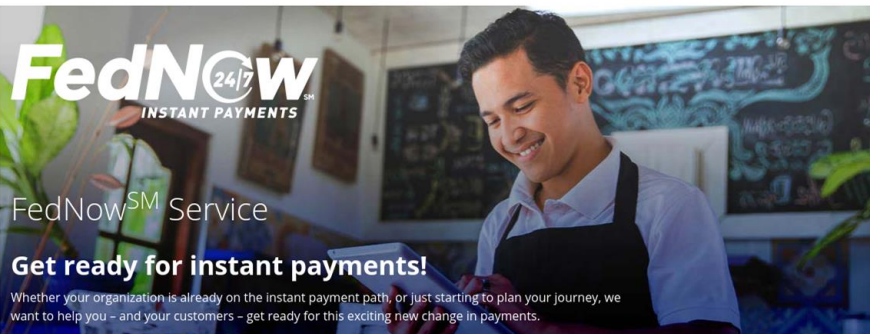


An Agent-Based Model of Strategic Adoption of Real-Time Payments

Katherine Mayo, Shaily Fozdar, Michael P. Wellman

ICAIF '21
November 4, 2021





FedNowSM Service

Get ready for instant payments!

Whether your organization is already on the instant payment path, or just starting to plan your journey, we want to help you - and your customers - get ready for this exciting new change in payments.

Real-Time Clearing

Allows for clearing of interbank payments within 60 seconds

Real-time clearing (RTC) - known by terms like Pay & Clear and Instant EFT to the end consumer - allows for interbank payment clearing without any noticeable delay. This means that once your financial institution becomes an RTC participant, your customers will always have the option to receive payments from and make payments to any account within the network of RTC-participating banks.

Related News

APIs, automation and fighting fraud - the latest in electronic payments
2020 has been a whirlwind year of note. However, it didn't put a stop to payments. Gar...
[READ ARTICLE](#)

Responding to the big demand for APIs in payments
Our Chief Business Officer, Martin Grunewald, unpacks the role of APIs in BankservAfrica's...
[READ ARTICLE](#)

BECOME A PAF

Home > Banking > Real-Time Enables the Next Frontier of Payments

Banking

REAL-TIME ENABLES THE NEXT FRONTIER OF PAYMENTS

July 7, 2021

Real-time payment systems are becoming increasingly popular around the globe.

Singapore's Liquid Group Debuts Real-Time B2B, B2C Payments

By PYMNTS

Latest in Article



Home > World Menu > Asia > Real-Time Payments Just as Popular as Cash in Southeast Asia

Asia Latest News Payment

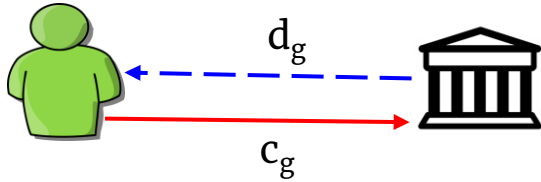
Real-Time Payments Just as Popular as Cash in Southeast Asia

by Polly Jean Harrison | July 16, 2021

Real-time payments are now as popular as cash as a payment method for consumers in Southeast Asia, according to new research from ACI Worldwide and YouGov. Three out of five consumers (61%) in Indonesia, Malaysia, Thailand and Singapore prefer real-time payments as a favoured way to pay in 2021, level with cash (61%) and higher than other payment categories, including digital wallets requiring cash or card top-ups (56%) and credit cards (30%).

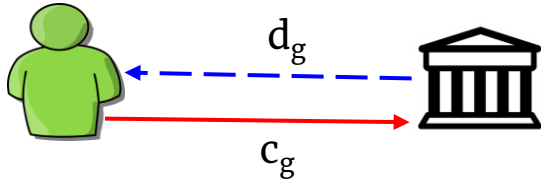


Modeling Payments



Green holds some amount of deposits, d_g , in its bank account, which is considered a debt owed by the bank to Green.

Modeling Payments



The maximum amount of additional deposits green is willing to hold in its account, c_g , is considered credit Green extends to its bank.

