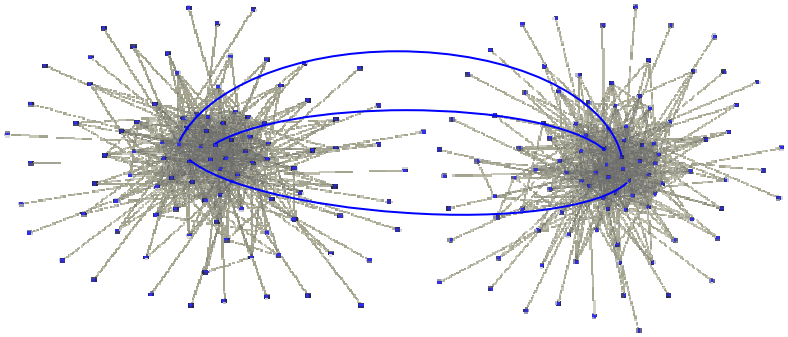
Performance and resilience to liquidity disruptions in interdependent RTGS payment systems



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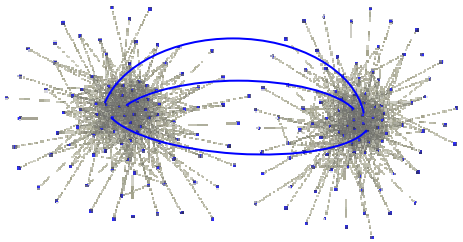
Joint Banque de France / European Central Bank conference on "Liquidity in interdependent transfer systems"
Paris, 9 June 2008

The views expressed in this presentation are those of the authors and do not necessarily reflect those of their respective institutions

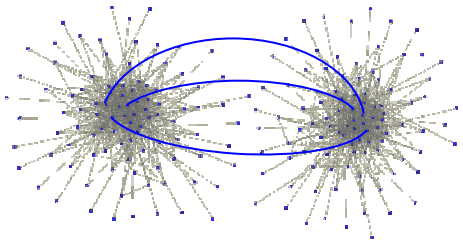


Motivation

- The 2001 Group of Ten *"Report on Consolidation in the Financial Sector"* (the Ferguson report) noted a possible increased interdependence between the different systems due to:
  - The emergence of global institutions that participate to many systems
  - The emergence of global service providers offering services to many systems
  - The development of DvP procedures linking RTGS and SSS
  - The development of CLS

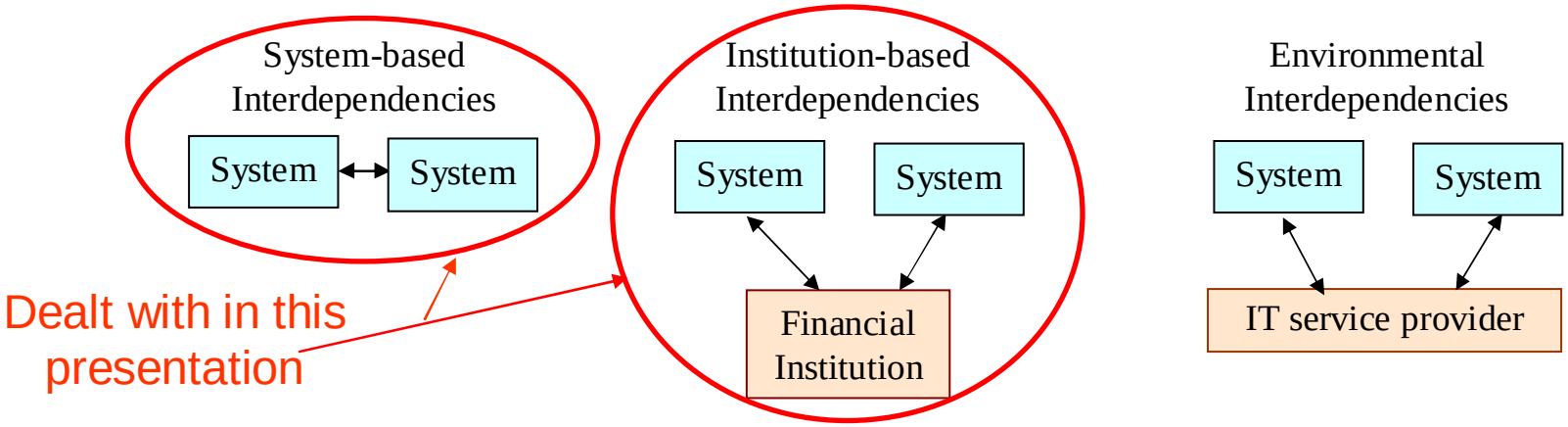
- The report suggested that these trends might accentuate the role of payment and settlement systems in the transmission of disruptions across the financial system.

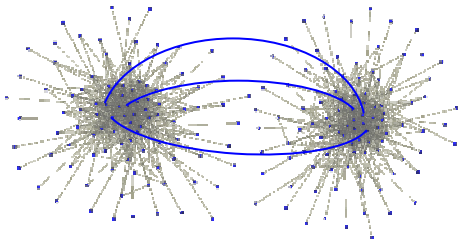
- To complement this previous work, the CPSS (Committee on Payment and Settlement Systems) commissioned a working group to:
  - describe the different interdependencies existing among the payment and settlement systems of CPSS countries
  - analyze the risk implications of the different interdependencies



Motivation

- Could a modeling approach provide any useful additional information to the regulators ?
- So far, payment and settlement system modeling has been mainly limited to a single system, with a few exceptions
- We want to model the interactions between two payment systems and understand how interdependencies arise
- We wish to understand how disruptions in one system manifest in the other

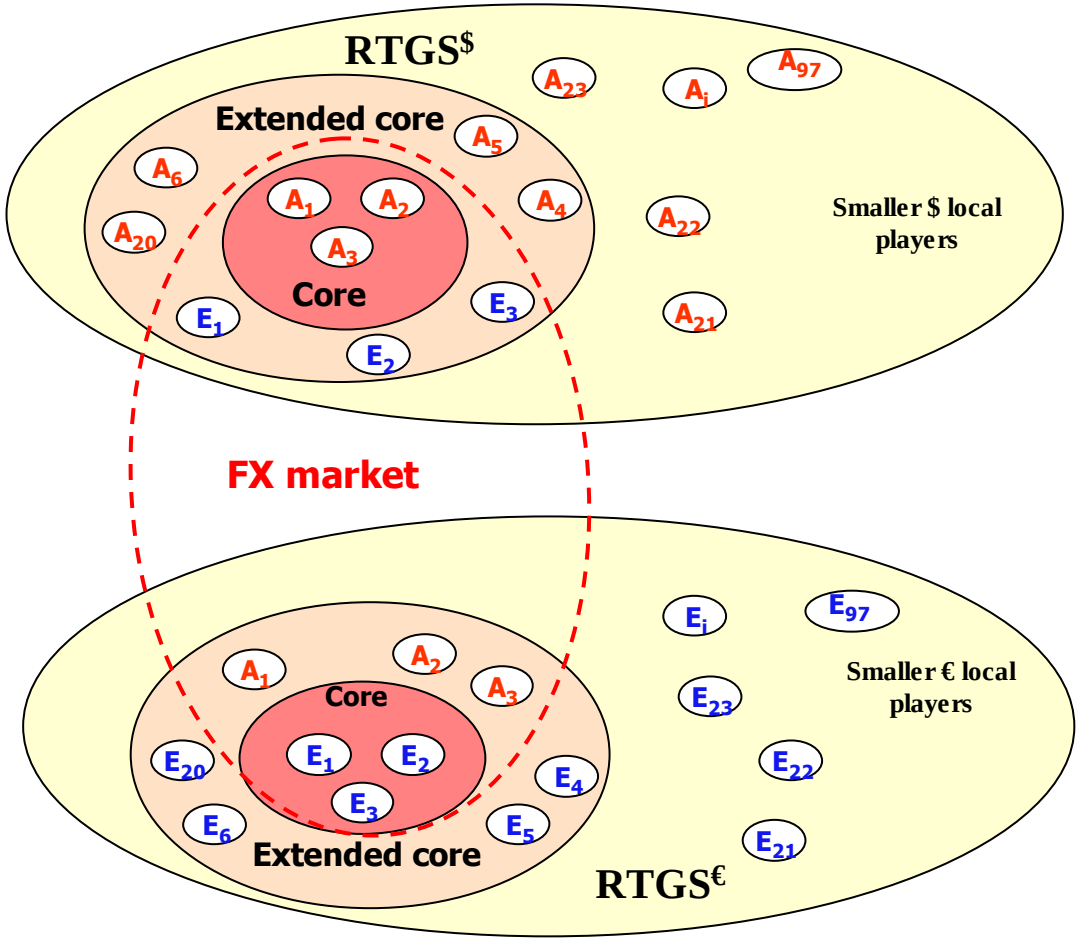




Coupled RTGS model

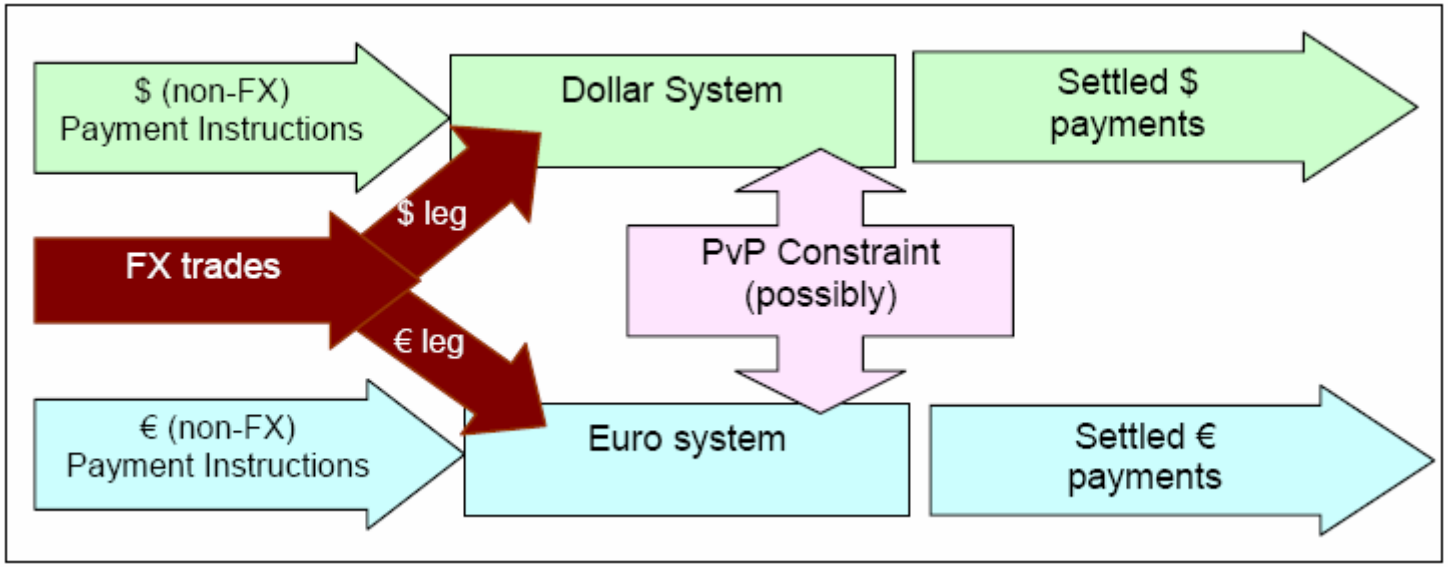
Model description

- Two RTGS systems in two different currencies: $ and €
- Both systems are similar in structure with 100 banks
- Six “global banks”. Top three banks in each system have a presence also in the other system
- The global banks make FX trades (at constant exchange rate) among each other
- All banks make local payments



Coupled RTGS model

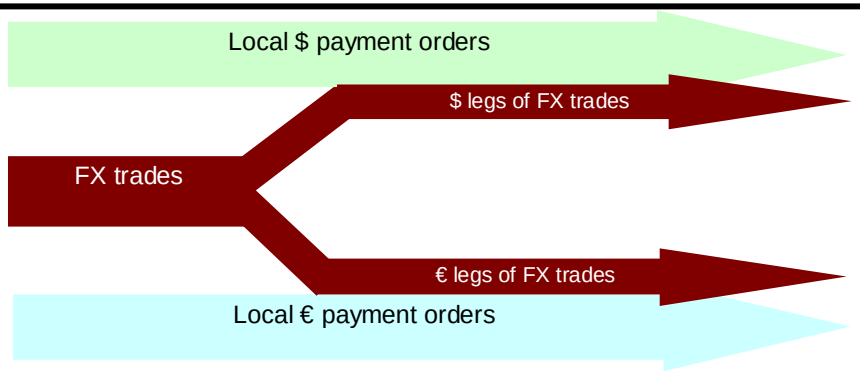
Model description



- Payment instructions arrive according to a non-homogenous Poisson process
  - intuition: customers who have received funds issue payments more frequently than bank customers who have already sent many payments
- FX trades arrival is similar as above, now taking into account balances in both currencies
  - E.g. banks with high euro positions are likely to sell euro and vice versa
- Those two systems are linked
  - Via the dual participation of some global banks that can make FX trades (institution-based interdependency)
  - Via a possible PvP (Payment versus Payment) constraint on the FX trades (system-based interdependency), the alternative being a non-PvP settlement

