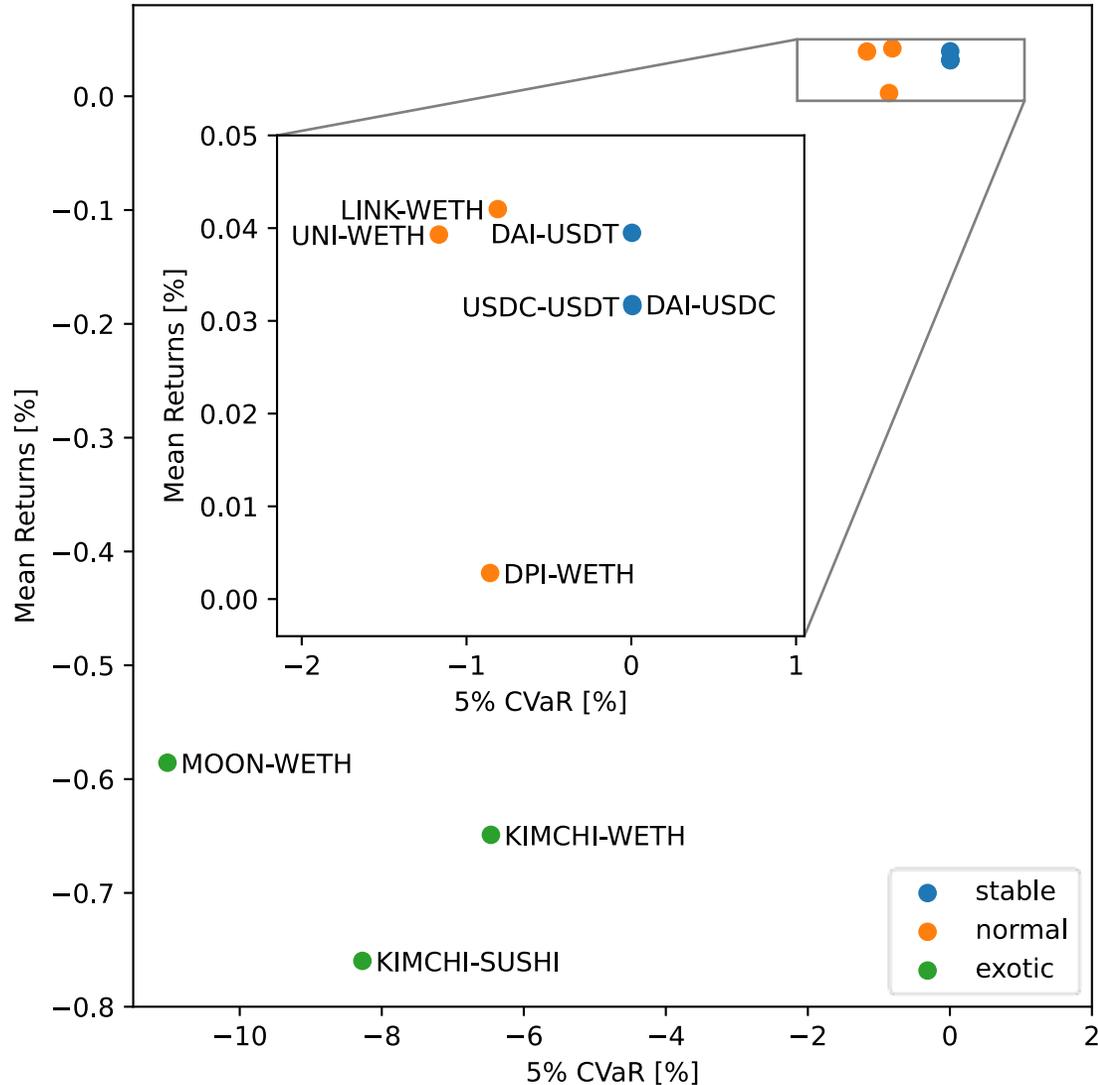
# Conditional value at risk



conditional value at risk (CVaR) quantifies tail behavior of an investment

CVaR at 5% level is the expected return on an investment in the worst 5% of cases

