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Platform Fee Floors, Market Power, and Missing Markets in Digital Payments: An Industrial-Organisation Calibration

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Abstract

This paper studies the industrial organisation of platform fee floors. In payment systems, fixed fees are market-boundary instruments as well as payment costs: they determine which firms, platforms, and automated services can transact at small scale. I model a two-sided payment platform in which the fixed component of the price schedule creates a participation floor for low-flow relationships. The model separates three objects often conflated in payment-policy debates: resource-cost savings on observed payments, surplus-transfer stakes from platform margins, and feasible relationship flow outside the current fixed-fee boundary. Lower switching cost affects the extensive margin only when passed through to the user-facing fixed fee or imposed by competition or regulation. The empirical contribution is a bounds and sensitivity exercise, not a point forecast. Using US card data, public fee schedules, alternative fixed-fee floors, lower-tail attenuation, and a non-Pareto capped-tail check, I estimate a model-implied feasible-flow envelope. The central specification can exceed current card value, but the magnitude is conditional on a Pareto extrapolation and an explicit transaction-to-relationship-flow assumption. The robust result is comparative-static: fixed fees define missing markets, and fixed-fee policy affects an extensive margin that interchange regulation over observed transactions cannot reach.

Keywords payment systems; two-sided markets; platform market power; fixed fees; digital transition; industrial policy

JEL Classification: D24, D43, D61, E42, L13, L41, L51, L86

1 Introduction

Payment platforms are industrial intermediaries. They choose price schedules, allocate liability, set access conditions, and determine which forms of exchange are commercially addressable. Their fixed per-transaction fees therefore do more than recover processing cost. They define a market boundary: a relationship whose periodic value flow cannot cover the fixed fee does not settle on the rail, even when the underlying exchange would generate positive surplus. The missing lower tail is then absent from payment data because the price schedule has excluded it from the feasible set.

This paper studies that boundary as an industrial-organisation problem. The question is not whether a particular technology replaces incumbent card networks. The question is how the feasible set of exchange changes when the fixed component of payment pricing falls by orders of magnitude while trust continues to be supplied by law, identity, reputation, compliance, and regulation. The minimal mechanism is a participation inequality: a relationship with period flow x , surplus rate m , and fixed fee ϕ can settle only if $mx \geq \phi$. The full model embeds that inequality in a two-sided payment platform to study pass-through and market power.

The main result is comparative-static. Lower switching cost does not by itself relax the participation floor. An interior profit-maximising platform sets the fixed fee above the fixed component of marginal cost whenever the semi-elasticity of transaction volume with respect to that fee is finite. The floor falls only when cost reductions are passed through into the user-facing fixed fee, or when competition or regulation forces that pass-through. The fixed fee is therefore not merely a processing charge; it is a market-boundary instrument.

The paper separates three quantities that are often conflated in payment-policy debates. The first is the resource saving on observed transactions, about \$700 million annually under the reported switching-cost proxy. The second is the incumbent platform-margin stake, on the order of \$20 billion annually under an upper-bound accounting counterfactual; that is a surplus-transfer stake, not a welfare gain. The third is the feasible-flow envelope outside the current fixed-fee boundary. It is not realised demand, adoption, revenue, transaction count, or welfare. It is the model-implied value of relationship flow that becomes commercially addressable only if the fixed fee falls.

The empirical exercise is organised as bounds and sensitivity analysis rather than as a point estimate. The Federal Reserve data measure observed transaction values, while the model primitive is unobserved relationship flow. The transaction-to-relationship-flow link is therefore stated as an identifying assumption. The central Pareto scenario is reported for reproducibility, but the empirical claim rests on the pattern across alternative fee floors, lower-tail attenuation, and a non-Pareto capped-density continuation. Those exercises ask whether the extensive-margin mechanism survives when the lower tail is made much less favourable than the fitted upper-tail extrapolation.

The policy implication follows directly. Fixed-fee caps, regulated access to low-fixed-fee settlement rails, or public/private instant-payment infrastructure affect the extensive margin of market formation. Interchange regulation over observed transactions mainly reallocates surplus within the already-settled set. The industrial-policy question is therefore not only how much payment networks charge on existing transactions, but which firms, platforms, automated services, and machine-to-machine relationships their fixed fees exclude from exchange.