Modeling Payments: Standard Payment



Modeling Payments: Standard Payment



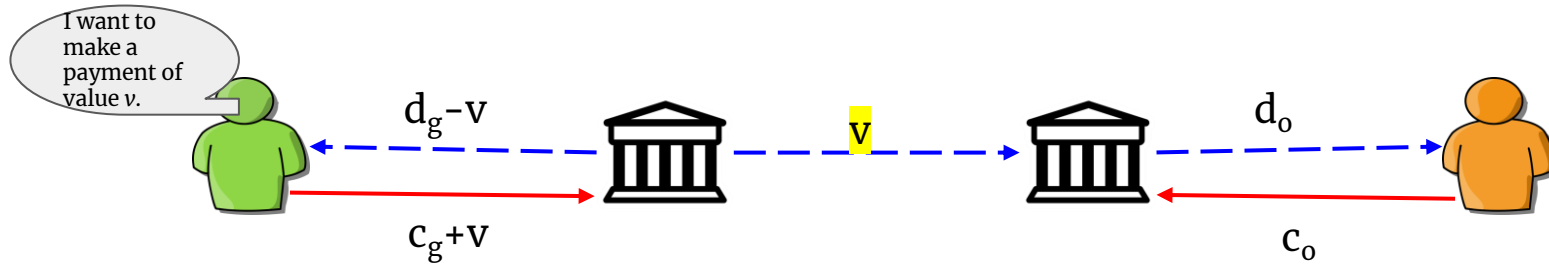
Payment requests are stored in a queue and processed in batches in regular intervals referred to as *clearing periods*.

Modeling Payments: Standard Payment



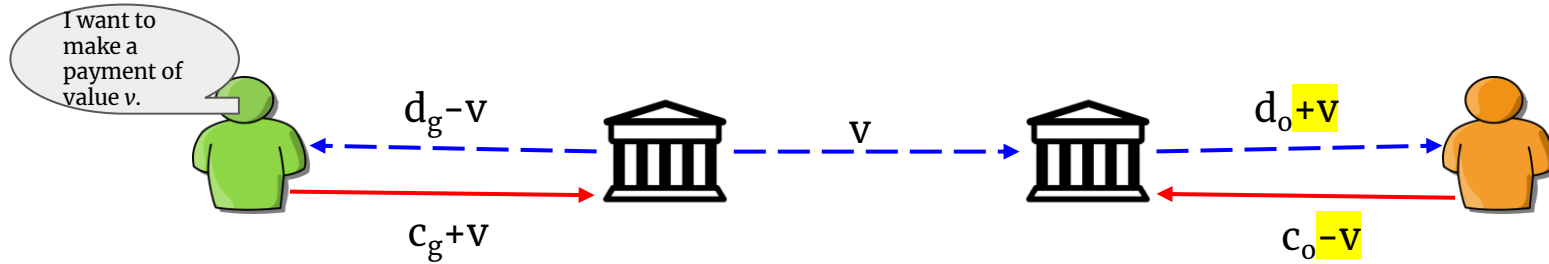
The bank uses Green's deposits to make the payment, withdrawing the amount equal to the value of the payment, v , from Green's account.

Modeling Payments: Standard Payment



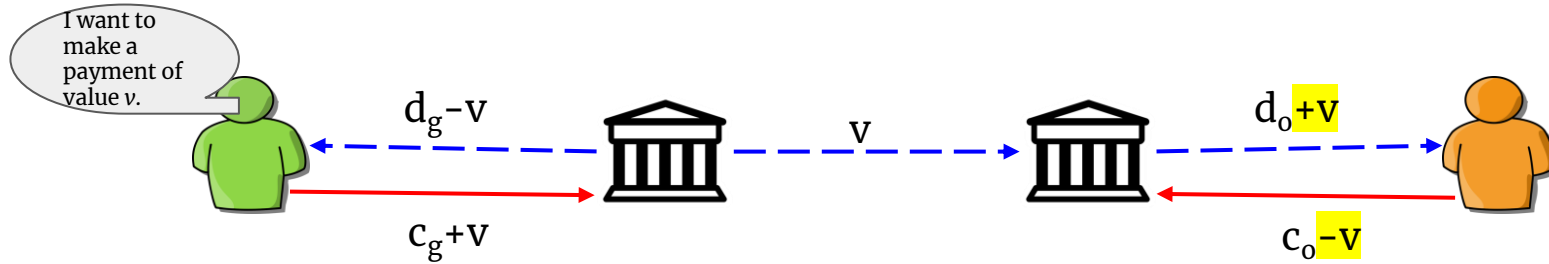
The bank will use the *interbank network* to send the payment to Orange's bank.