# Conditional value at risk

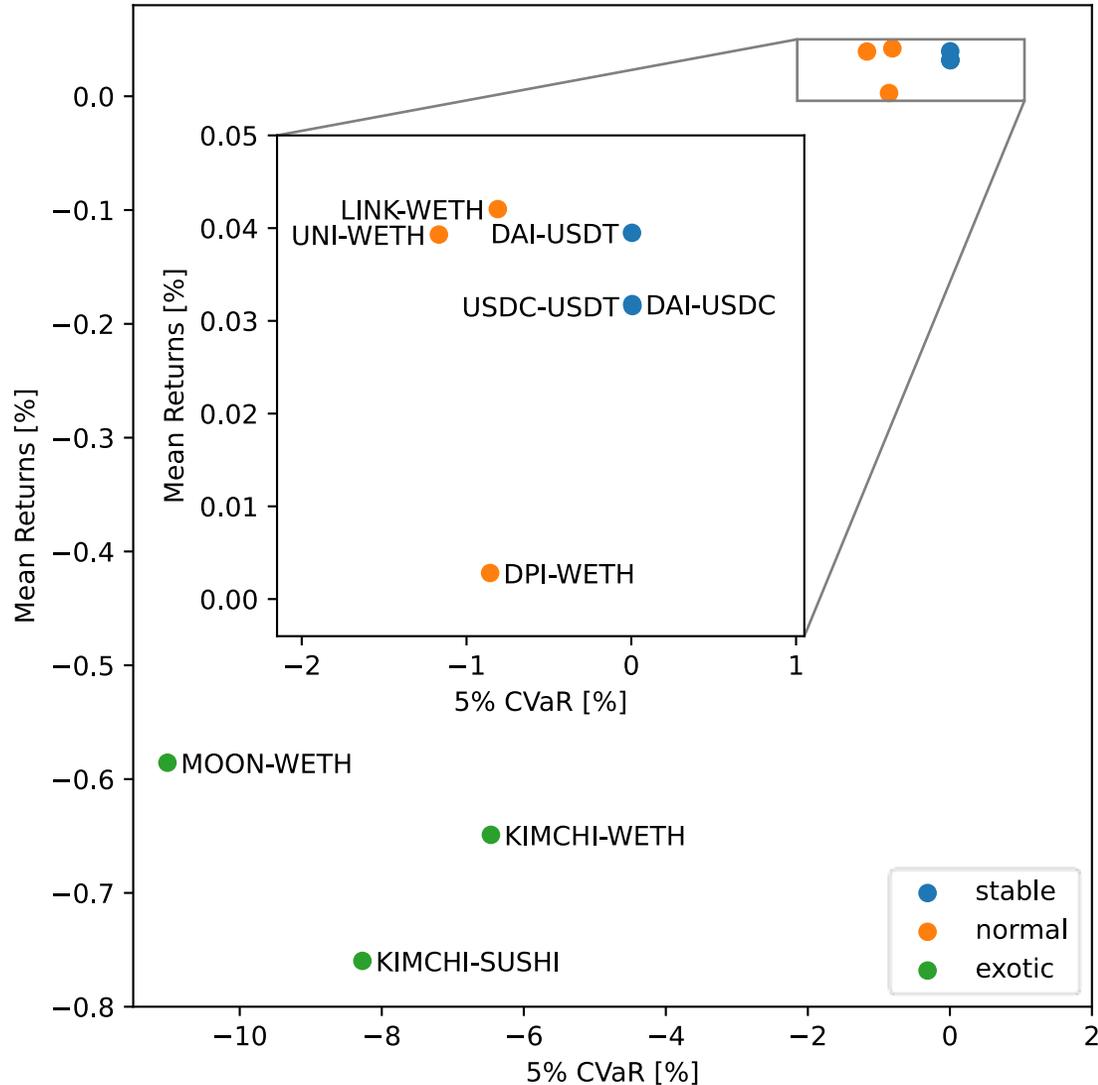


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exotic pairs are an unattractive investment

# Conditional value at risk



conditional value at risk (CVaR) quantifies tail behavior of an investment

CVaR at 5% level is the expected return on an investment in the worst 5% of cases

exotic pairs are an unattractive investment

stable and normal pairs may provide attractive opportunities

# Outlook: Uniswap V3

## fee tiers

- **0.05% fee tier:** best for stable pairs
- **0.3% fee tier:** best for most pairs
- **1.0% fee tier:** best for exotic pairs