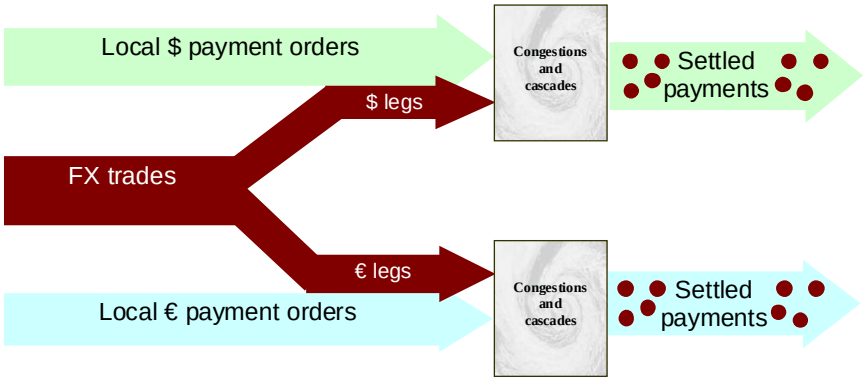
Correlation dynamics

High liquidity
PvP or non-PvP



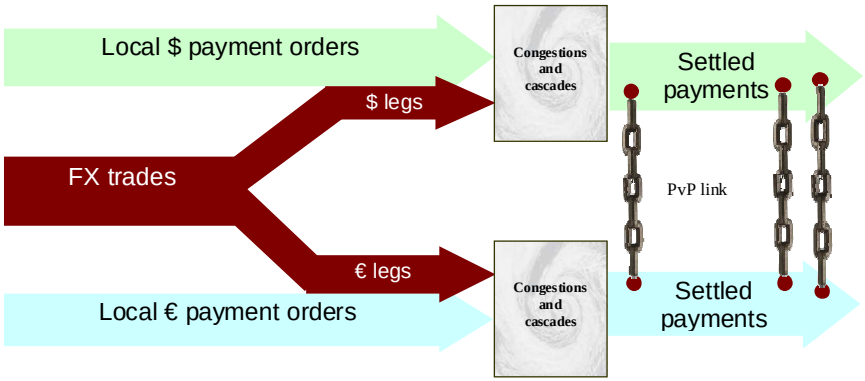
Correlation: 0.22
(institution-based interdependency)

Low liquidity
non-PvP

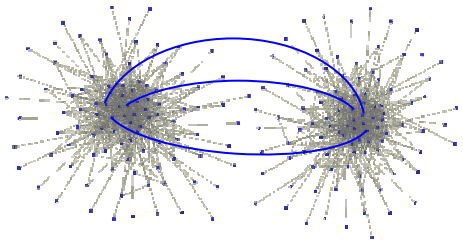


Correlation: -0.02
(none)

Low liquidity
PvP

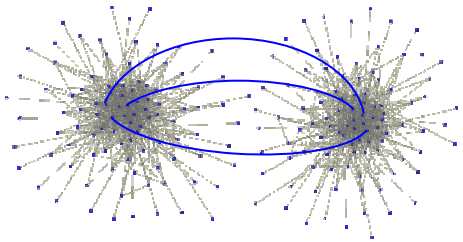


Correlation: 0.83
(system-based interdependency)



Summary of main results

- PvP
  - increases queues
  - eliminates exposures
- Lower liquidity
  - increases queues
  - Increases exposures (in case of non-PvP)
- Liquidity differences in the two systems
  - Reducing liquidity in one system increases queuing in the other (in case of PvP)
  - Banks selling the more liquid currency face higher exposures (in case of non-PvP)
- Higher priority for FX trades
  - Decreases queues in the more liquid system (in case of PvP)
  - Does not affect queues when both systems have same liquidity
  - Substantially reduces exposures (in case of non-PvP)



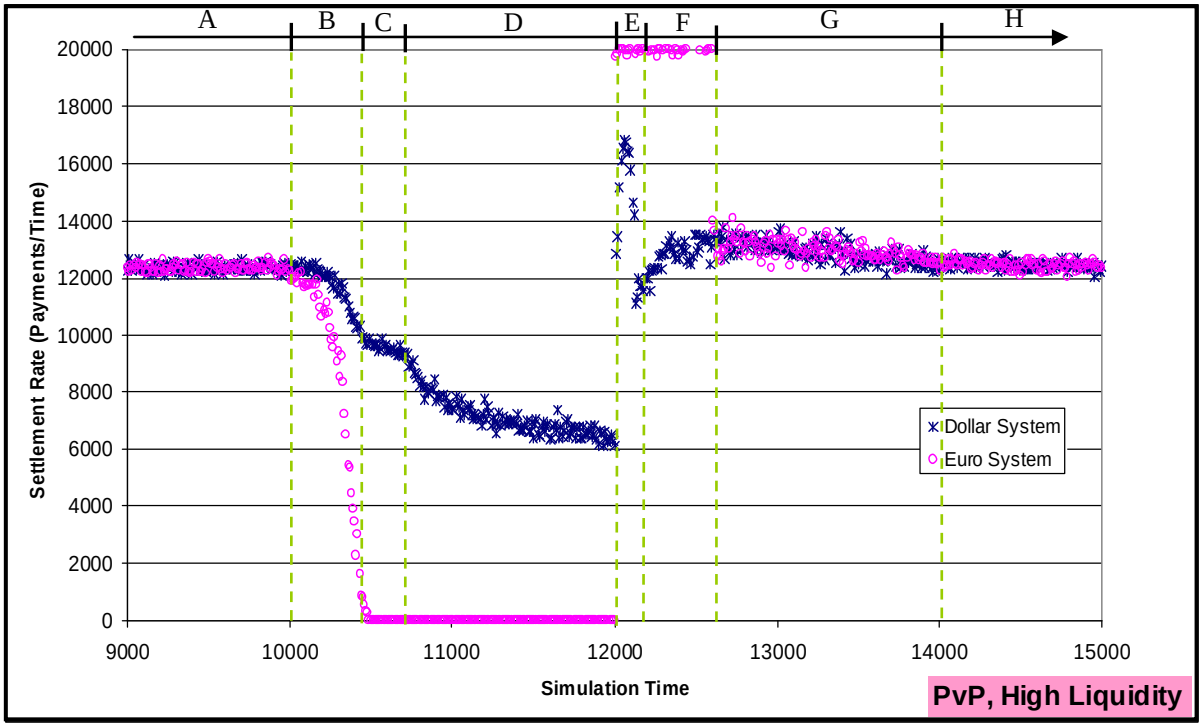
Operational disruption

- An operational disruption affects a significant local € bank
  - The affected bank does not participate in RTGS $, nor engage in FX transactions
  - The affected bank is unable to submit its € local payments for a certain duration
  - The affected bank acts as a liquidity sink for RTGS €

- To which extent will the disruption affect RTGS $?
  - Four different cases:
    - PvP or non-PvP
    - High Liquidity or Low Liquidity (the same in both systems)

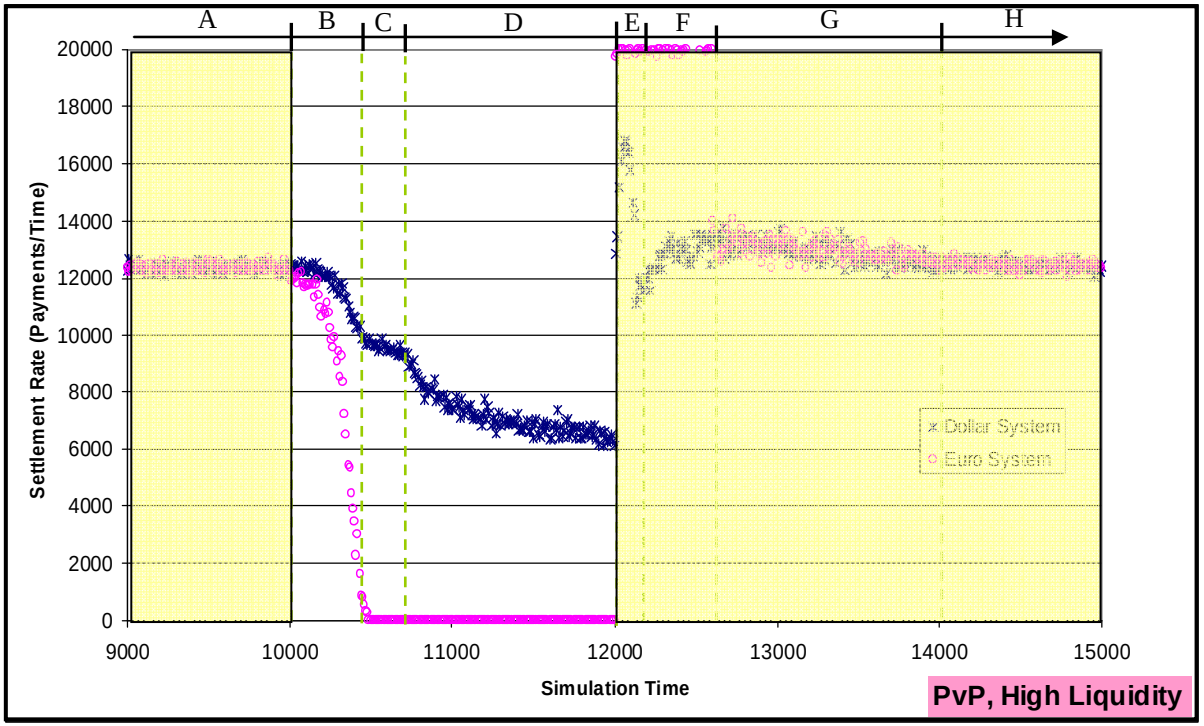
- What are the channels of propagation through which the crisis spreads from one RTGS to the other ?

Operational disruption



PvP High Liquidity

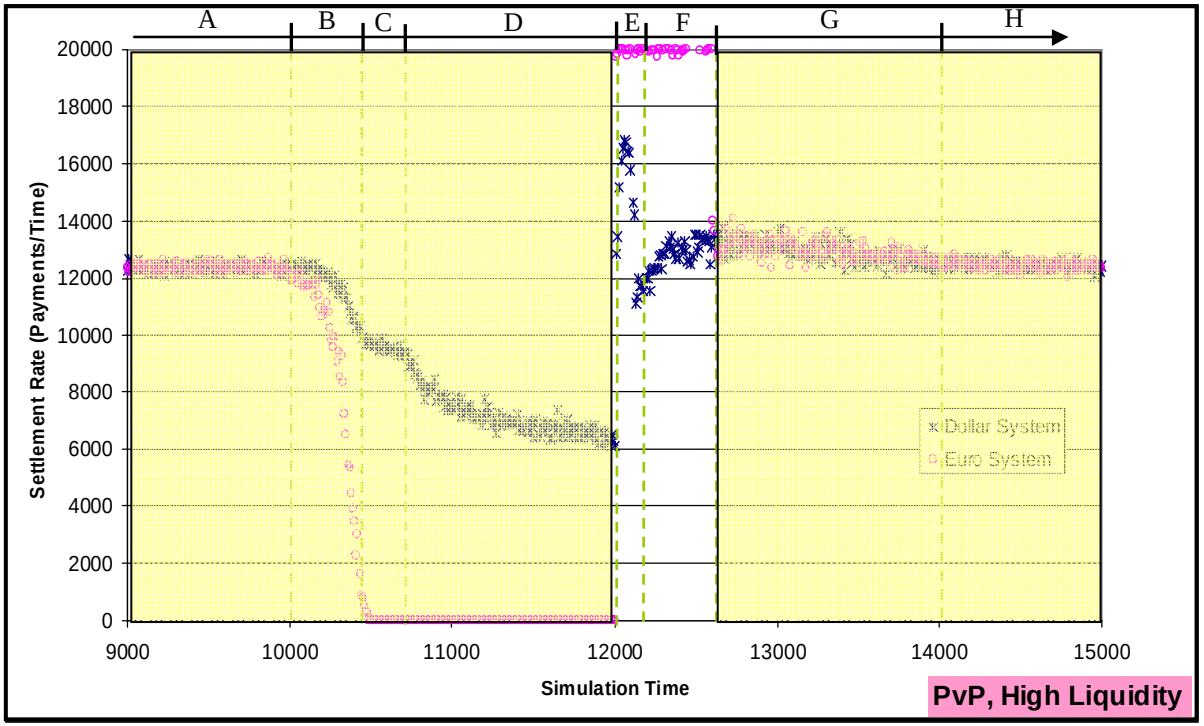
Operational disruption



PvP High Liquidity

- **Outage: settlement rate in RTGS $ decreases (-50 %)**

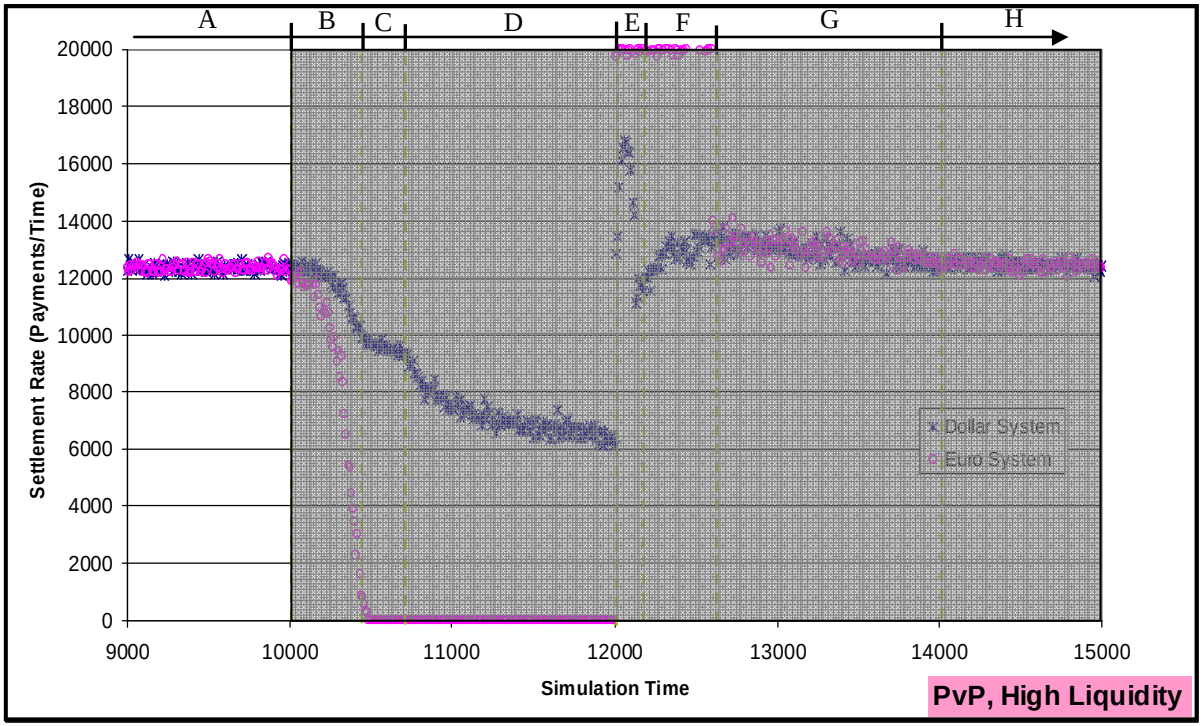
Operational disruption



PvP High Liquidity

- Outage: settlement rate in RTGS $ decreases (-50 %)
- **Recovery: settlement rate in RTGS $ overshoots**