Modeling Payments: Standard Payment



Upon receiving the funds, Orange's bank will credit Orange's account with the funds by increasing their deposits by the value of the payment.

Modeling Payments: Standard Payment



This series of steps represent the *clearing* and *settlement* of a payment and must be completed for a payment to be executed.

Modeling Payments: Real-Time Payment



Modeling Payments: Real-Time Payment



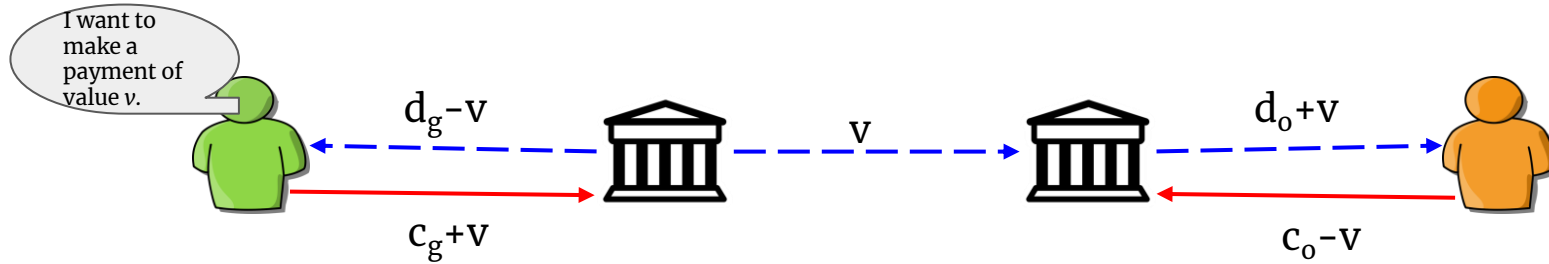
Orange's bank will immediately credit Orange's account with the value of the payment. This action is irrevocable and available 24/7, 365 days a year.

Modeling Payments: Real-Time Payment



Orange's bank will **immediately credit** Orange's account with the value of the payment. This action is **irrevocable** and **available 24/7, 365 days a year**.

Modeling Payments: Real-Time Payment



In the deferred settlement case, the remaining settlement steps are stored in the queue and handled during the next clearing period.