# Outlook: Uniswap V3

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## concentrated liquidity

- liquidity providers choose price range  $[p_a, p_b]$  in which they would like to provide liquidity

# Outlook: Relay services

private transactions

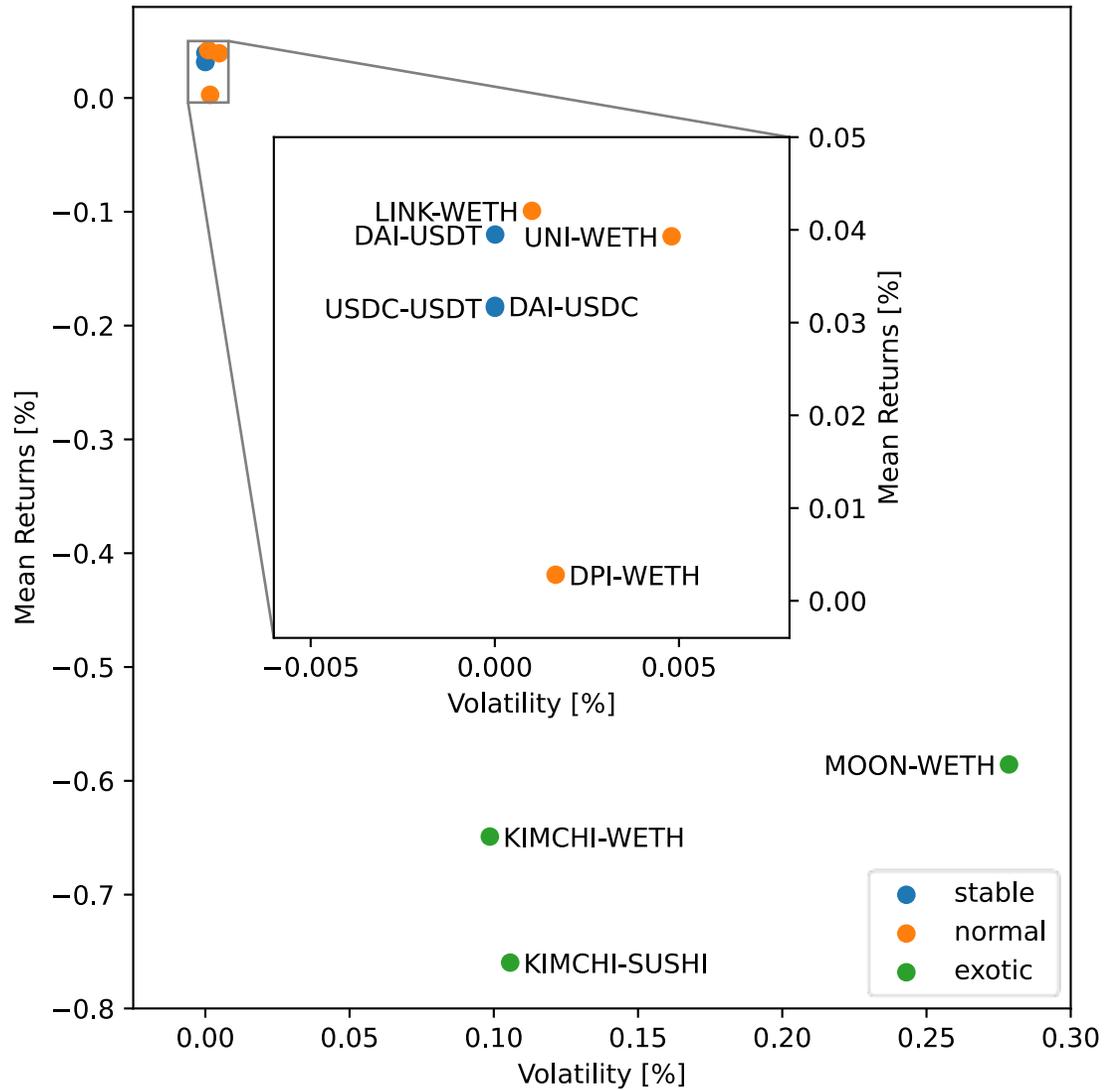
- dependent on level of adoption unexpected slippage higher or lower for traders
- affects liquidity provider returns

Thank You!  
Questions & Comments?