Operational disruption



Period A

- Steady state

PvP High Liquidity

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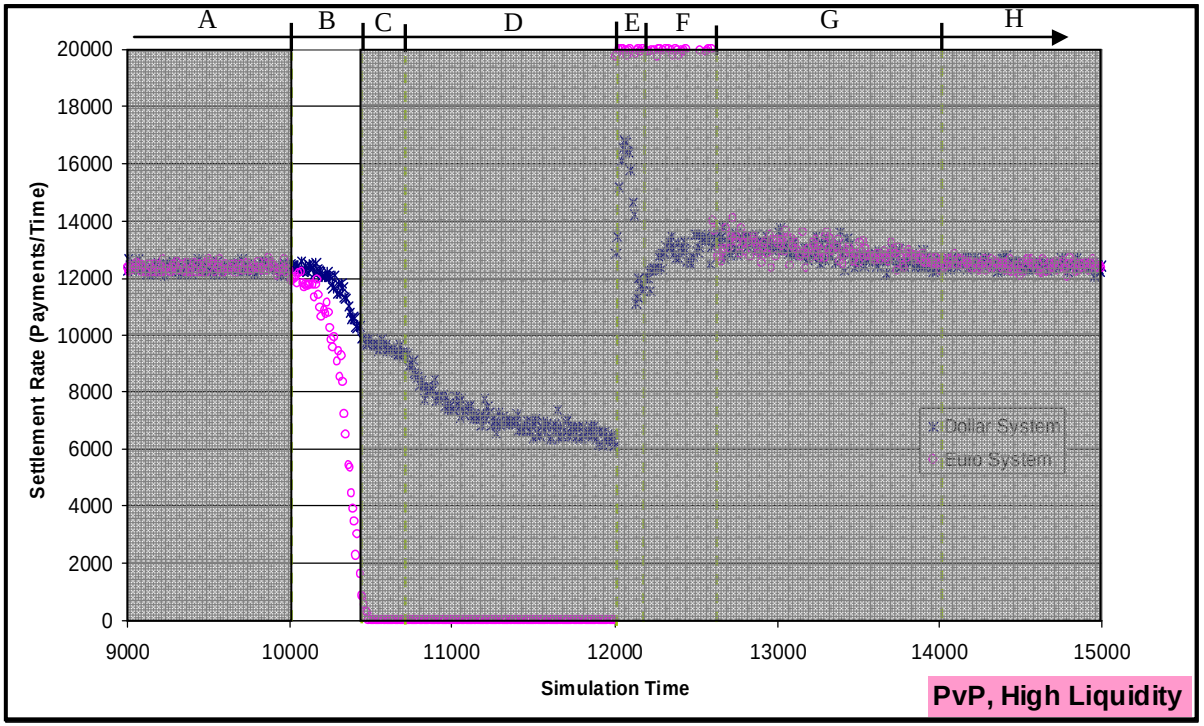
Operational disruption



Period A

- Steady state

Period B

- € balances vanish
- € local payments are queued
- Both legs of FX trades are queued, RTGS $ deprived of FX activity

PvP High Liquidity

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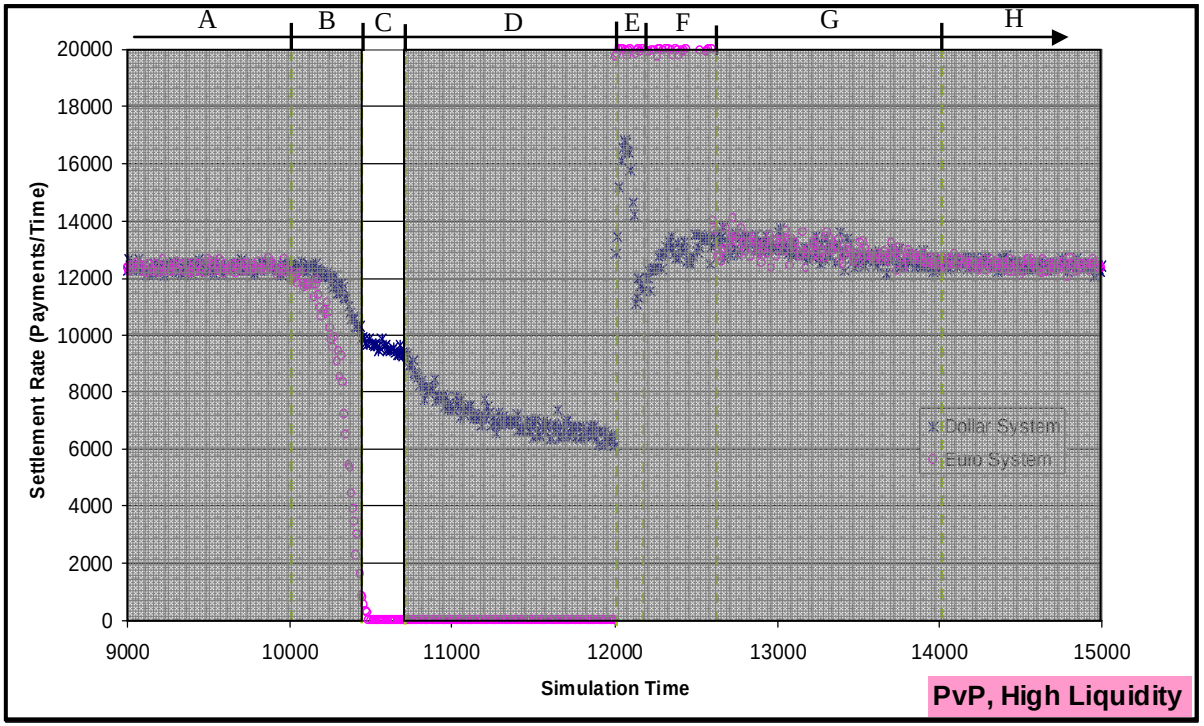
- Recovery: settlement rate in RTGS $ overshoots

Operational disruption



Period A

- Steady state

Period B

- € balances vanish
- € local payments are queued
- Both legs of FX trades are queued, RTGS $ deprived of FX activity

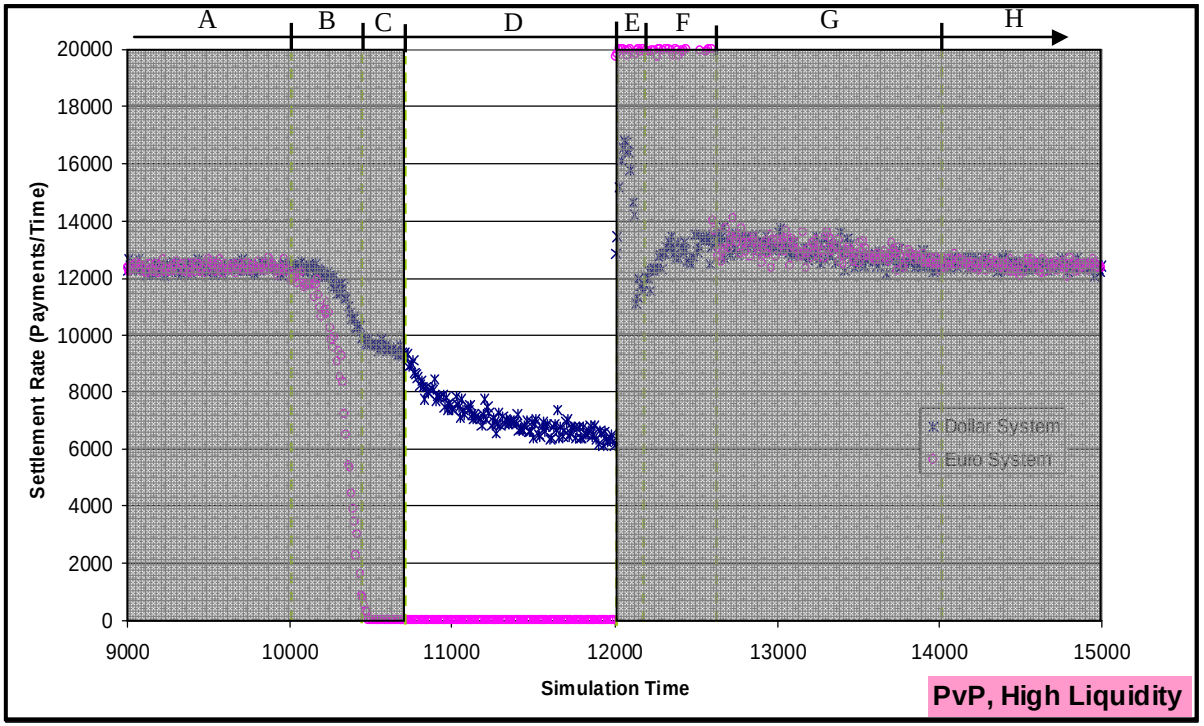
Period C

- RTGS $ down to local activity

PvP High Liquidity

- Outage: settlement rate in RTGS $ decreases (-50 %)
- Recovery: settlement rate in RTGS $ overshoots

Operational disruption



Period A

- Steady state

Period B

- € balances vanish
- € local payments are queued
- Both legs of FX trades are queued, RTGS $ deprived of FX activity

Period C

- RTGS $ down to local activity

Period D

- Because of the queuing of FX trades (PvP), customers have lower $ funds and make fewer $ local payments

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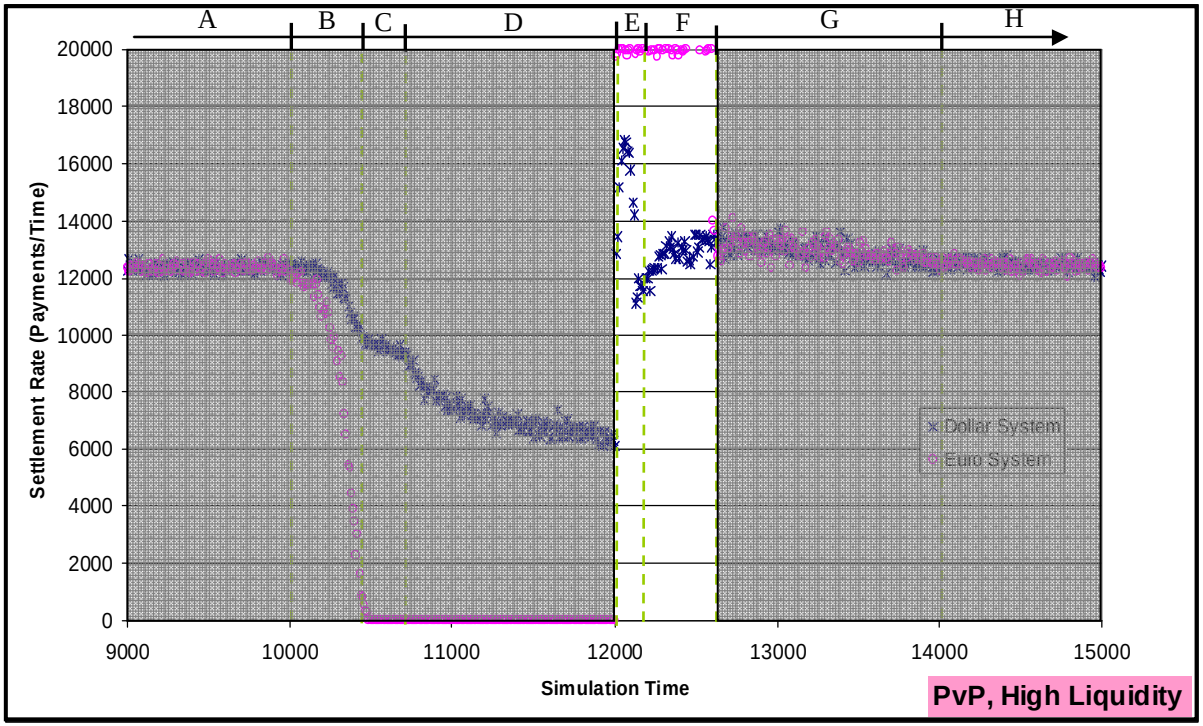
- Recovery: settlement rate in RTGS $ overshoots

Operational disruption



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Period C

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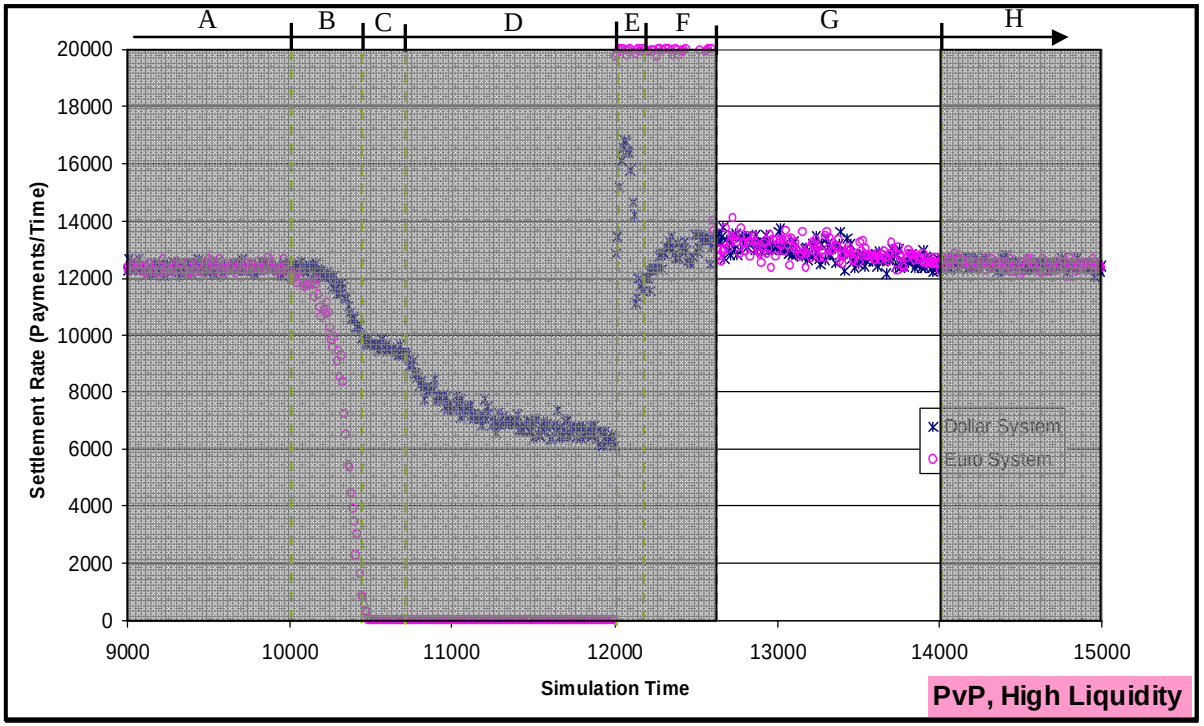
Period E-F