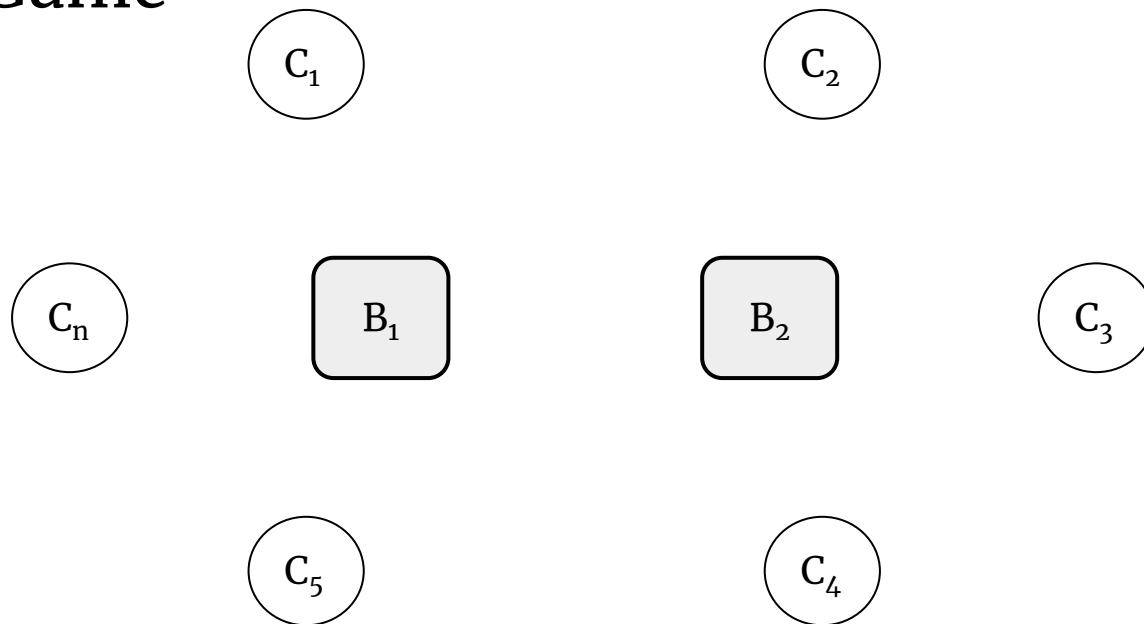
Real-Time Payments (RTPs) Risk

- Deferring settlement necessitates banks take on a credit risk
- Expediency of the payments make it more difficult to catch problems
 - Fraud, unintentional mistakes, etc.
 - Who is liable when issues arise?
- Given potential issues, banks may be selective in which consumers are allowed to use RTPs

Contributions

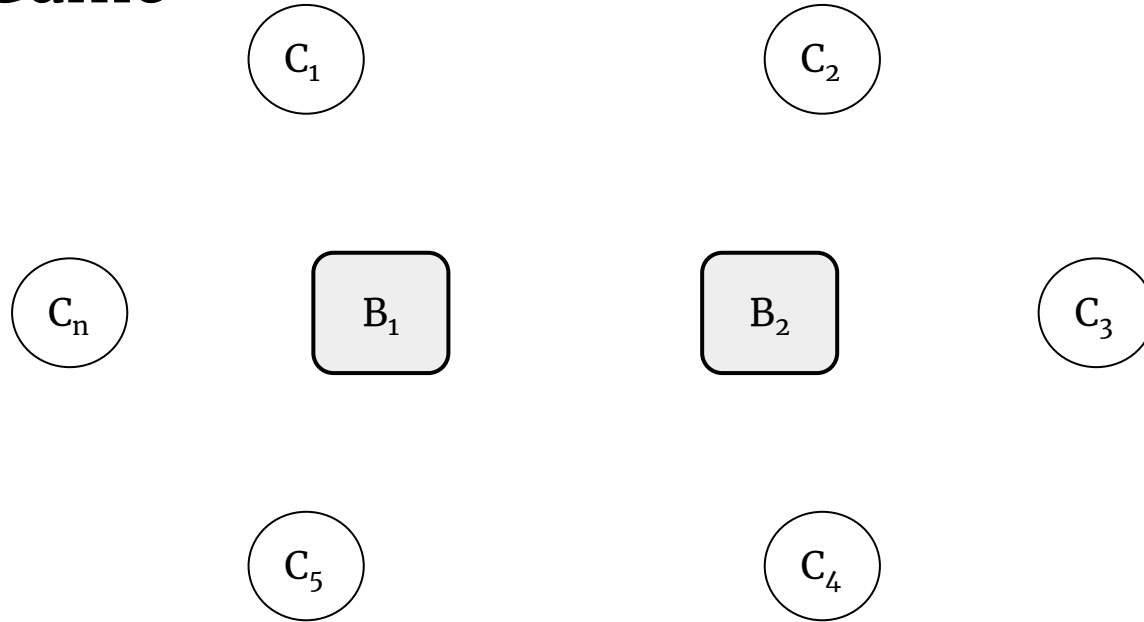
- Formulate the RTP adoption question as a strategic decision made by banks
 - Explore the scenario where consumers may accidentally make payments with values larger than their deposit holdings
 - Referred to as *insufficient payments*
- Define an agent-based simulation framework that supports standard payments and real-time payments with deferred settlement
- Analyze the effects of RTP adoption on banks and consumers