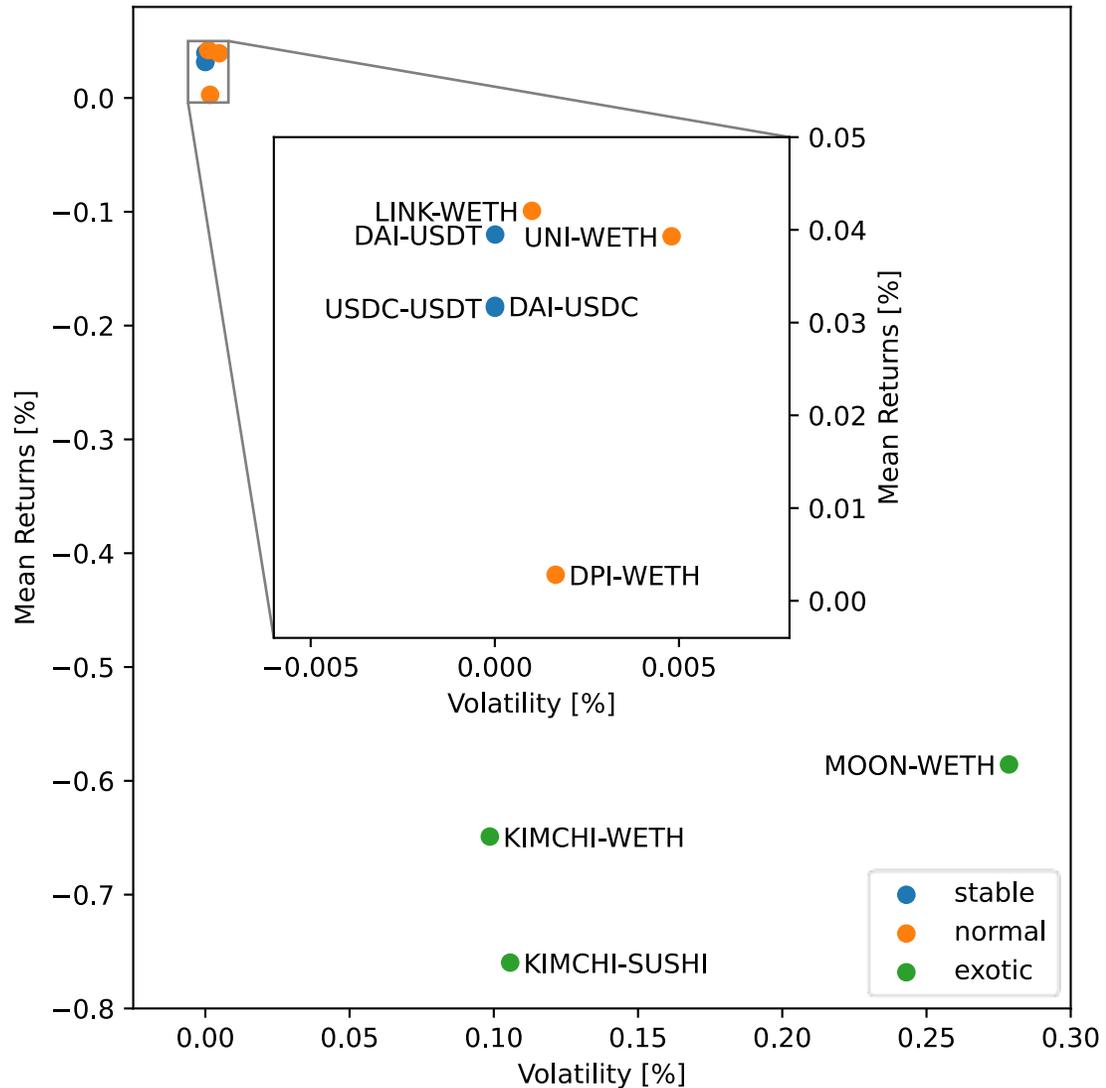
**Lioba Heimbach**, Ye Wang, Roger Wattenhofer  
ETH Zurich – Distributed Computing – [www.disco.ethz.ch](http://www.disco.ethz.ch)

# Volatility



volatile returns generally present greater risks to investors

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