The low-fee rail in the calibration is a price-floor counterfactual. Its relevant property is a value-independent low fixed fee, not adoption of a specific digital asset or consensus mechanism. The central low fee anchors an observed order-of-magnitude gap between retail-card fixed fees and message-based settlement fees; the paper then varies that fee over wider bounds. The same pricing experiment could in principle be implemented by a central bank, a regulated private processor, a bank consortium, or another legally accountable settlement operator. Fraud, compliance, dispute resolution, and adoption are not assumed away; they enter as trust-cost and participation constraints.

The relation to Budish (2025) is one of scope. Budish studies anonymous, permissionless Nakamoto trust, where security expenditure scales with value at risk. This paper studies regulated payment settlement with identified operators, legal enforcement, and separable switching and trust costs. It does not claim that proof-of-work can secure Visa-scale value at low cost. It claims that a low fixed fee in a legally governed payment rail changes the participation set. The contribution lies in platform pricing and missing markets, not in a claim about anonymous consensus.

1.1 Related Literature

This paper is closest to the literature on two-sided payment markets. Rochet and Tirole (2003), Schmalensee (2002), Wright (2004), and Rysman (2009) analyse card-network pricing, interchange, adoption, and platform competition. The present paper keeps the two-sided structure but adds a viability margin: the fixed fee changes the set of relationships that can settle at all. This differs from models that take the set of transactions as observed and study only the division of surplus over that set. The two-sided-market literature is also a guardrail: lower processing cost alone need not produce efficient adoption when rewards, steering, brand trust and merchant acceptance matter. The present paper therefore reports a feasible-flow envelope, not realised take-up.

Recent contributions in *Journal of Industrial and Business Economics* help define the journal-specific positioning of this paper. Gutiérrez-Hita et al. (2026) study market concentration and competitiveness in Moroccan telecommunications and show that liberalisation affected adoption unevenly across voice and internet segments, with mobile connectivity weakening incumbent fixed-infrastructure dominance. The present paper uses the same industrial-organisation logic but shifts the infrastructure margin from broadband access to payment settlement: the user-facing fixed fee is an access condition that governs whether low-flow relationships can enter the market. Perez et al. (2026) decompose Colombian retail gasoline prices into wholesale cost pass-through, strategic complementarities, and market-power components. This paper adopts a parallel decomposition for payment platforms by separating switching-cost savings, platform-margin surplus stakes, and flow excluded by the fixed-fee boundary. In both settings, pass-through is not a mechanical consequence of cost change; it depends on market structure and strategic pricing.

The paper also connects to JIBE work on demand externalities, market creation, digital transition, and digital risk. Angelini et al. (2026) show that price competition under vertical differentiation depends on willingness to pay, income heterogeneity, and demand externalities. Payment platforms exhibit the same problem in two-sided form: pricing changes adoption, and adoption changes the value of the platform to the other side. Adilov and Alexander (2026) model market creation as a function of demand, production cost, and institutional risk, showing how regulation can make previously infeasible markets viable. The fee-floor mechanism here is a payment-market analogue: lowering the fixed fee and preserving institutional trust can move low-flow relationships from non-existence to commercial feasibility. Succurro (2026) shows that digital transformation affects firm performance most strongly when technological adoption is paired with strategic digital intent. This paper extends that digital-transition perspective to payment infrastructure: small-flow settlement is a strategic input for firms, platforms, and

automated services, not merely a back-office cost. Finally, Abrardi et al. (2026) emphasise that digital infrastructures require attention to firms, users, attackers, and regulators. That framing motivates the paper's separation between switching cost and trust cost: lower processing cost does not eliminate fraud, compliance, dispute-resolution, or regulatory constraints.

The paper also contributes to industrial-organisation work on technology, scale, and market power. Lashkari et al. (2024), Elliott et al. (2025), and Kalyani et al. (2025) study how technological primitives alter cost structure, returns to scale, and diffusion. The contribution here is analogous for payment processing: a cost primitive is translated into a platform-pricing, market-boundary, and industrial-policy problem. The relevant economic object is the fixed-fee floor and the lower tail of excluded exchange, not the technical system itself.