RTP Game



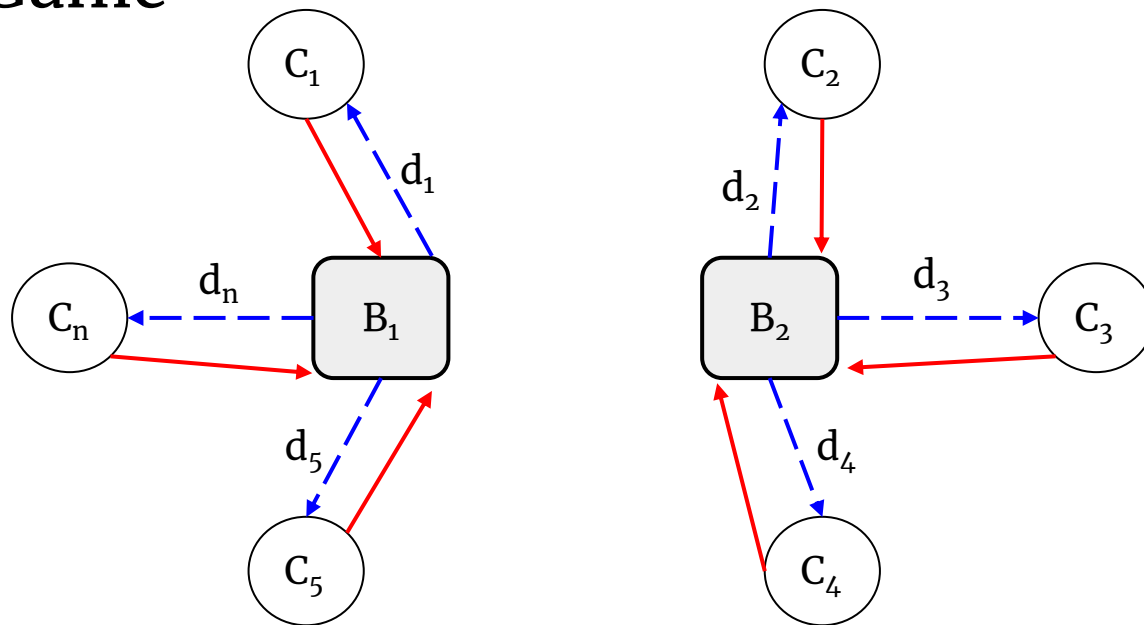
Consumer nodes are initialized with a random amount of deposits and a desire to receive certain kinds of payments (any or RTP-only).

RTP Game



Bank nodes adopt a strategy that determines which consumer nodes are allowed to send RTPs, balancing the risk of insufficient payments and benefit of attracting consumers.

