Payment Initiation and Transaction Costs

Ka Kei Chan, **Alistair Milne** and David Skeie

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Paper overview and presentation agenda

- Section 1 Introduction (Push v. pull)
- Section 2 Examples (historical, current)
- Section 3 Conceptual framework
- **Section 4 An illustrative model**
- **Section 5 Pull initiation and settlement of financial market transactions**
- Section 6 Conclusions

Focus today: Sections 4 and 5

Some Basics

- A **payment initiation** is the instruction to make a payment.
- There are two types of initiation:
  1. **Push** initiation when a payer makes/instructs a transfer to a payee. E.g. cash payment, bank transfer.
  2. **Pull** initiation when a payee (or a third party) instructs a transfer from the payer .
- Pull initiation very common, nowadays typically initiated by code

Economics and finance literatures have remarkably little on payment initiation.

Takeaways

- A basic choice : push or pull?
  - Both appear in all contexts of financial exchange
  - A trade off: pull greater costs (overheads) v. direct and indirect benefits.
  - Direct: communication and cognitive costs $\downarrow$
  - Indirect: pull a pre-commitment device
- Illustration: unobserved quality, bilateral exchange
  - dispute resolution expensive (high costs of state verification)
  - asymmetry $\rightarrow$ buyer incentive to renege on deal
- Pull initiation and settlement
  - pull initiation central to 'atomic settlement' (i.e. DvP, PvP)
  - standard market practice since 1992 (not DLT)
  - permissionless DLT supports 'atomic trading and settlement' in decentralised finance
  - quite different from permissioned DLT where settlement differs little from that on centralised ledgers
  - recent innovation (DLT and centralised) public-private key crytography supporting authorisation of third party pull

Section 2: historical and current examples

- Cowry shells, notes and coin (push)
- Bill of exchange, letter of credit (pull)
- Negotiable bill of rxchange (push)
- Payment between deposit banks — Continental Europe: giro (push); Anglo Saxon: cheque (pull)
- Crypto—Bitcoin (push); Ethereum ('push' and 'pull' in the ERC-20 token standard.)

Section 3: Initiation and transaction costs

- **Costs of pull:**
  1. requires an additional mechanism to reserve or guarantee funding for the transfer.
  2. requires trust in the party given the right to execute a payment transfer (legal/ regulatory/ reputational *or* transparent agreed code)

- **Benefits:**
  1. (direct) reducing communication costs and cognitive costs.
  2. (indirect - 1) pre-commitment in consumer and business transactions, reducing informational and contractual costs
  3. (indirect - 2) pre-commitment in settlement (DvP/PvP) reducing counterparty risk in financial markets

Section 4: A simple formal model

- A setting where payment initiation—whether by **payer (push)** or **payee (pull)**—affects incentives and welfare.
- Incomplete contracts and unverifiable quality make initiation a potentially valuable commitment tool.
- Demonstrating that **choice between push and pull can effect trade feasibility and welfare**.
- some limited related literature on smart contracts/ programmability and welfare

The Environment

- Two agents: **Buyer (payer)** and **Seller (payee)**.
- Timeline:
  - $t = 0$: Buyer and Seller agree on a contract specifying delivery of the good in period 2 at a fixed price v.
  - $t = 1$: Seller decides whether to produce (high or low effort).
    - **Low effort:** Production cost is 0.
      Always produces a 'dud" with very low quality $g < g_0$.
    - **High effort:** Production cost is $c > 0$.
      With prob ϵ, produces a dud.
      With prob $1 - \epsilon$, produces a good with quality $g \in [g_0, g_1]$.
  - $t = 2$: Buyer privately observes quality g and decides whether to pay/consume or not. The cdf of quality:

$$F(g) = \begin{cases} 0, & g < 0 \\ \epsilon, & 0 \leq g < g_0 \\ \epsilon + (1 - \epsilon) R(g), & g_0 \leq g < g_1 \\ 1 & g \geq g_1 \end{cases}$$

Buyer's Utility

- Buyer's utility from consuming a good of realized quality g is:

$$U = \begin{cases} u(g) \geq 0, & \text{if } g_0 \leq g \leq g_1; \\ 0, & \text{if } 0 \leq g < g_0; \\ 0 & \text{if the good is not consumed.} \end{cases}$$

- High production effort is socially efficient if $c < \mathbb{E}[u(g)]$.
- Denote g^* denote the threshold quality at which the buyer's consumer surplus is zero, defined implicitly by

$$u(g^*) - v = 0.$$

Verifiability

- Verifiable:
  - Monetary transfers—including payments and refunds—are perfectly verifiable through the payment system.
  - Delivery of the good is verifiable through a technological mechanism, such as an Internet-of-Things (IoT)–based system.
- Imperfect verifiability:
  - Seller's choice of production technology is unverifiable.
  - The realized quality of the delivered good is observable only to the buyer. Quality is not verifiable except in the special case of a "dud".