Finally, the paper relates to blockchain and digital-payment economics. Budish (2025), Huberman et al. (2021), Easley et al. (2019), and Catalini and Gans (2020) study mining, fees, verification, and trust costs in blockchain systems. Hendrickson et al. (2016), Garratt and Wallace (2018), Auer et al. (2025), and Bolt et al. (2024) examine monetary and institutional features of digital settlement systems. This paper uses that literature to delimit the counterfactual cost environment. Its central claim is an industrial-organisation claim about fixed fees, market power, and missing markets under payment-platform pricing.

2 Payment-Platform Institutions and the Cost Counterfactual

This section identifies the institutional facts used in the model. Payment networks perform two economically distinct functions. They switch messages and records so that a transaction can be authorised, cleared, and settled. They also supply trust: rules, liability allocation, fraud management, chargeback procedures, compliance, and finality. The model separates those functions because only the first is a pure processing-cost primitive. The second remains an institutional cost and is not assumed to vanish.

2.1 Authorisation, Clearing, and Settlement

A card payment passes through authorisation, clearing, and settlement. In authorisation, the merchant routes a transaction through an acquirer and card network to the issuer, which approves or declines the transaction. In clearing, transaction records are matched, batched, and netted. In settlement, net funds move between financial institutions, typically through a bank settlement mechanism. Each stage contains a computational switching task and an institutional trust task. The switching task is the transmission, validation, and recording of data. The trust task is the set of guarantees, liabilities, and enforcement rules that make the recorded outcome credible.

The distinction matters because the fixed fee paid by merchants is not simply the resource cost of moving data. It bundles switching, risk, rewards, dispute resolution, compliance, network rules, and platform margin. A reduction in switching cost therefore need not eliminate trust costs, and it need not be passed through to users. The paper's calibration treats the switching-cost saving, the incumbent margin, and the excluded lower tail as separate objects.

2.2 The Fee Stack and the Fixed-Fee Floor

For a typical US retail card transaction, the merchant-facing charge combines a fixed per-transaction component and an ad valorem component. The ad valorem part includes interchange, network assessments, acquirer margin, and the reward system funded through interchange. The fixed component includes authorisation and processing charges that are material for small transactions. Visa's FY2024 filing reports total operating expenses of \$12.3 billion on 233.8 billion processed transactions, or \$0.053 per transaction. The line item closest to pure switching cost is the reported network-and-processing expense of \$778 million, or about \$0.0033 per transaction.¹

The empirical gap between merchant fees and reported switching cost is large. End-user card acceptance costs on a representative \$50 credit-card transaction are roughly one to two dollars, depending on card type, merchant category, acquirer terms, and rewards, while the reported network-and-processing cost proxy is a fraction of one cent. The model does not treat this gap as pure deadweight loss. Some of it compensates issuers, acquirers, fraud management, compliance, consumer rewards, and network investment. Some may be rent. The relevant point for the fee-floor mechanism is simpler: a positive fixed fee creates a discontinuity at the bottom of the value distribution, because a small-flow relationship must cover the fixed fee before it can settle at all.

2.3 Budish's Trust-Cost Result and Its Scope

Budish (2025) studies the cost of anonymous proof-of-work trust. In that setting, a free-entry zero-profit condition for miners and an attacker incentive-compatibility condition imply that security expenditure must scale with the value at risk. The result is a theorem about Nakamoto trust. It is not a theorem about every payment system, and it is not a model of card pricing, interchange, legal enforcement, chargebacks, fraud governance, or regulated settlement.

The present paper uses Budish as a boundary condition. If switching and trust are fused inside anonymous proof-of-work, the security-cost result dominates. If switching is performed by identified operators inside an institutional enforcement environment, switching cost and trust cost can be modelled separately. The model below therefore writes per-transaction cost as a value-independent switching component plus fixed and proportional trust components. This does not assume trust is free. It says only that the mechanical act of processing a transaction need not scale with the transaction's dollar value.

Table 1 is used again in the model interpretation: rows 1–3 define the institutional-enforcement boundary, rows 4–6 define the market-power and deterrence boundary, and rows 7–8 define the switching-cost boundary. The table is not used to reject Budish's result. It is used to identify which object is being analysed. The fee-floor mechanism developed below requires only that the payment rail has a fixed per-transaction price and that a lower fixed price is technologically and institutionally feasible. The economic mechanism is independent of whether the rail is operated by a private processor, a bank consortium, or a public authority.