RTP Game

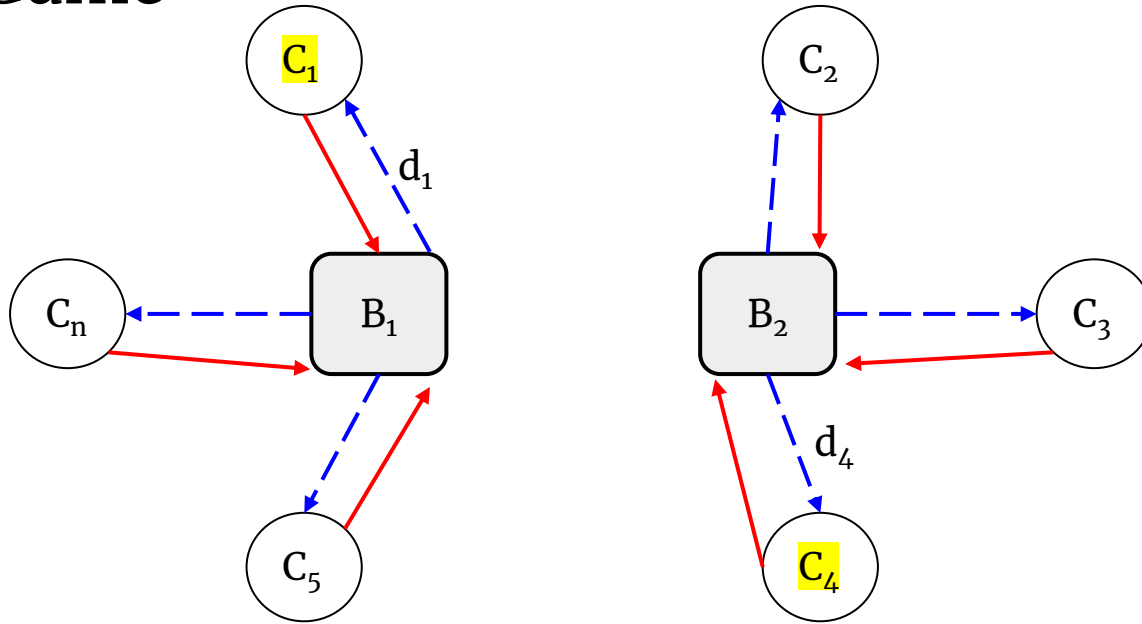


Consumer nodes are assigned to banks with a preference for banks that would allow them to send RTPs.

Heuristic Strategies

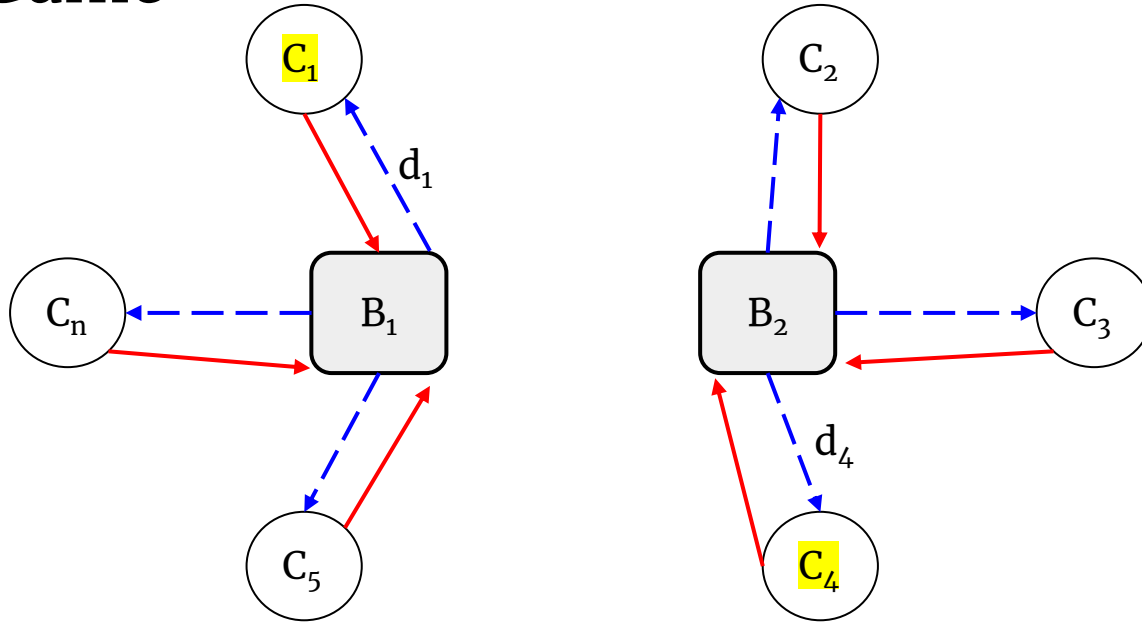
- Set thresholds on the initial deposit values of consumer nodes
 - Only consumer nodes above the threshold can send RTPs
- 6 such strategies
 - Low threshold that allows all consumer nodes to send RTPs
 - High threshold that allows no consumer nodes to send RTPs

RTP Game



Random payments are created in the network over T time steps. Each payment is created by randomly selecting the payment sender, receiver, and value of the payment.

RTP Game



With probability p , the *consumer check probability*, the sender checks their payment value before sending and adjusts its value if it is insufficient.

RTP Game

Sender	Receiver	Payment Processed As:
RTP	Any/only-RTP	RTP
Standard Payment	Any	Standard Payment
Standard Payment	only-RTP	---

The payment is then processed subject to the constraints of the sender and receiver.

