Temporal B2B Debt Netting
or how to save liquidity and reduce risks

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Context: B2B Trade Credits and Debt Chains

Trade credits in B2B networks

- Companies use **deferred** B2B payments
- Primary source of short-term financing: surpasses bank credit
- Creates **interdependent debt chains**: companies are both creditor and debtor

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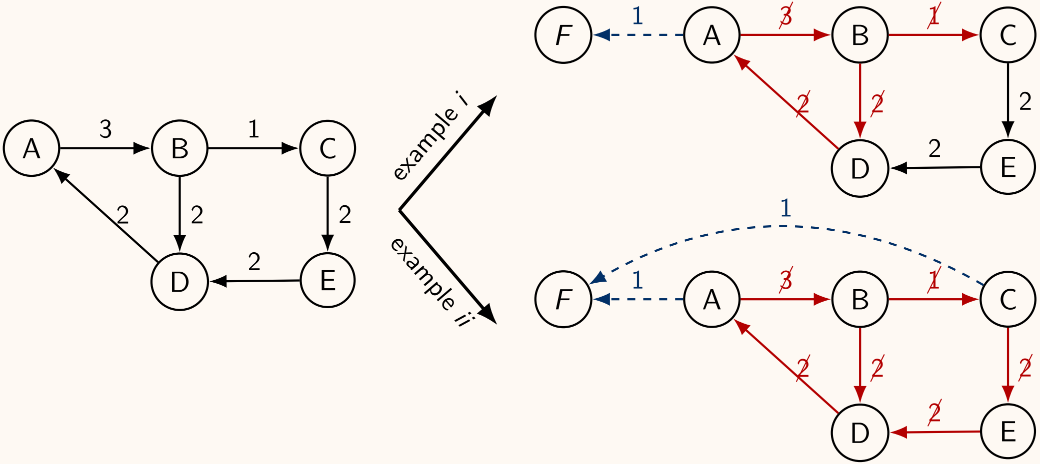
The problem: liquidity shortages

- **Late payments** propagate along debt chains
- Can trigger **liquidity crises** and cascading bankruptcies
- **Systemic risk** for the whole exchange network

Integral Netting: the Idea



Integral netting possibilities on example network

Integral Netting: the Idea

Principle

Integral multilateral netting fully settles selected invoices using **minimal external liquidity** as loans.

- A financer injects the *minimum* capital needed
- Net positions drive the settlement
- Notion of **amplification** i.e. efficiency

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Existing approaches: limitations

- **Static setting only**: time-independent networks
- Invoices treated as a fixed snapshot
- No temporal dynamics, no lifespan, no recycling

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Our approach

- Based on debt trees with high amplification factor
- Maximises the network coverage while respecting and amplification threshold

How to apply netting on dynamic graphs ?

Reality: networks are **dynamic**

- Invoices are **issued every day**, the graph evolves dinamically
- An unpaid invoice may still be **relevant**
- A completely static approach **misses** the temporal structure

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- Split dynamic into **discrete periods**
- At each period: collect **new & still-active** invoices
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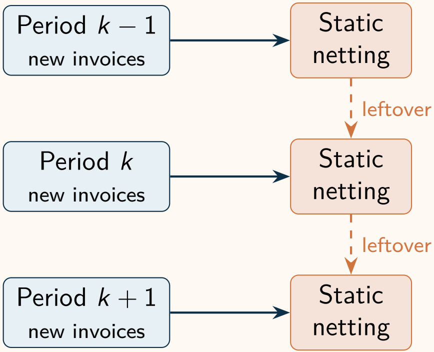
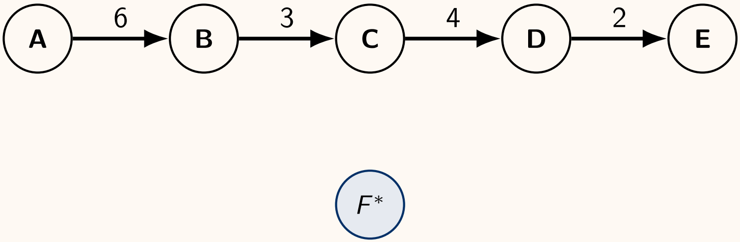