- Queued € local payments settle
- Queued FX trades settle

Operational disruption



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Period B

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- € local payments are queued
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Period C

- RTGS $ down to local activity

Period D

- Because of the queuing of FX trades (PvP), customers have lower $ funds and make fewer $ local payments

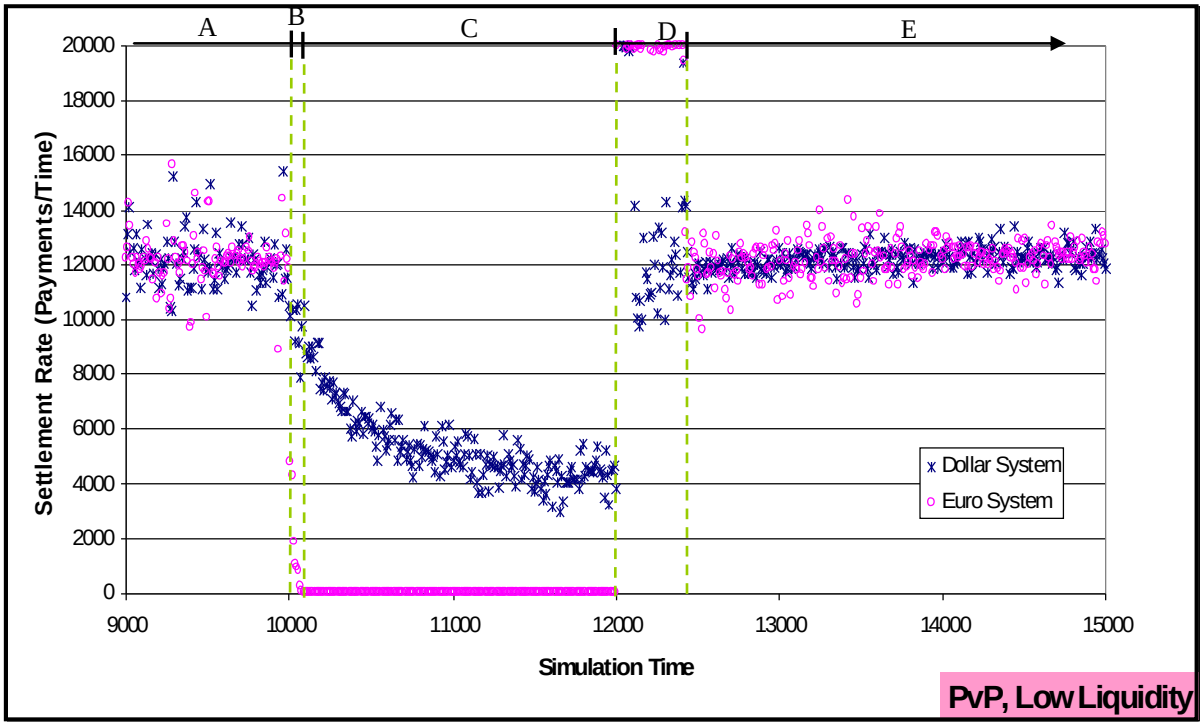
Period E-F

- Queued € local payments settle
- Queued FX trades settle

Period G

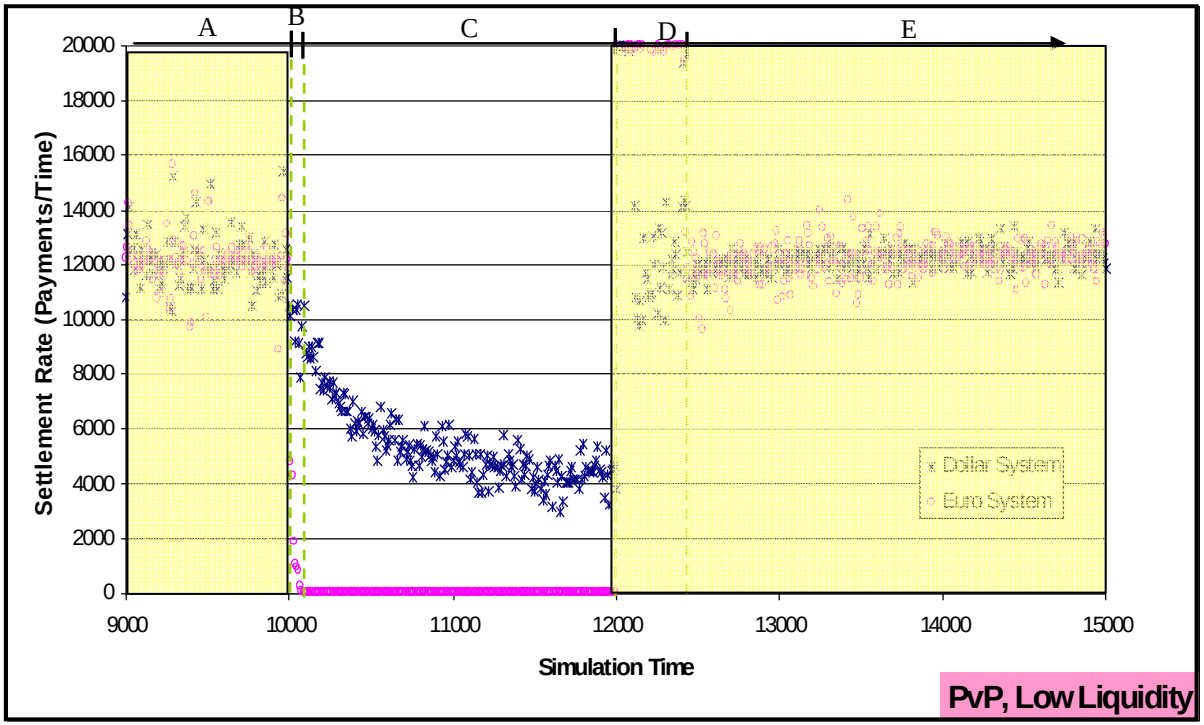
- Return to equilibrium generates extra trades

Operational disruption



PvP Low Liquidity

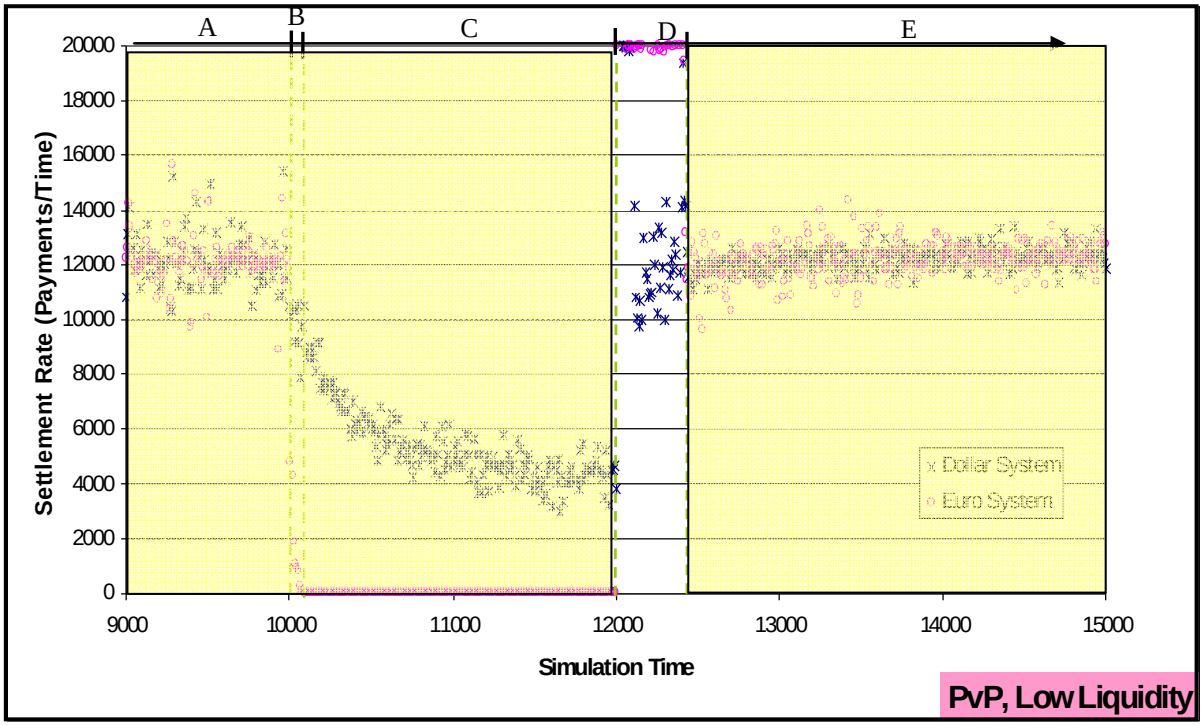
Operational disruption



PvP Low Liquidity

- **Outage: settlement rate in RTGS $ decreases (-65 %)**

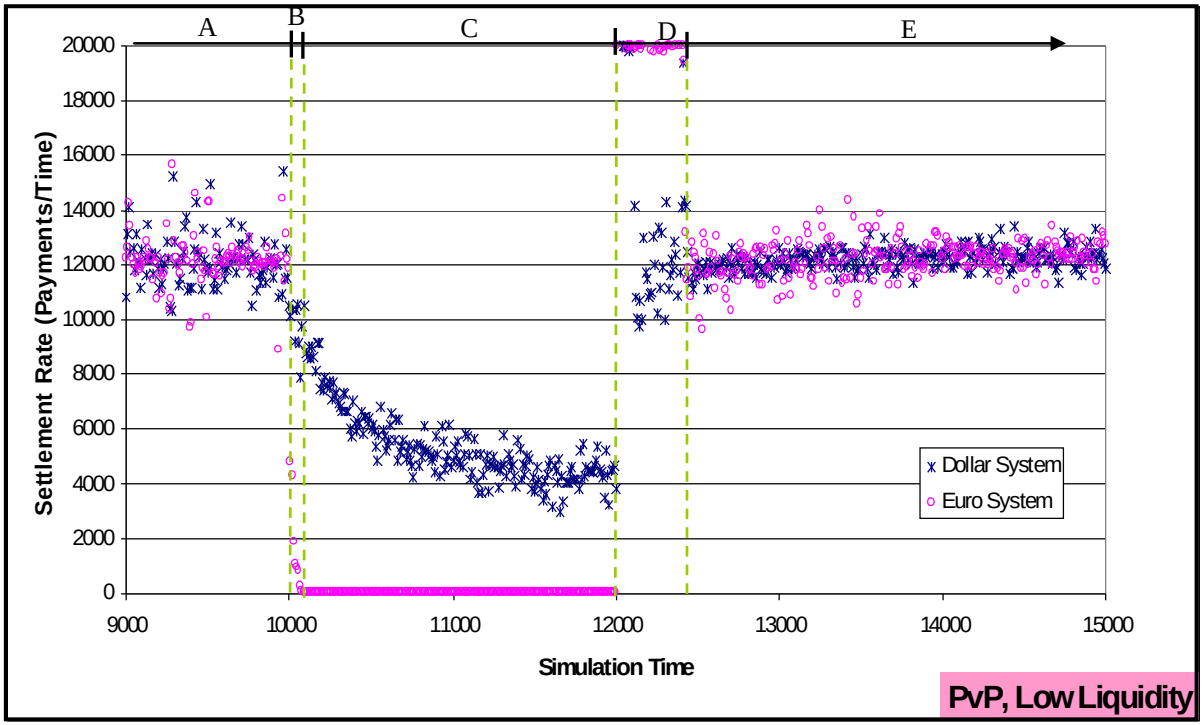
Operational disruption



PvP Low Liquidity

- Outage: settlement rate in RTGS $ decreases (-65 %)
- **Recovery: settlement rate in RTGS $ overshoots (reaches maximum rate)**

Operational disruption



PvP Low Liquidity

- Outage: settlement rate in RTGS $ decreases (-65 %)
- Recovery: settlement rate in RTGS $ overshoots (reaches maximum rate)

Period B

- € balances vanish
- € local payments are queued
- Both legs of FX trades are queued, RTGS $ deprived of FX activity

Period C

- The queuing of FX trades decreases $ deposits. Agents are uncertain about their $ position, fewer $ local payments emitted
- The distribution of $ deposits is brought out of equilibrium because of the disruption. In this low liquidity context, this causes $ local payments to be queued