RTP Game

Sender	Receiver	Payment Processed As:
RTP	Any/only-RTP	RTP
Standard Payment	Any	Standard Payment
Standard Payment	only-RTP	---

If a standard payment is insufficient, it is terminated immediately.

RTP Game

Sender	Receiver	Payment Processed As:
RTP	Any/only-RTP	RTP
Standard Payment	Any	Standard Payment
Standard Payment	only-RTP	---

If a RTP is insufficient, the sender's bank will be required to provide the *insufficient coverage* ($v-d_1$).

Payoffs

- Banks receive a payoff at the end of T time steps equal to:

$$= 0.5D + 0.02R - I$$

D: total value of initial deposits attracted

R: total value of RTPs routed

I: total amount of insufficient payments coverage

Experiments

- Use empirical game-theoretic analysis to identify Nash equilibria
- Model details:
 - 225 consumer nodes and 3 bank nodes
 - 720 time steps
 - 45 payments attempted per time step
 - Payment values: $v \sim U\{1, \dots, 100\}$
- Clearing period lengths: $X \in \{4, 6, 12, 24\}$
 - How frequently payments in the queue are cleared and settled
- Consumer check probabilities: $p \in \{0, 0.25, 0.5, 0.75\}$
 - How likely senders check their payment values before sending

Results

	Consumer Check p	0			0.25			0.5			0.75		
Clear Period X	Strategy Threshold	low	med	high	low	med	high	low	med	high	low	med	high
24		0.58	0.42	0	0.61	0.39	0	1	0	0	1	0	0
12		Probability in equilibrium of adopting a strategy with a low/med/high threshold in our game.						1	0	0	1	0	0
6								0.92	0.08	0	1	0	0
4		0.48	0.52	0	0.39	0.61	0	0.75	0.25	0	1	0	0

Results

	Consumer Check p	0			0.25			0.5			0.75		
Clear Period X	Strategy Threshold	low	med	high	low	med	high	low	med	high	low	med	high
24		0.58	0.42	0	0.61	0.39	0	1	0	0	1	0	0
12		0.54	0.46	0	0.46	0.54	0	1	0	0	1	0	0
6		0.51	0.49	0	0.37	0.63	0	0.92	0.08	0	1	0	0
4		0.48	0.52	0	0.39	0.61	0	0.75	0.25	0	1	0	0

In all game configurations, the bank nodes prefer lower or medium level strategies that allow most, but not all consumer nodes the use of RTPs.

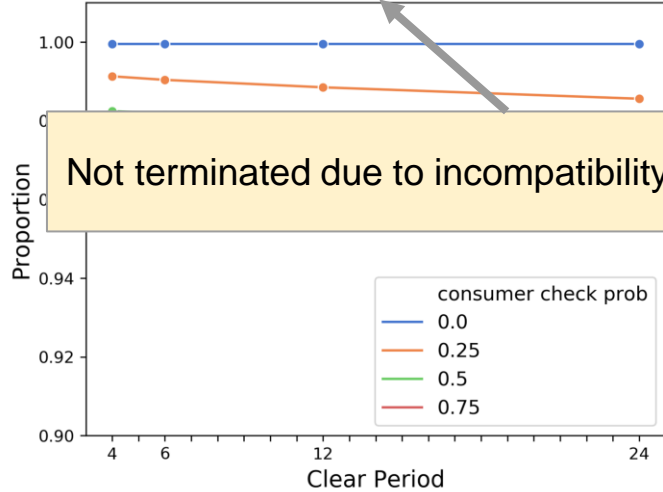
Results

	Consumer Check p	0			0.25			0.5			0.75		
Clear Period X	Strategy Threshold	low	med	high	low	med	high	low	med	high	low	med	high
24		0.58	0.42	0	0.61	0.39	0	1	0	0	1	0	0
12		0.54	0.46	0	0.46	0.54	0	1	0	0	1	0	0
6		0.51	0.49	0	0.37	0.63	0	0.92	0.08	0	1	0	0
4		0.48	0.52	0	0.39	0.61	0	0.75	0.25	0	1	0	0

As consumer nodes are more likely to check their payments or the clear period increases, bank nodes are more likely to choose a low-threshold strategy.