Why Temporal? Day k



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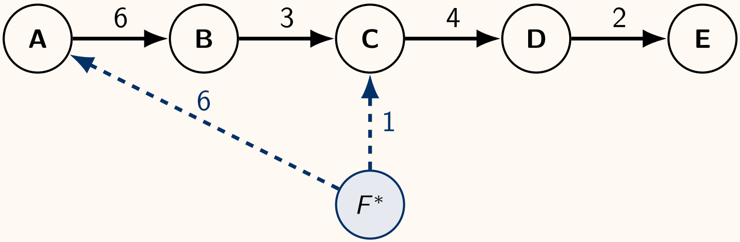

- $f_k = 7$
- $dbcl_k = 15$
- $\alpha_k \approx 2.14$

Financing needed: F^* covers all deficits

A is in deficit (0 in, 6 out); C also owes more than it receives (3 in, 4 out).
The financer must inject capital on **both** edges.

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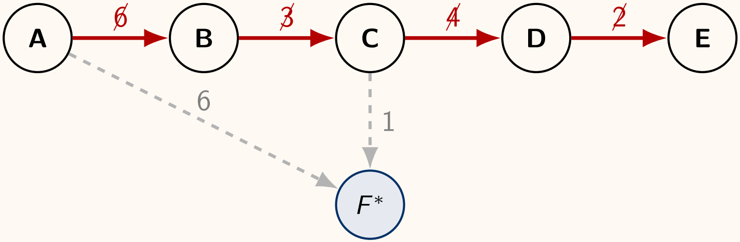

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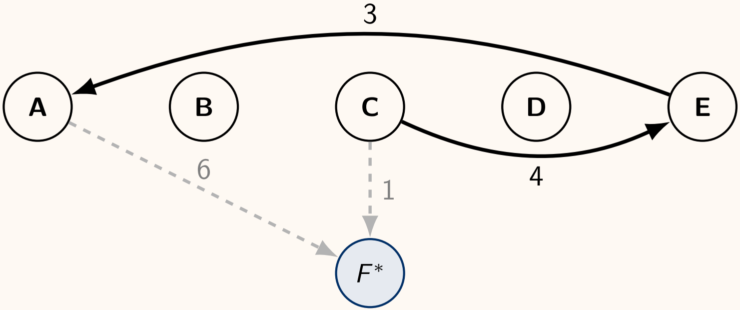
After reduction: all settled, but at high cost

All invoices cleared (red). Financing edges $F^* \to A$ and $F^* \to C$ are **reversed and carried over** to day $k{+}1$ (dashed gray, lifespan $\mathcal{D}_f$).

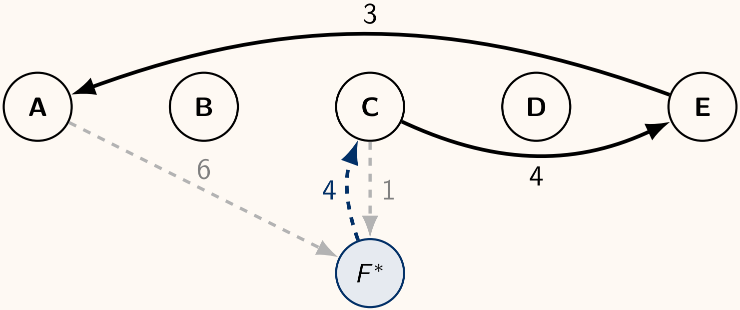
Why Temporal? Day $k+1$



Joint graph J_{k+1}: new invoices + carried financings

- C→E and E→A arrive (black)
- Financing edges from day k still active (gray)
- Not netted invoices could be active depending on the amplification threshold chosen

Why Temporal? Day $k+1$



- $f_{k+1} = 4$
- $dbcl_{k+1} = 7$
- $\alpha_{k+1} = 1.75$

- $f_{sep} = 11$
- $dbcl_{sep} = 22$
- $\alpha_{sep} = 2$

Financing needed: less than day k

$\rightarrow$ Inject 4 in C to reduce all

$\rightarrow$ Recover 3 from A to F

$\rightarrow$ Global amplification higher than disjoint case

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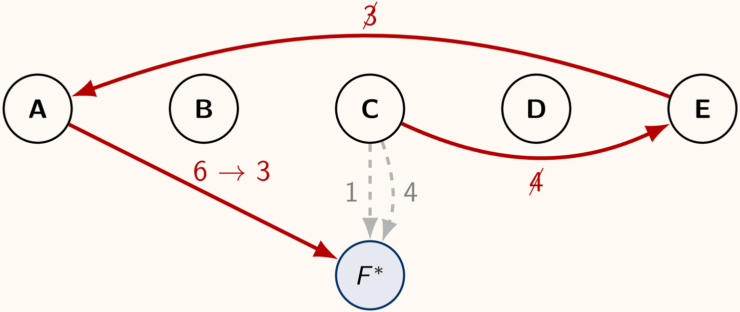