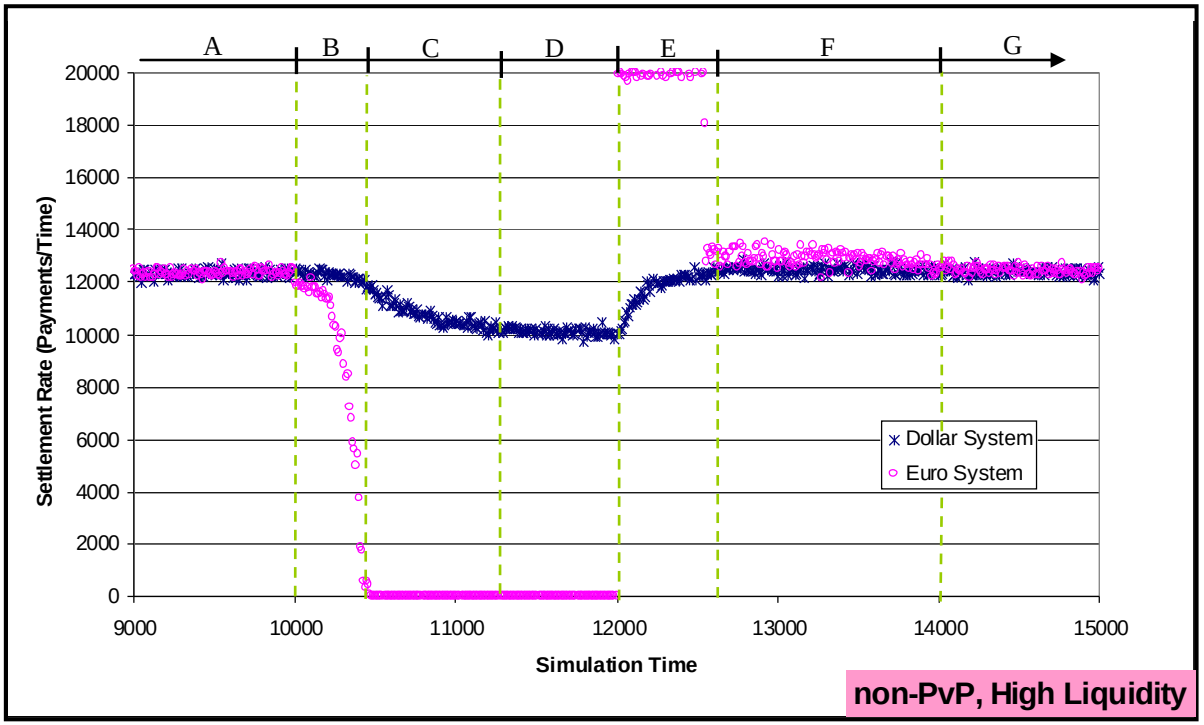
Period D

- Queued € local payments settle
- Queued FX trades settle
- Queued $ local payments settle

Period E

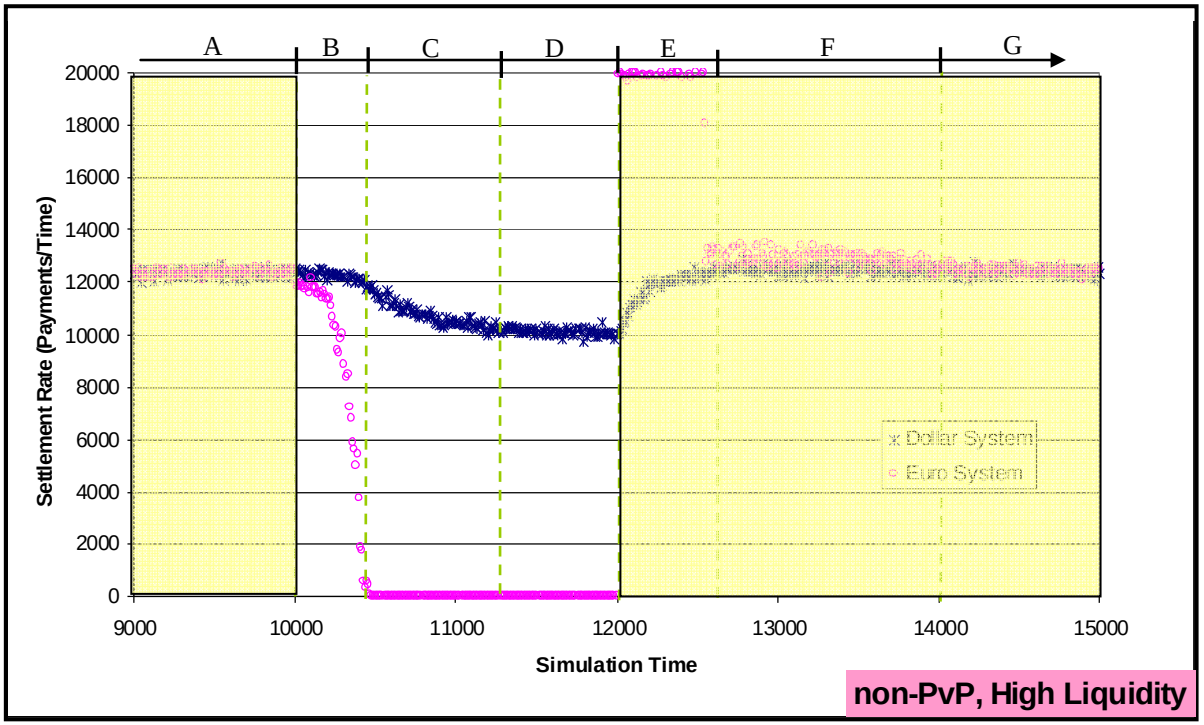
- Return to equilibrium marginally affects settlement rate

Operational disruption



Non-PvP High Liquidity

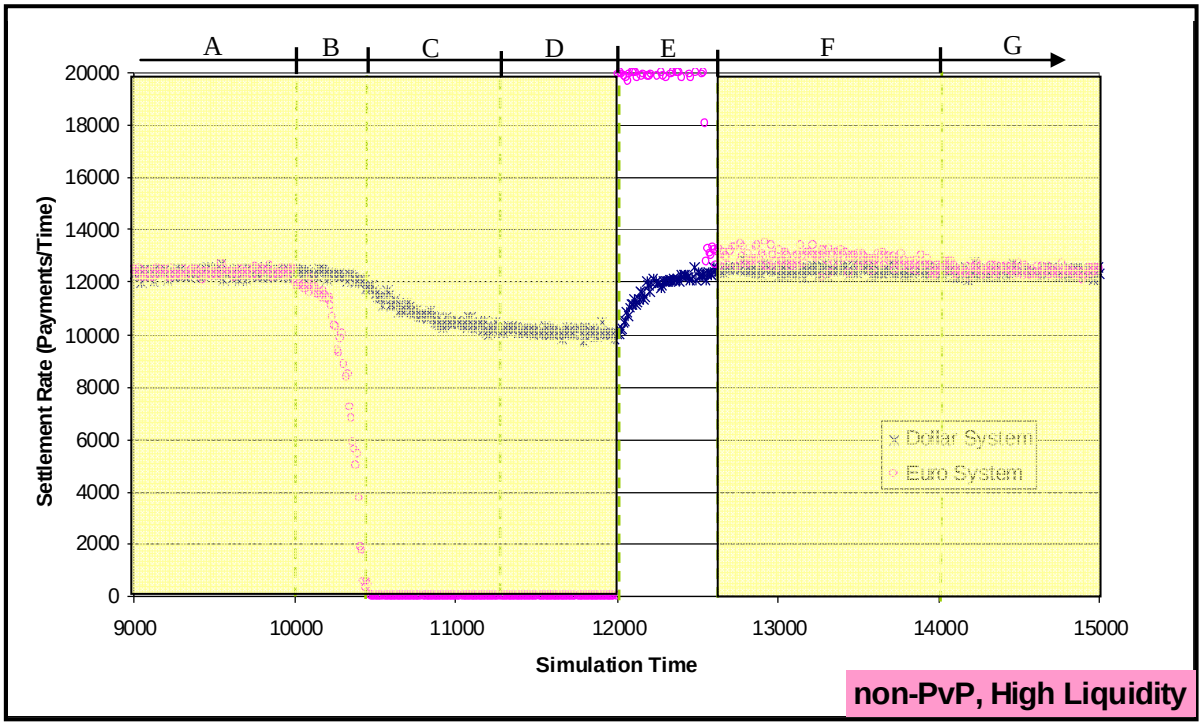
Operational disruption



Non-PvP High Liquidity

- **Outage: settlement rate in RTGS $ decreases (-17 %)**
- Recovery: no overshoot in RTGS $

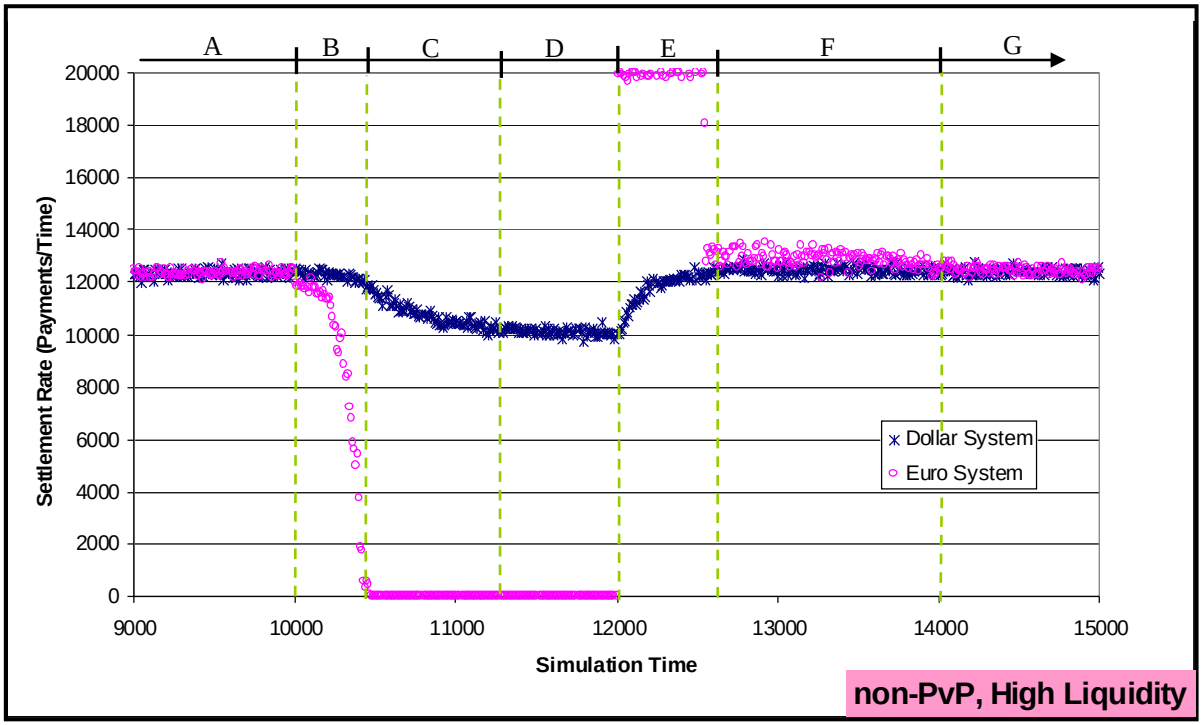
Operational disruption



Non-PvP High Liquidity

- Outage: settlement rate in RTGS $ decreases (-17 %)
- **Recovery: no overshoot in RTGS $**

Operational disruption



Non-PvP High Liquidity

- Outage: settlement rate in RTGS $ decreases (-17 %)
- Recovery: no overshoot in RTGS $

Period B

- € balances vanish
- € local payments are queued
- € leg of FX trades are queued
  $ leg of FX trades still settle

Period C

- The queuing of € local payments decreases € deposits. Agents are uncertain about their € position, fewer FX trades emitted. RTGS $ is deprived from FX activity