Payment Initiation and Enforcement

- Payment Initiation:
  - **Push initiation.** Payer sends payment after delivery of good.
  - **Pull initiation.** Payee (or an automated third-party protocol) is authorized to pull payment once the IoT system confirms successful delivery.
- Enforcement:
  - **Gross breaches** are verifiable contract violations. E.g. Seller accepting payment without delivering; Buyer retaining the good without paying; assumed to be costless to enforce.
  - **Lesser breaches** are contract violation that are inherently unverifiable. E.g. Buyer returning the good without paying, claiming unsatisfactory quality–dispute can then determine whether the good is a verified dud, and the cost κ is borne by the losing party in the dispute.

Behavioral Outcomes under Push and Pull

Under Push

- ϵ small (but non-zero).
- Dispute costs high (limiting case ∞ seller never disputes)
- Buyer then pays only if $g \geq g^*$
- Seller faces risk of non-payment and return of lower-quality goods.
- Inefficient: production without consumption.
- A hold-up problem — buyer opportunism creates welfare loss

Under Pull

- Payment executed automatically upon verified delivery.
- Buyer consumes all non-dud goods: no discretionary returns.
- Enforcement needed only for genuine duds (off equilibrium).
- Eliminates hold-up inefficiency.

Equilibrium outcome (limiting case)

- **Consumer Surplus:**

$$\mathrm{CS} = \begin{cases} \int_{g^*}^{g_1} [u(g) - v]\, r(g)\, dg & \text{(push)} \\ \int_{g_0}^{g_1} [u(g) - v]\, r(g)\, dg & \text{(pull)} \end{cases}$$

- **Producer Surplus:**

$$\mathrm{PS} = \begin{cases} [1 - R(g^*)]v - c & \text{(push)} \\ v - c & \text{(pull)} \end{cases}$$

- **Welfare:**

$$\mathrm{W} = \mathrm{CS} + \mathrm{PS}$$

Proposition 1 — Welfare Ranking

- Pull initiation removes the buyer's ex-post cancellation option.
- Implemented allocation = **constrained first-best**.
- Expected welfare:

$$W_{\text{pull}} - W_{\text{push}} = \int_{g_0}^{g^*} u(g)\, r(g)\, dg \geq 0.$$

- $\Rightarrow$ Pull yields higher welfare.

Propositions 2 and 3 — Market Power Effects

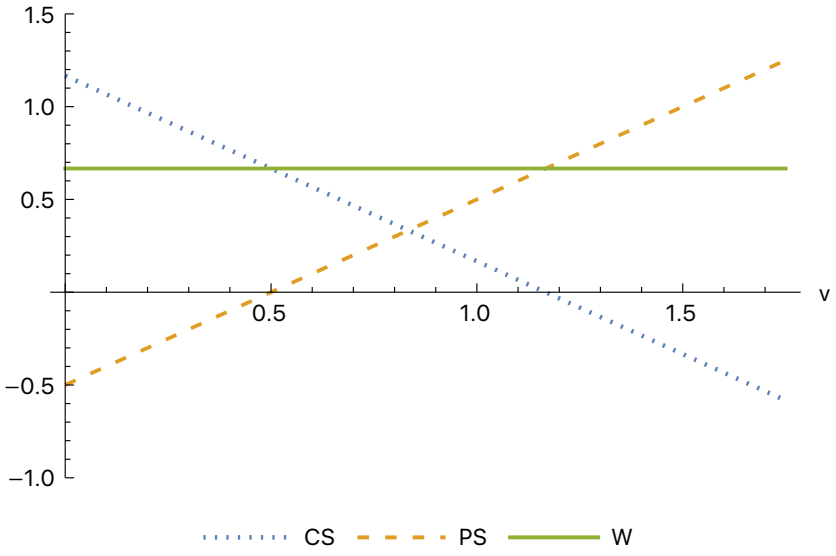
- **Monopsony (buyer sets price):** Post-push requires compensating seller for non-payment risk $\Rightarrow$ lower buyer surplus, higher v.