¹Visa Q4 FY2024 Earnings Release, fiscal year ended September 30, 2024. The "network and processing" line reports \$778 million for the twelve months ended September 30, 2024. I treat it as a conservative accounting proxy for switching cost, not as a directly observed marginal cost.

Table 1: Scope conditions in Budish (2025) and regulated-payment analogues

#	Model assumption	Role in result	Regulated-payment analogue
1	Anonymous participants	Prevents identification and legal sanction of attackers	KYC-identified operators; forensic deanonymisation
2	Costless entry into trust support	Ensures zero economic profit in equilibrium	IT capital, licensing, compliance systems, and regulatory approval are sunk
3	No legal enforcement	Attack deterred only by flow expenditure	Fraud prosecuted; operators are legal entities
4	Zero-profit equilibrium	Sets flow expenditure equal to flow revenue	Regulated payment processors report positive operating margins
5	Attack value scales with system importance	V_{attack} unbounded	Bounded by confirmation rules, withdrawal limits, law
6	Flow expenditure is the sole deterrent	No durable collateral, no stock-like penalties	Sunk IT and compliance capital, licensing bonds, legal asset seizure
7	Processing and trust fused	Switching cost inherits security-cost scaling	Switching and institutional trust can be separated
8	Fixed throughput	No processing economies of scale	Throughput-elastic processing lowers average switching cost

2.4 The Cost-Shock Counterfactual

The cost-shock counterfactual is a value-independent near-zero fixed fee. The comparison rail charges by transaction data size rather than by transaction value: a standard payment message faces the same processing fee whether it carries a small or large value. The main text uses a central low fixed fee of approximately \$0.000003 and reports sensitivity to alternative fixed-fee floors. Implementation-specific conversion details are left to the online appendix; the structural assumption used in the model is value independence of the fixed fee.

This cost shock is not enough to predict entry or adoption. A low-fee rail still needs trust, legal accountability, fraud controls, user adoption, merchant acceptance, and routing incentives. Those constraints are why the paper reports a feasible-flow envelope rather than realised take-up. The role of the cost shock is to move the fixed-fee floor. Once the floor falls from approximately \$0.10 to approximately \$0.000003, the set of relationships that can in principle settle expands by orders of magnitude at the bottom of the flow distribution.

3 Model

3.1 Minimal mechanism and full platform environment

The minimal mechanism is a participation inequality. A relationship with period flow x , surplus rate m , and fixed fee ϕ can settle only if $mx \geq \phi$. The platform model below adds buyer adoption, seller acceptance, ad valorem pricing, and market power because those margins determine pass-through and observed volume. They are not required to create the fixed-fee boundary itself. This separation is important for interpretation: the paper's central comparative static is the movement of the participation floor, while the two-sided structure explains why a lower cost need not become a lower user-facing fixed fee.

3.2 Players and Timing

The economy has three types of agents: a *payment platform* (monopolist processor, later extended to competition), a unit mass of *buyers*, and a unit mass of *sellers*. Transactions are heterogeneous in value.

1. The platform chooses infrastructure/payment rail $\theta \in \{C, H\}$ (incumbent or low-fixed-fee), a per-transaction fee ϕ_0^θ , and an ad valorem rate ϕ_1^θ .
2. Buyers observe fees and decide whether to adopt the platform.
3. Sellers observe fees and buyer adoption, and decide whether to accept.
4. Adopted buyer–seller pairs draw transaction values $v \sim G(v)$ on $(0, \infty)$ with density g , mean μ_v , and finite variance. Each pair generates $\mu_\alpha > 0$ transaction opportunities per period. A transaction of value v occurs if it is *viable*: the seller's net surplus from the transaction exceeds zero.

3.3 Transaction Costs and Fees

Assumption 1 (Cost Structure). *The platform's per-transaction cost for a transaction of value v under architecture θ is:*

$$q_\theta(v) = \underbrace{s_\theta}_{\text{switching cost (value-indep.)}} + \underbrace{\tau_0^\theta + \tau_1^\theta \cdot v}_{\text{trust cost (fixed + proportional)}} \quad (1)$$

where s_θ is the per-transaction switching cost (architecture-determined, independent of v); τ_0^θ is the fixed per-transaction trust cost (compliance check, dispute infrastructure, base fraud screening); and $\tau_1^\theta \cdot v$ is the value-proportional trust cost (fraud risk, chargeback exposure, AML monitoring, insurance). For routine retail payments within the legal system's design parameters, τ_1 is small but positive. For high-value or high-risk transactions, τ_1 may be substantial.