Period D

- Only local activity in RTGS $

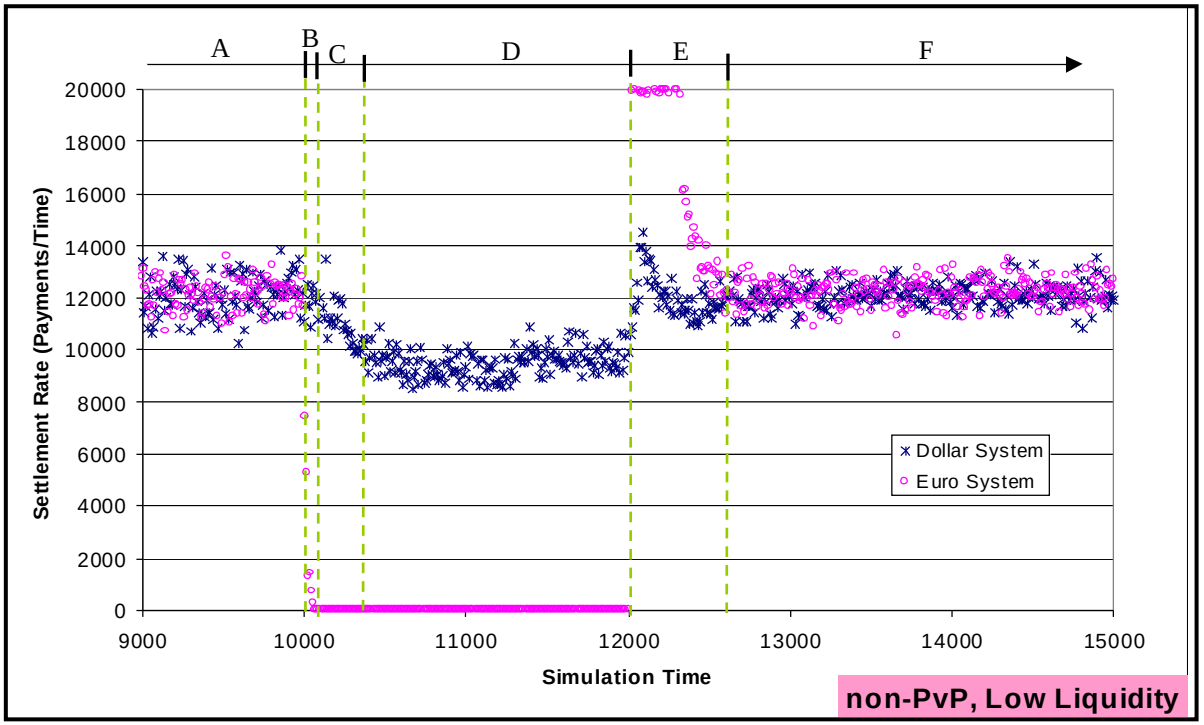
Period E

- Queued € local payments settle
- Queued € leg of FX trades settle

Period F

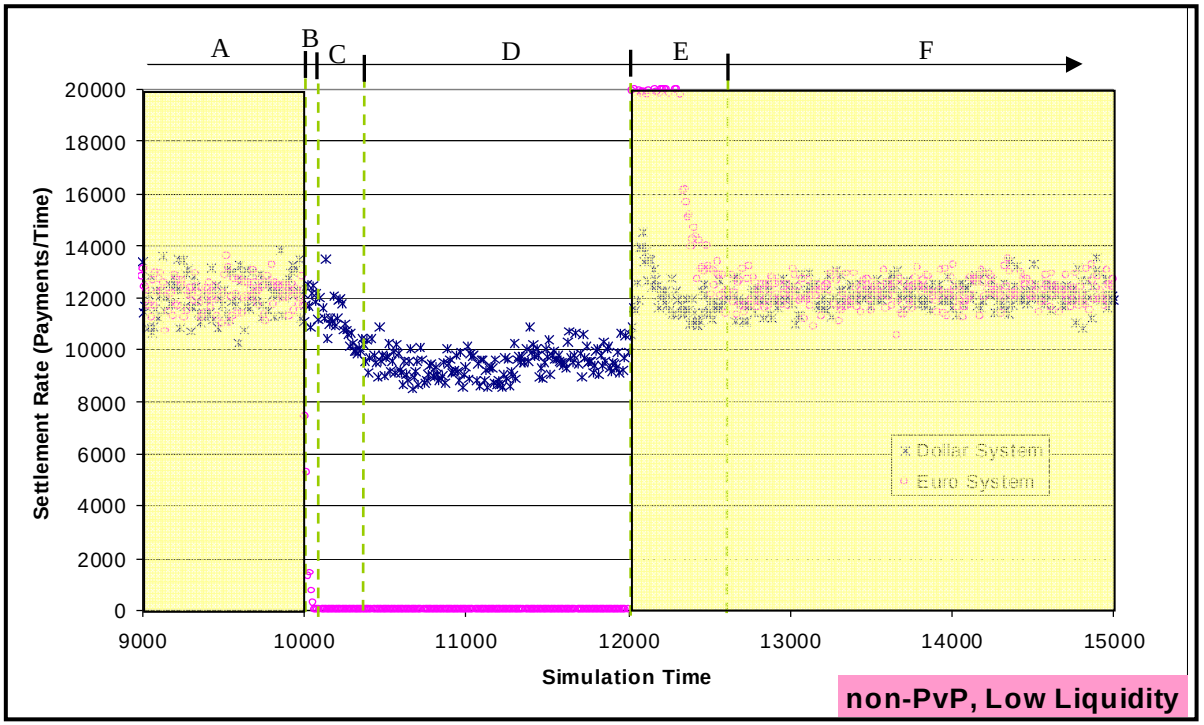
- Return to equilibrium generates extra trades

Operational disruption



Non-PvP Low Liquidity

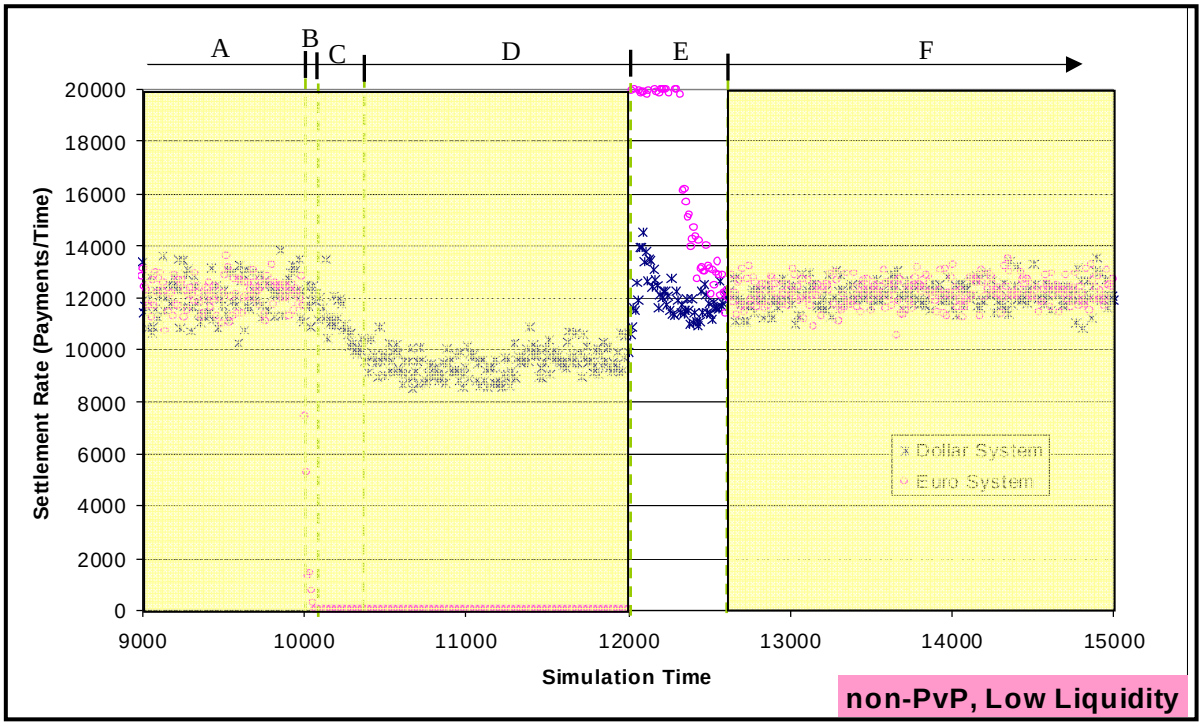
Operational disruption



Non-PvP Low Liquidity

- **Outage: settlement rate in RTGS $ decreases (-25 %)**

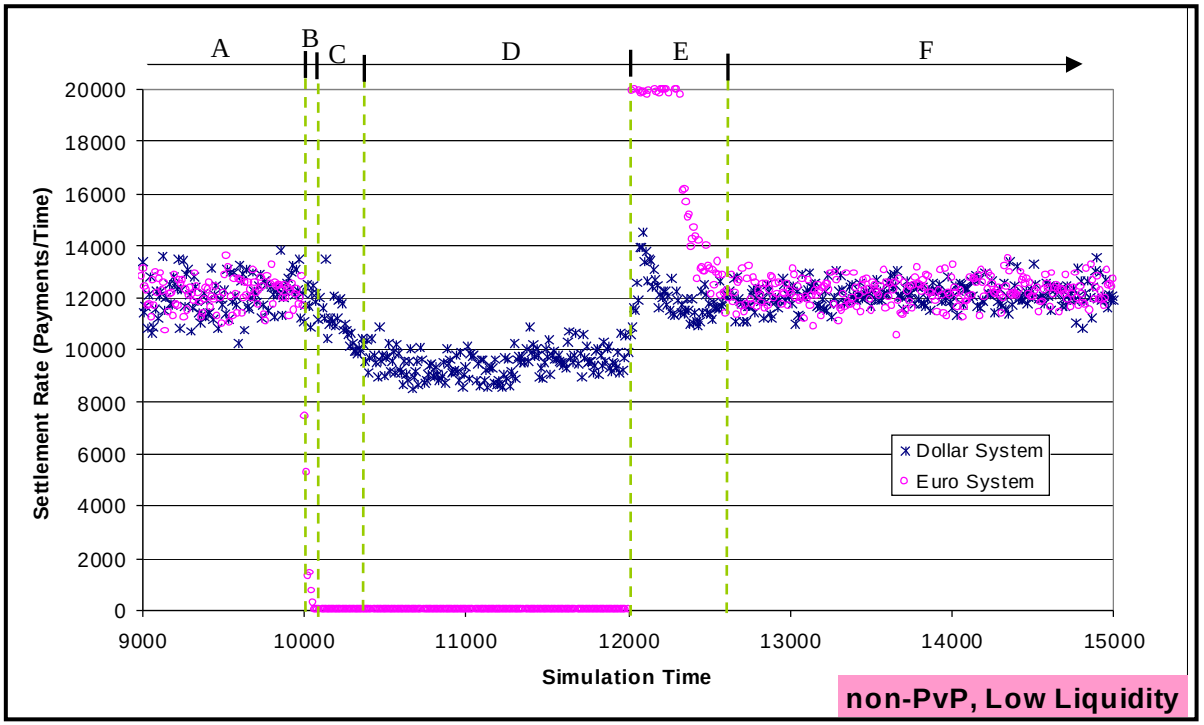
Operational disruption



Non-PvP Low Liquidity

- Outage: settlement rate in RTGS $ decreases (-25 %)
- **Recovery: settlement rate in RTGS $ overshoots**

Operational disruption



Non-PvP Low Liquidity

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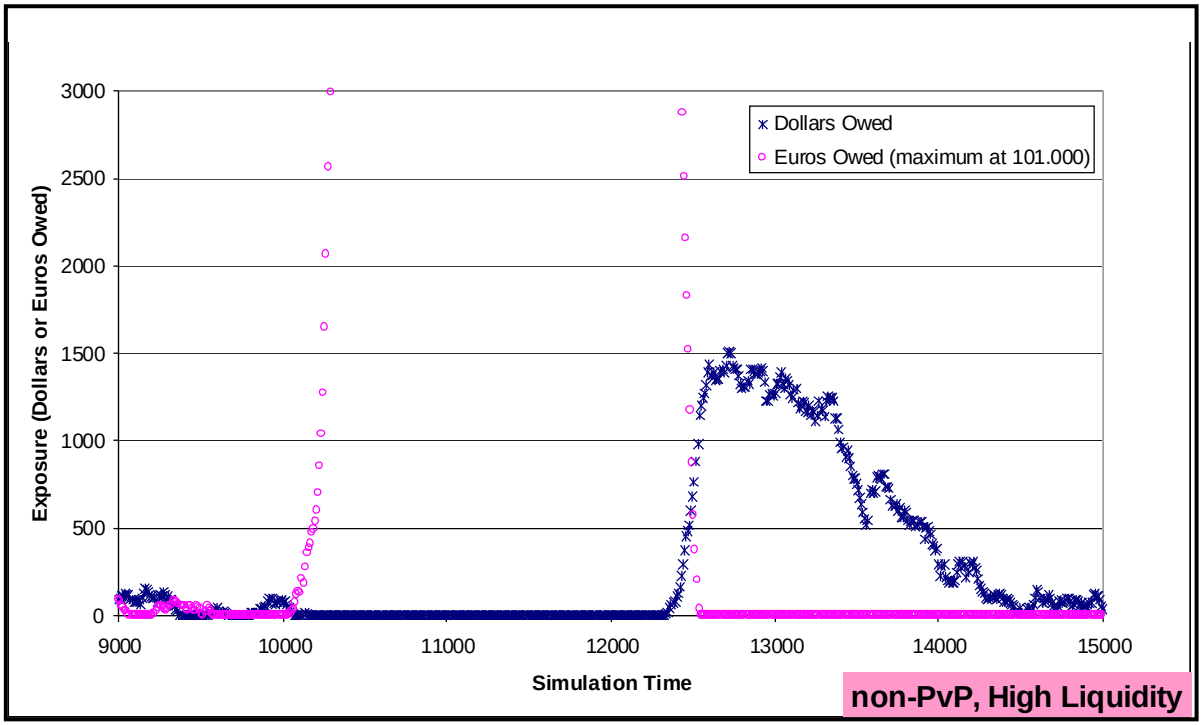
Period D

- Only local activity in RTGS $
- The distribution of $ deposits is brought out of equilibrium because of the disruption. In this low liquidity context, this causes $ local payments to be queued

Period E

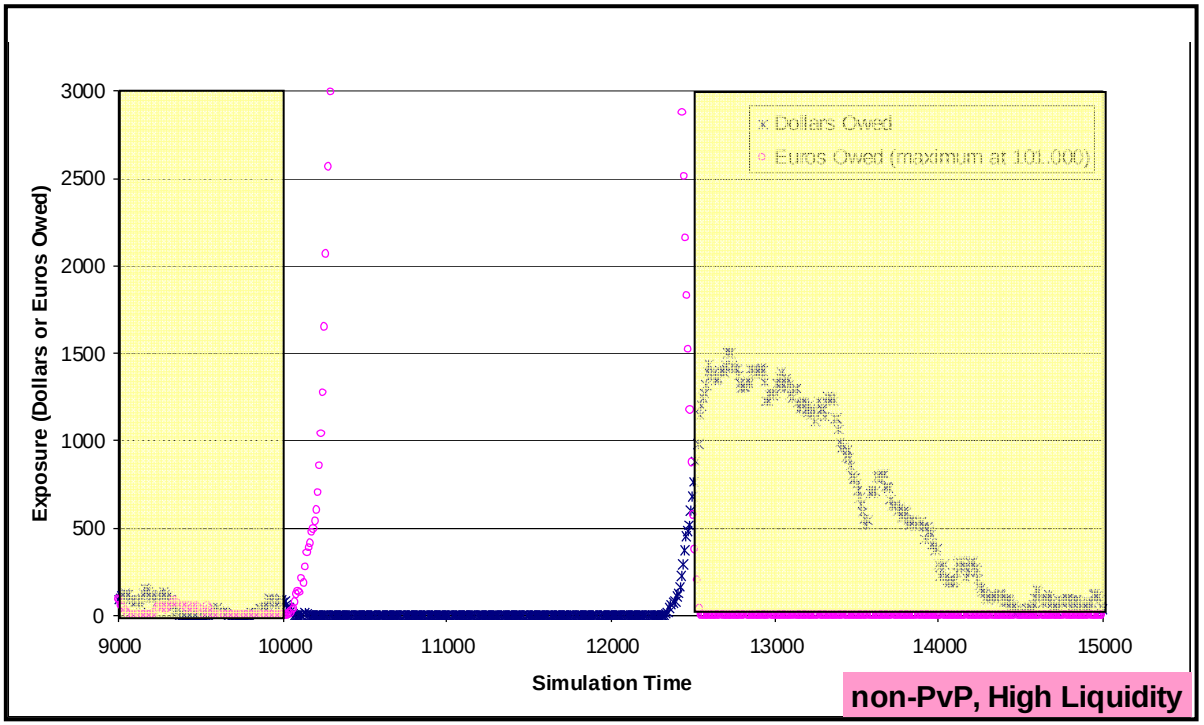
- Queued € local payments settle
- Queued FX trades settle
- Queued $ local payments settle