$$v^M_{\text{push}} \geq v^M_{\text{pull}} = c$$

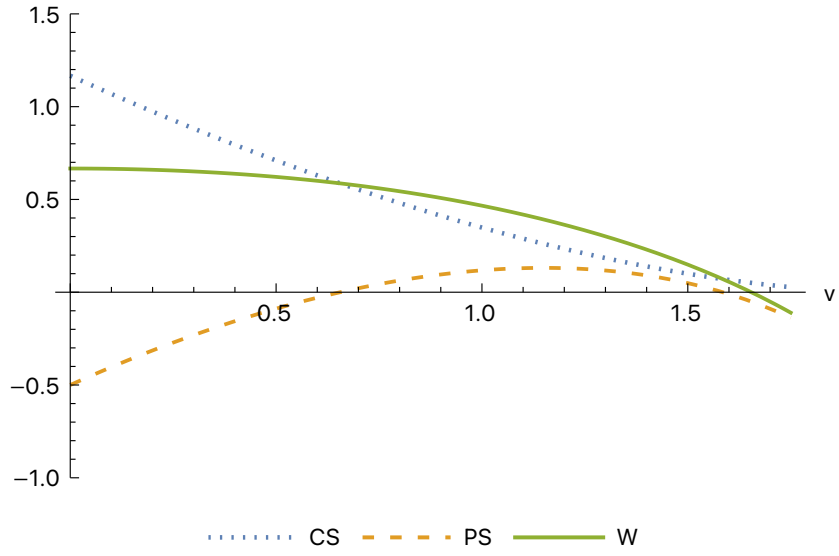
- **Monopoly (seller sets price):** Post-push lowers feasible price since higher v raises return risk $\Rightarrow$

$$v^M_{\text{push}} \leq v^M_{\text{pull}}.$$

Illustration: benchmark comparison



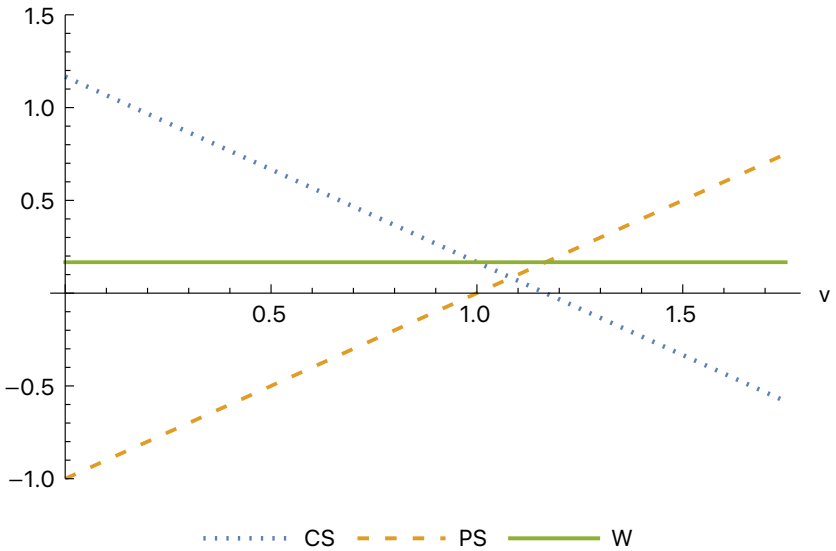
Benchmark: Pull payment



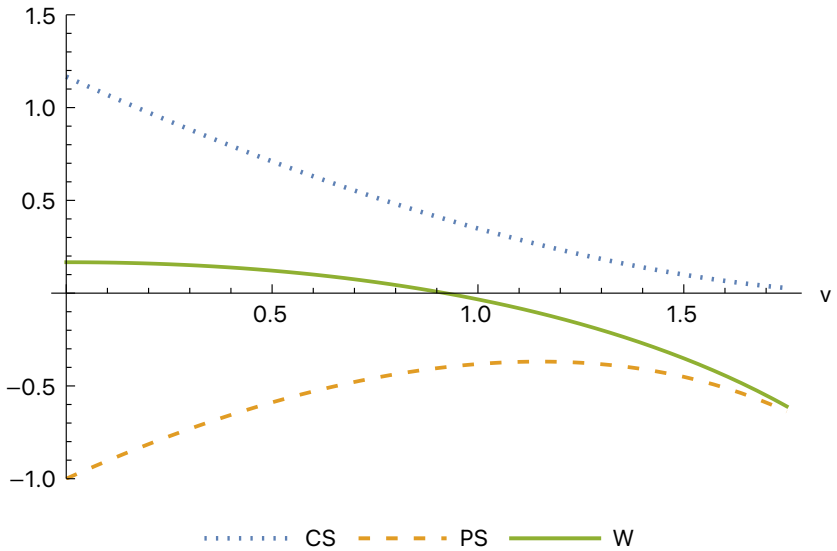
Benchmark: Push payment

- Welfare is higher under pull than push.
- The range of price is determined jointly by buyer and seller under pull, but solely by seller under push.
- Consumer surplus has a put-option-like feature under push.
- The lower (higher) boundary of price is smaller (larger) under pull than push.