- $f_{sep} = 11$
- $dbcl_{sep} = 22$
- $\alpha_{sep} = 2$

- $f_{temp} = 8$
- $dbcl_{temp} = 22$
- $\alpha_{temp} = 2.75$

Temporal netting: more debt cleared for a lower cost

→ We recover part of the old financing

→ **Effective amplification is higher** (2.75) vs treating each day in isolation (2)

→ Some structures may appear only when given enough time (not shown on the example)

Experimental Setup : Real-World Dataset

Dataset

- **Provider**: Infocert, Italy (2019)
- **22 million invoices** ≈ € 95 billion
- **2 million companies**
- Span: **1 year** (365 daily periods)
- ≈ 70,000 new invoices per day
- Active set: up to **several millions** of invoices per session

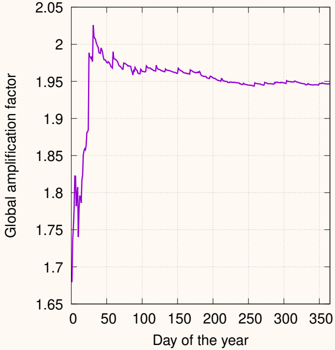
Parameters used

Parameter	**Value**
Period length	1 day
n (periods)	365
$\mathcal{D}_i$ (invoice lifespan)	28 days
$\mathcal{D}_f$ (financing lifespan)	84 days
Minimal amplification factor	1.95

Global Results : Debt Cleared & Amplification

Raw amplification factor

$$\text{Amplification} = \frac{\text{Debt cleared}}{\text{Capital injected}}$$



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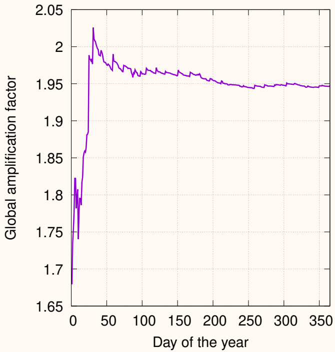
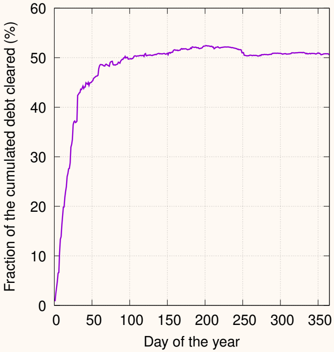


Fraction of total debt cleared

- Netting clears ≈ **50% of yearly debt** while reducing liquidity by 1.95



Financer's Perspective : Capital Recycling

Two extreme scenarios for expired financings

Scenario	Description
Worst case	Remaining unpaid financing is **lost** upon expiry
Best case	Companies **repay all** unpaid financing upon expiry

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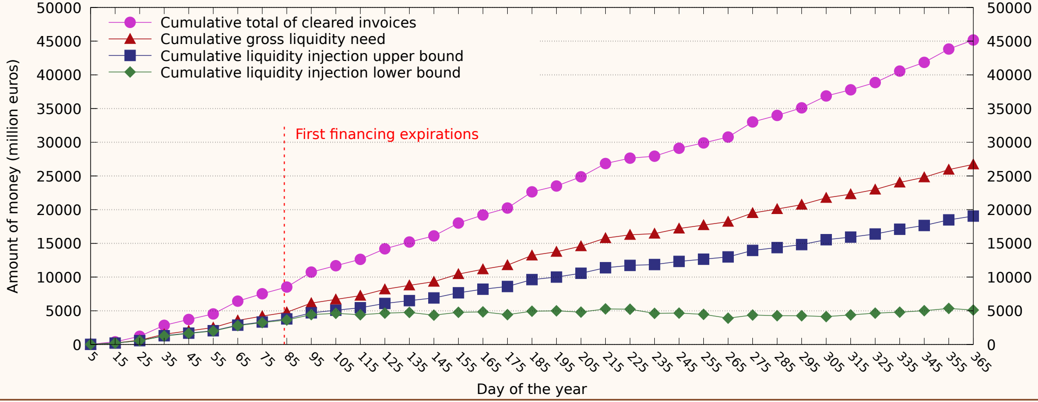