Operational disruption



Non-PvP High Liquidity, FX exposures

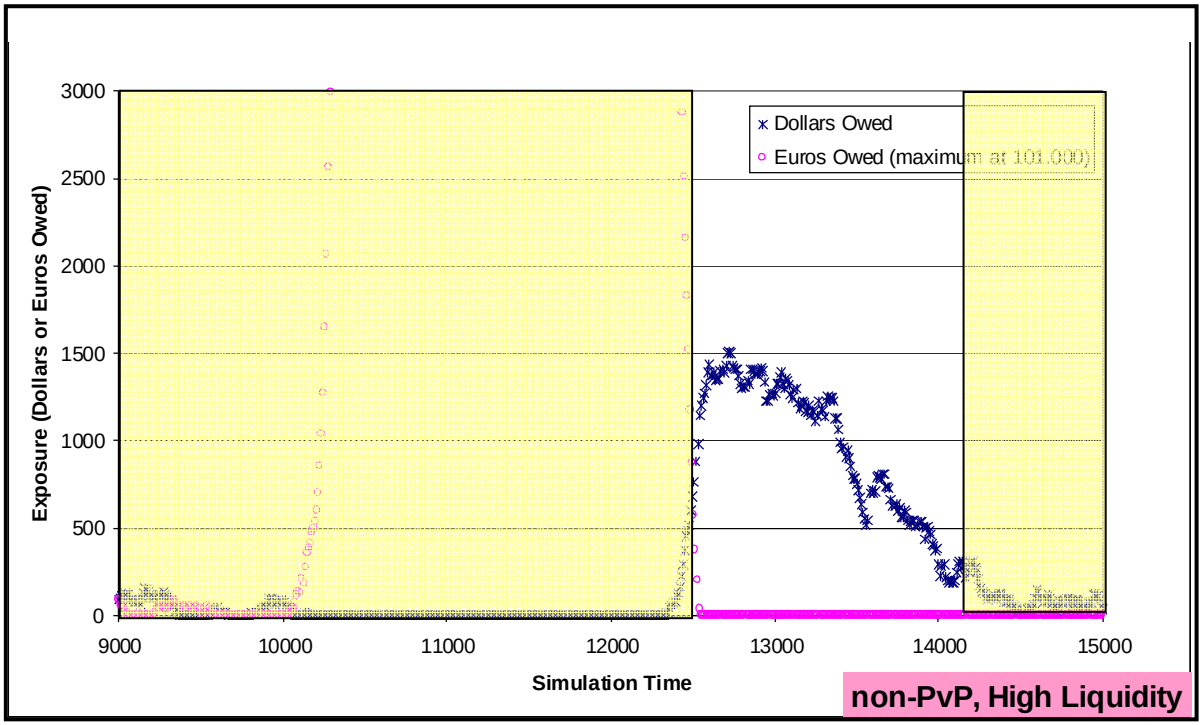
Operational disruption



Non-PvP High Liquidity, FX exposures

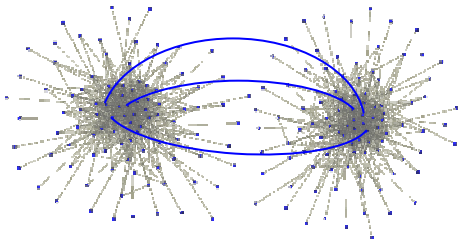
- **Outage: huge increase in € owed (1 000 times normal exposures)**

Operational disruption



Non-PvP High Liquidity, FX exposures

- Outage: huge increase in € owed (1 000 times normal exposures)
- **Recovery: large increase in $ owed (15 time normal exposure)**



Cross-currency channels of disruption propagation

- **Channel 1: Low € balances at the CB prevent settlement of € leg of FX transactions (PvP) or create FX exposures (non-PVP)**

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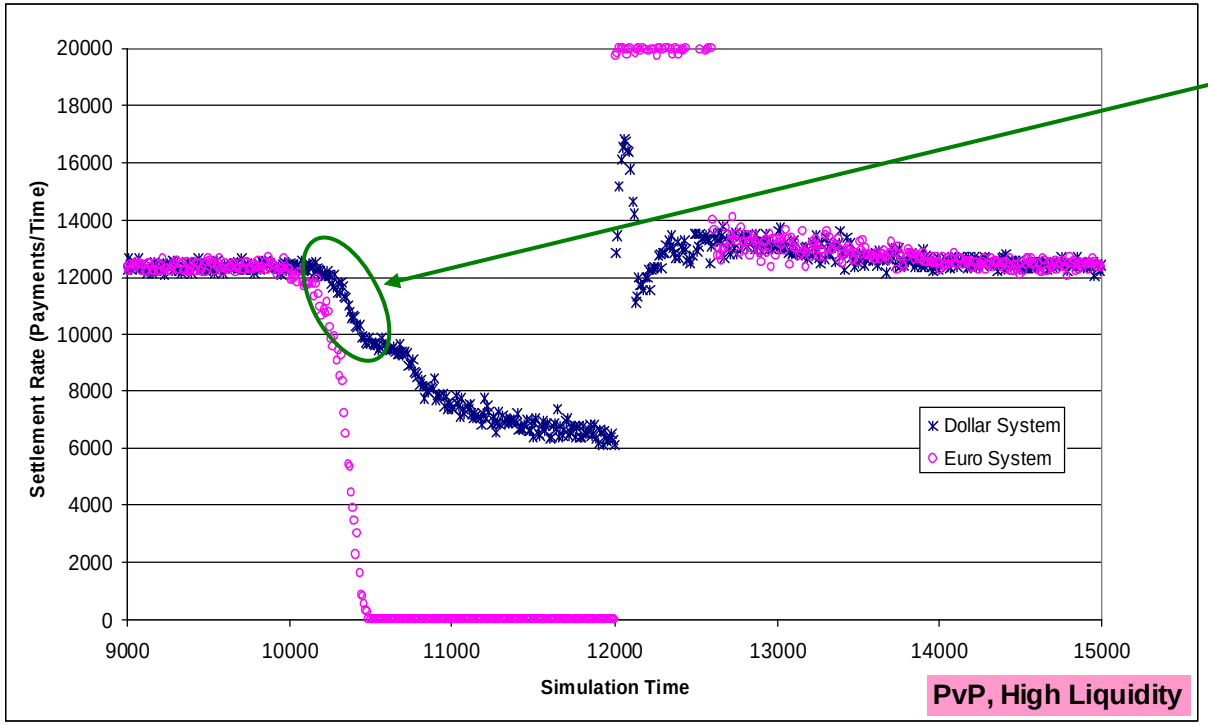

- PvP:
  - All FX settlement activity stops, RTGS $ is deprived from FX settlement activity

Cross-currency channels of disruption propagation

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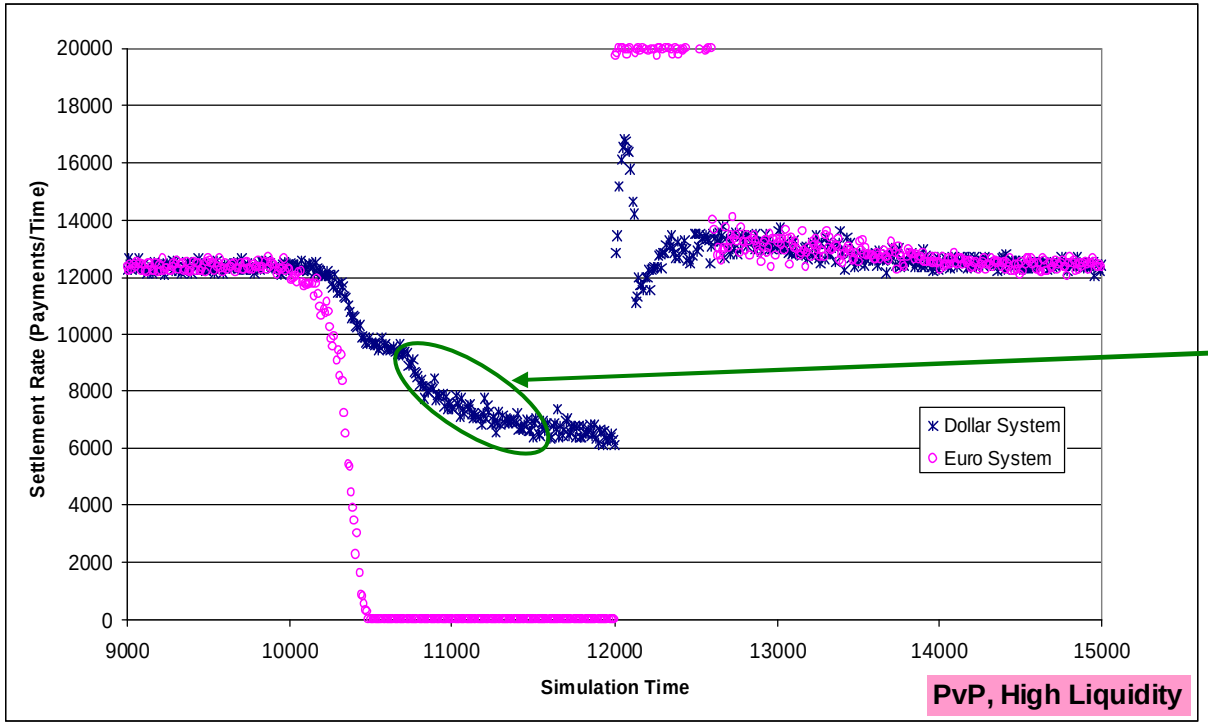
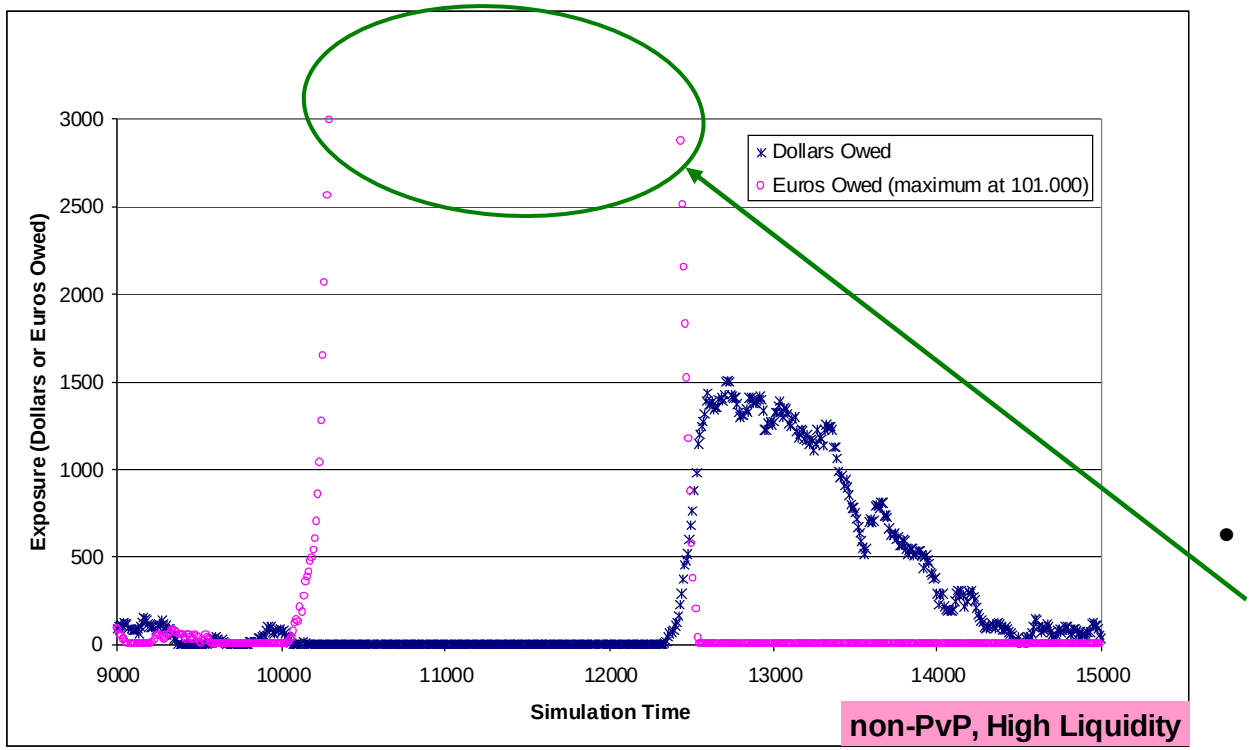


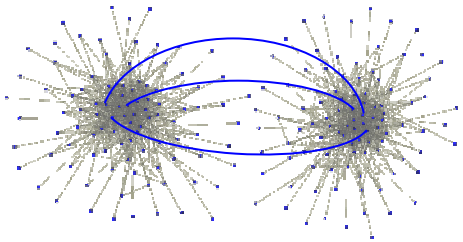
- PvP:
  - All FX settlement activity stops, RTGS $ is deprived from FX settlement activity
  - Because of the queuing of FX trades (PvP), customers have lower $ funds and make fewer $ local payments

Cross-currency channels of disruption propagation

- **Channel 1: Low € balances at the CB prevent settlement of € leg of FX transactions (PvP) or create FX exposures (non-PVP)**

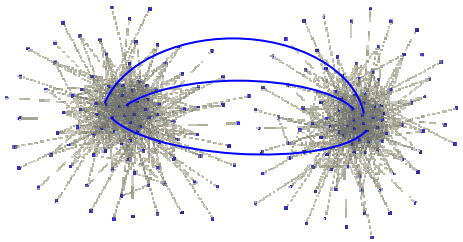


- PvP:
  - All FX settlement activity stops, RTGS $ is deprived from FX settlement activity
  - Because of the queuing of FX trades (PvP), customers have lower $ funds and make fewer $ local payments
- Non-PvP:
  - Very high exposures (unsettled € legs) during crisis



Cross-currency channels of disruption propagation

- **Channel 2: Low € customer funds lead to fewer emitted FX trades**
  - Banks customers' € liquidity is trapped within queued payments. Therefore, customers emit fewer FX trades