Illustration: high production cost



High Prod Cost: Pull payment



High Prod Cost: Push payment

- Producer surplus shifts downward under both push and pull, but consumer surplus is unaffected.
- The range of price shifts to the higher end under pull; transaction is still possible.
- No transaction under push at all.

Section 4 Model Summary

- Payment initiation can shape incentives, feasibility, and welfare.
- Pull initiation:
  - Eliminates inefficient returns.
  - Implements constrained first-best allocation.
  - Affects feasible equilibrium prices (range of bargaining outcomes).
- A simple specific model, abstracting from costs of pull

Overview of Section 5

- Closely related to the model of Section 4 - pull as a precommitment device
- DvP/ PvP is (mutual) pre-commitment to settling one leg of a trade, conditional on the other leg settling
- This requires pull initiation (5.1)
- 1990s DvP/ PvP implementation in security markets and foreign exchange, rested on (5.2):
  1. well established data science; *and*
  2. two forms of pull initiation (escrow, hybrid)
- Distributed ledger technologies (5.3)
  - DLT offer new ways of implementing pull initiation
  - rests on public-private key cryptography and a third form of pull (third-party)
  - can also be implemented on traditional centralised databases
  - atomic settlement v. atomic trading and settlement

The essential role of pull in DvP/PvP

- If both legs are push initiated, there is no DvP/PvP
- Pre-commitment to settling one leg of a trade, conditional on the other leg settling
- three forms of pull support DvP/PvP:
  1. Escrow (example CLS bank PvP);
  2. Third party (example DLT code-based DvP, synchronization operators);
  3. Hybrid (example Security market DvP)
- Usually both legs are pulled in DvP/ PvP settlement, an exception is in decentralised finance (atomic clearing and settlement) where one is pull, the other push.

The adoption of DvP and PvP: timeline

- 1974 Herstatt crisis
- 1980s Development of RTGS payment systems (precondition for DvP, PvP)
- 1992 CPSS recommendations on DvP/ PvP
- 1997 creation of CLS Bank, live PvP from 2002

The underlying tech - not DLT

> *"Atomicity. A transaction's changes to the state are atomic: either all happen or none happen." Gray1992, pg 48*

- Atomicity, a standard computer science concept, from the 1970s/ 80s
- Part of the sub-discipline of databases and transaction processing
- Atomicity is enforced within a single transaction processing system, using BEGIN_WORK() followed by either COMMITT_WORK() or ROLLBACK_WORK()
- DLT is just one form of transaction processing system

Terminological issues in DLT

Helpful to translate DLT terminology back to the better established language of database management.

- Atomic settlement - applying the basic database management concepts from the 1970s/80s, just a synonym for PvP/DvP
- Atomic Trading and settlement
  - new in decentralised finance provides
  - trading and settlement are together one atomic operation
  - requires trading and settlement combined in one transaction processing system
- 'smart contracts' another form of atomic operation, utilising 'composability' and 'conditional invocation'.
- 'on chain' just another word for a transaction processing system.

What is new about DVP settlement?

Permissionless DLT (decentralised finance)

- settlement without trusted third parties
- code-based third-party pull
- code open-source on the ledger
- single atomic operation for trading and settlement

Permissioned DLT (tokenization)

- settlement with trusted third parties
- code-based third-party pull
- code open-source on the ledger
- separate atomic operations for trading and settlement

Settlement: Permissioned DLT v. Centralised databases

- Not so different
- A trusted third party retains responsibility for pull initiation to ensure atomic settlement (DvP, PvP)
- Third party pull (with authorisation provided through public-private key cryptography) works on both DLT and centralised ledgers.
- DLT means the supporting code is more transparent - but change of code still requires instituional approval

Conclusions

- Initiation an economically significant and underexamined element of financial transactions
- Relevant to both retail payments and financial markets
- Prominent historically, even more prominent with automated digital transactions
- Pull involves greater infrastructure, but is a direct cost reducer
- Also a pre-committment device
- Central to atomic settlement i.e. DvP/ PvP
- Permissioned DLT not really so different from centralised databases
- main recent innovation is employing public-private key crypotography to authorise third-party pull in settlement
- BUT this does not rely on DLT

Further research

- Fuller modelling of economic outcomes and choice of payment initiation
- Quantifying the costs of cognitive processing in 'micro' payments and reduction through 'pull' solutions.
- Exploring the role of institutional guarantees, for 'pull' payments and the replication in non-card payment solutions such as bank to bank 'Faster Payments'.
- Quantifying and comparing the different trade-offs between counterparty and liquidity/ funding risks for alternative initiation architectures in traditional and decentralized finance.
- Analyzing the consequences of initiation arrangements for other fintech and decentralized-finance innovations, such as stablecoins, tokenized deposits and CBDCs.