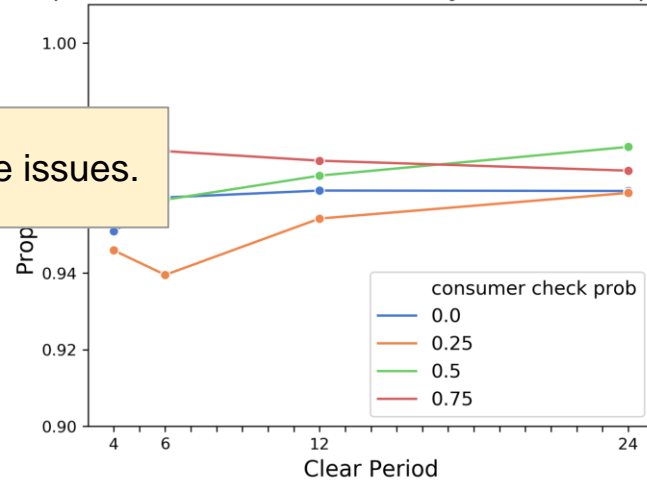
Results

Proportion of Bank's Successful Payments with all RTP



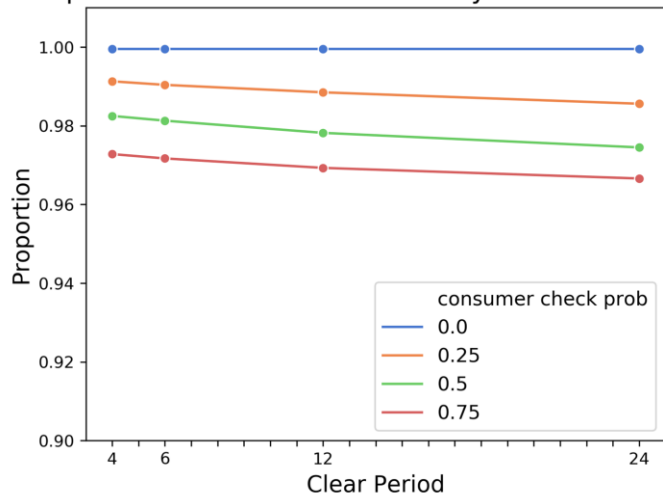
Not terminated due to incompatibility or value issues.

Proportion of Bank's Successful Payments with Equilibria

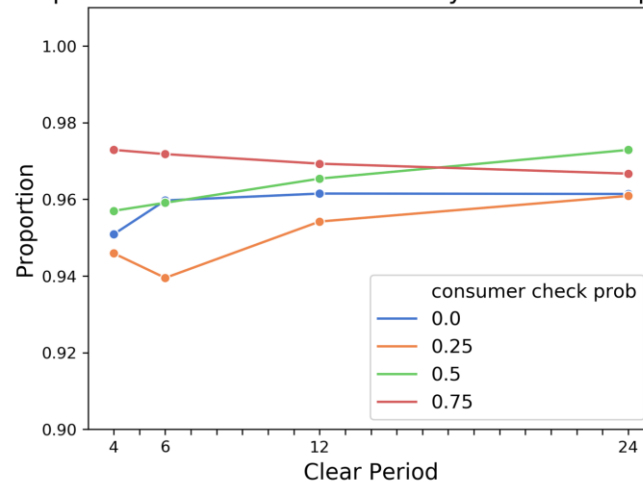


Results

Proportion of Bank's Successful Payments with all RTP



Proportion of Bank's Successful Payments with Equilibria



The proportion of successful payments is higher when all consumer nodes are allowed to send RTPs than under the equilibria.

Results

- Bank nodes in our game allow most, but not all consumer nodes the use of RTPs in equilibria
- Bank nodes in our game have more successful payments when all consumer nodes are allowed to send RTPs

Results

- Bank nodes in our game allow most, but not all consumer nodes the use of RTPs in equilibria
- Bank nodes in our game have more successful payments when all consumer nodes are allowed to send RTPs

While bank nodes in our game may be better off when all consumer nodes use RTPs, they are generally unwilling to accept the risk necessary to reach this outcome.

Questions?