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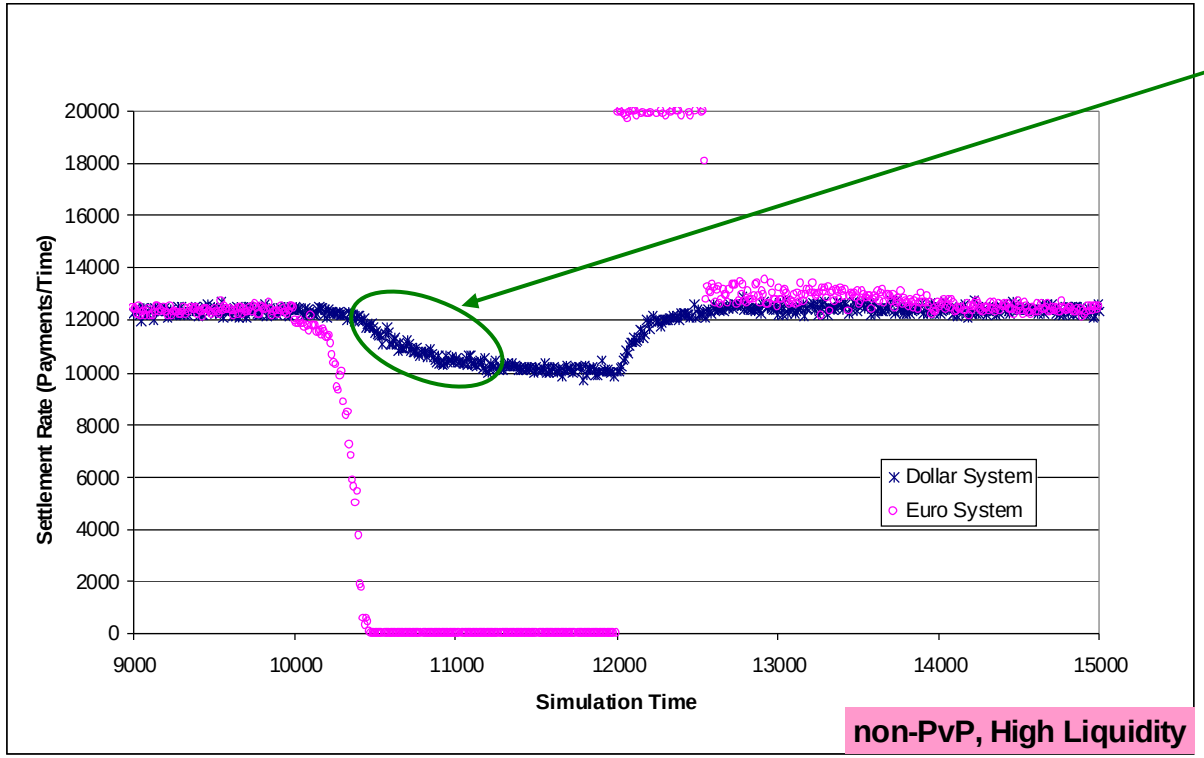
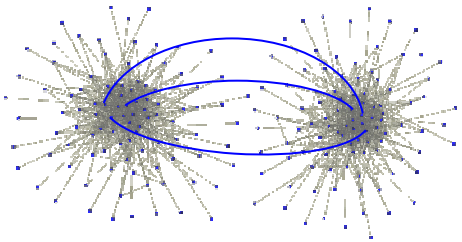
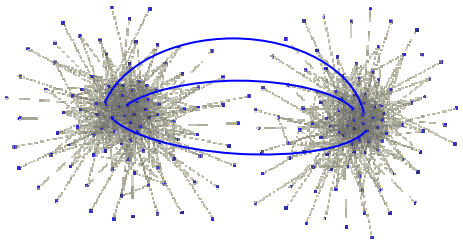


This leads to RTGS $ being eventually deprived of FX activity, even in the non-PvP case



Cross-currency channels of disruption propagation

- **Channel 3: As not all banks are similarly affected, the system becomes unbalanced**
  - The FX banks for which the disrupted bank is an important counterparty see their level of € customer funds decrease more rapidly.
  - These banks become net € buyers ($ sellers) on the FX market. RTGS $ becomes unbalanced.



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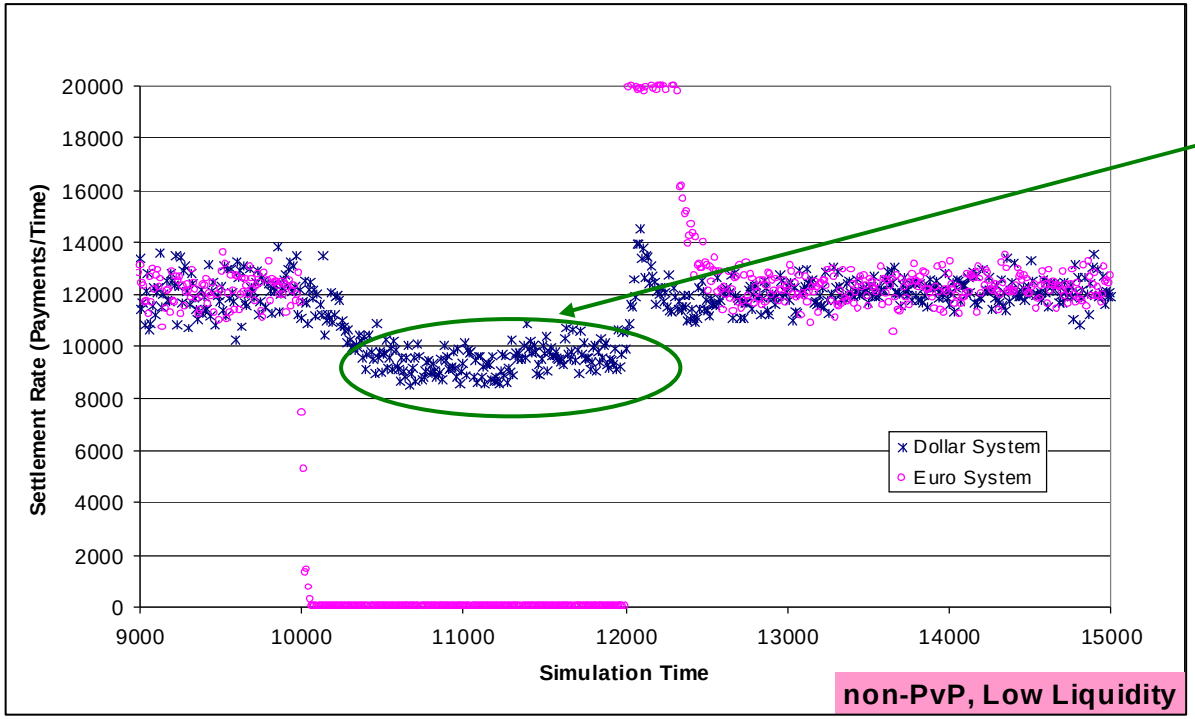
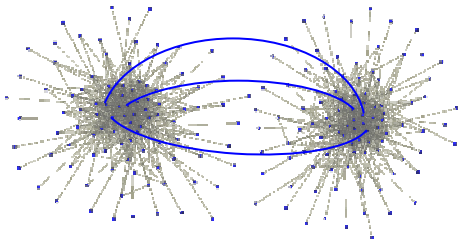


- Low Liquidity:
  - this leads to the queuing of several $ local payments, even in the non-PvP case…



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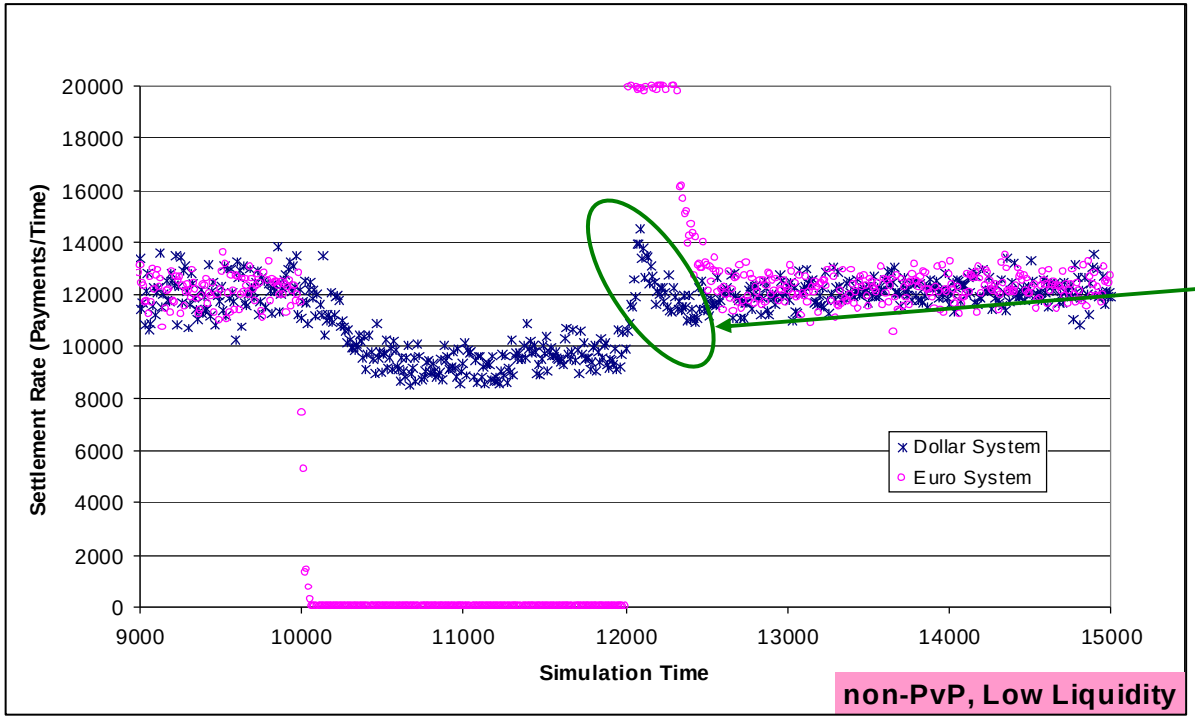
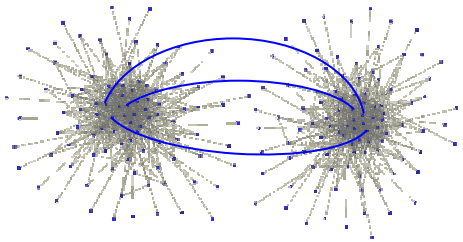


- Low Liquidity:
  - this leads to the queuing of several $ local payments, even in the non-PvP case…
  - And to an overshoot at recovery, even in non-PvP case



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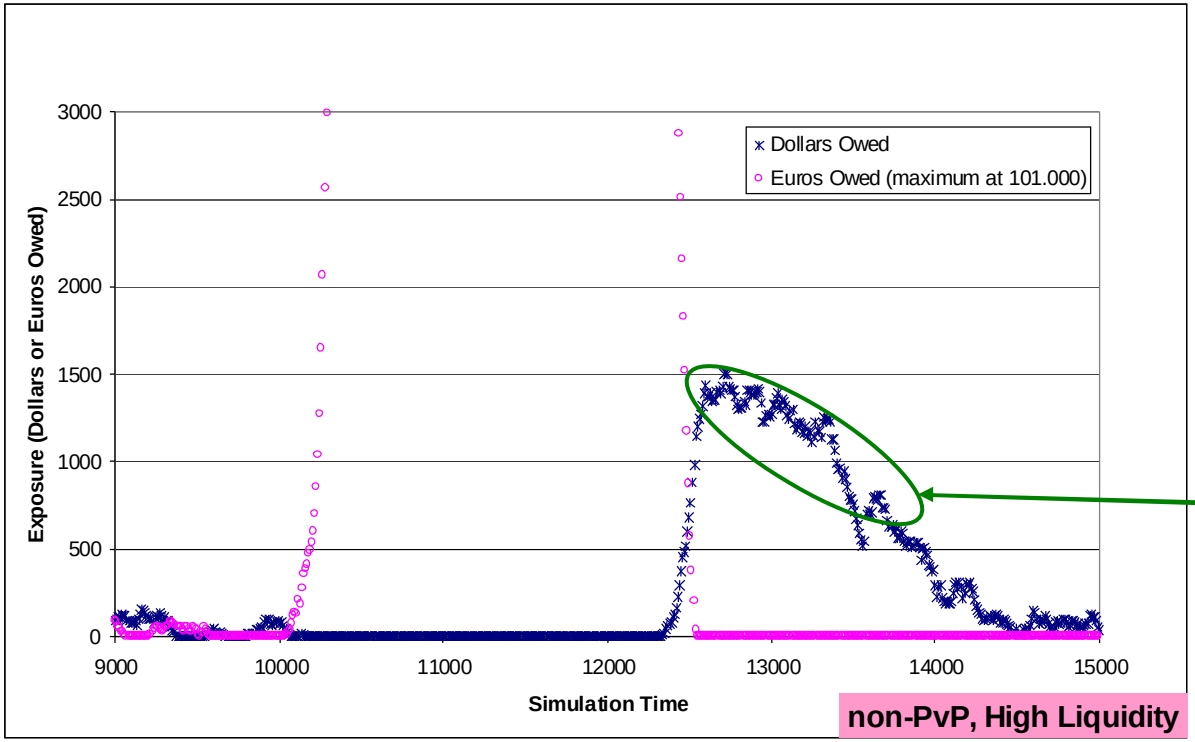
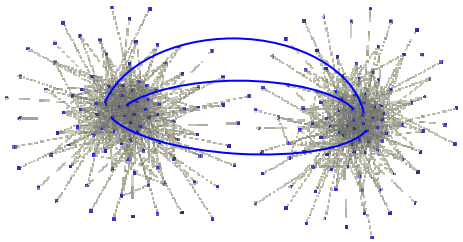


- Low Liquidity:
  - this leads to the queuing of several $ local payments…
  - And to an overshoot at recovery, even in non-PvP case
- Non-PvP:
  - This creates a peak in $ owed exposures at recovery, event at high liquidity



Conclusions

- A simple model of interconnected RTGS was developed
- During normal operation, the two RTGS are shown to be interdependent
- When a liquidity crisis affects one RTGS, the crisis propagates to second RTGS in all considered cases
  - PvP:
    - sharp decrease in activity (local and FX) in second RTGS
  - Non-PvP:
    - Decrease in activity in second RTGS due to fewer FX trades emitted
    - At low liquidity, local payments in second RTGS are also affected
    - Large increase of FX exposures during crisis and recovery