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Effective amplification

$$\text{Eff. ampl.} = \frac{\text{Debt cleared}}{\text{Capital at risk}}$$

$\approx$ **3** in worst case scenario

Up to **10** in best case scenario

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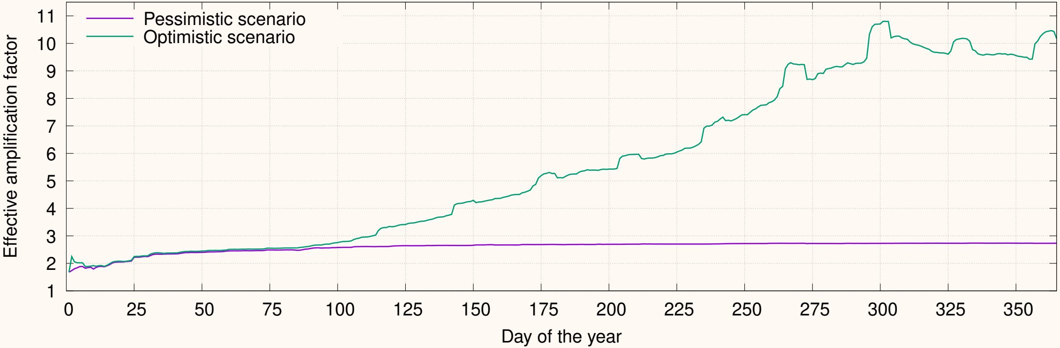

Conclusion & Future Work

Summary

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- → Daily netting clears $\approx$ **50%** of yearly B2B debt
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- $\rightarrow$ **Temporal netting framework**: invoices with lifespan, partial reimbursements
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Future work

- Intermediate repayment scenarios (between catastrophic and optimistic)
- Improved **reimbursement policies**
- Further **scalability improvements** for large networks
- Sensitivity analysis on $\mathcal{D}_i$, $\mathcal{D}_f$ parameters

Thank you!

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Building the Temporal Algorithm

What comes in at each period

- **New invoices** E_k: issued this period
- **Leftover invoices** O_{k-1}: still unpaid from previous periods
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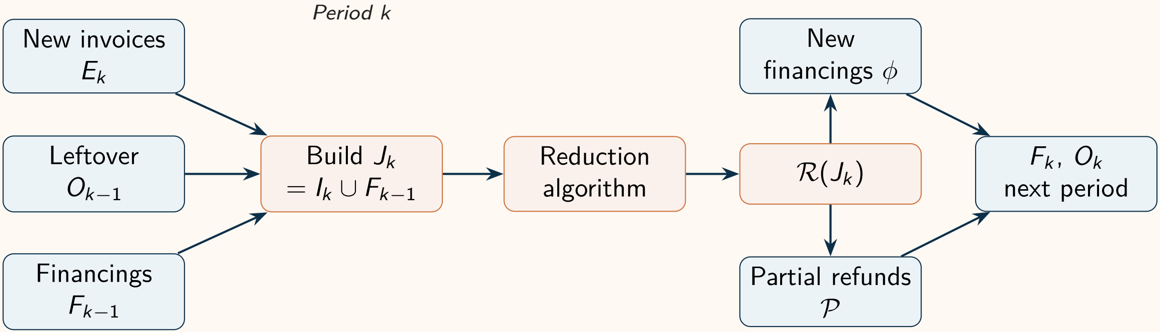
Two tunable lifespans

$\mathcal{D}_i$	**Invoice lifespan**: how long unpaid invoices can stay in the netting system
$\mathcal{D}_f$	**Financing lifespan**: how long a loan stays active for partial refund

Algorithm Overview



Modular design

The reduction step is a **black box**: any static netting algorithm can be plugged in.