Under the centralized architecture, $s_C = K_C/\Lambda + m_C$ (decreasing in volume). Under the low-fee settlement rail, $s_H = \kappa/(\lambda_1\eta(M))$ (approximately constant). For the counterfactual

low-fee rail, the relevant user-facing fixed fee is assumed to be value-independent in Assumption 3; institutional trust costs remain separate.

Assumption 2 (Fee Structure). *The platform charges a per-transaction fee ϕ_0 and an ad valorem rate ϕ_1 :*

$$f(v) = \phi_0 + \phi_1 \cdot v \quad (2)$$

The per-transaction fee ϕ_0 covers processing cost plus network margin. The ad valorem rate ϕ_1 includes interchange (which funds consumer rewards), acquirer margin, and network assessment. In the incumbent card network, $\phi_0 \approx \$0.10$ – $\$0.22$ (per-transaction authorisation fee) and $\phi_1 \approx 0.015$ – 0.025 (merchant discount rate). Consumer rewards are funded by a fraction β of interchange: $r(v) = \beta \cdot \alpha \cdot v$ where α is the interchange rate and $\beta \in [0, 1]$ is the passback rate.

3.4 Minimum Viable Transaction

Definition 1 (Minimum Viable Transaction Value). *A transaction of value v is viable for the seller if the seller's surplus from the transaction net of the platform fee exceeds zero:*

$$v \cdot p_S - f(v) = v \cdot (p_S - \phi_1) - \phi_0 \geq 0 \quad (3)$$

where $p_S > \phi_1$ is the seller's gross margin per unit of transaction value. The minimum viable transaction value is:

$$v^* = \frac{\phi_0}{p_S - \phi_1} \quad (4)$$

Transactions with $v < v^*$ are *priced out at the level of the standalone transaction*: the per-transaction fee exceeds the seller's net margin on that sale considered in isolation. This does not mean such transactions never occur—as the calibration documents, billions of sub-\$5 card payments occur annually—but that where they occur, the fixed per-transaction fee on the individual sale is not covered by that sale's own margin and is absorbed elsewhere in the customer relationship (formalised in the settlement model of Section 4). Lower ϕ_0 —which can be achieved through lower s_θ —reduces v^* and expands the set of transactions viable on a standalone basis.

3.5 Buyers, Sellers, and the Platform Problem

Buyers are heterogeneous in adoption cost $b \sim \tilde{B}$ on $[0, \bar{b}]$ and receive consumer rewards $r(v) = \beta\alpha v$; sellers are heterogeneous in acceptance cost $a \sim H$ on $[0, \bar{a}]$. A buyer adopts when the expected net surplus over viable transactions, scaled by seller participation n_S , exceeds her adoption cost; a seller accepts when expected net revenue, scaled by buyer participation n_B , exceeds her acceptance cost. The resulting participation masses are

$$n_B = \tilde{B} \left(\mu_\alpha n_S \int_{v^*}^{\infty} [(c_0 - \phi_0) + (\beta\alpha - \phi_1')v] g(v) dv \right), \quad (5)$$

$$n_S = H \left(\mu_\alpha n_B \int_{v^*}^{\infty} [v(p_S - \phi_1) - \phi_0] g(v) dv \right), \quad (6)$$

where c_0 is the cash outside-option cost and ϕ'_1 the buyer-side ad valorem cost (typically zero or negative net of rewards). The integrals run over viable transactions only. Online Appendix A.1 states the underlying type-by-type adoption conditions in full and proves existence and uniqueness of the resulting fixed point.

Definition 2 (Platform Equilibrium and Problem). *Given fees (ϕ_0, ϕ_1) , technology θ , and rewards (α, β) , an equilibrium is a triple (n_B^*, n_S^*, v^*) solving (5)–(6) with $v^* = \phi_0/(p_S - \phi_1)$, and transaction volume*

$$\Lambda^* = n_B^* n_S^* \mu_\alpha [1 - G(v^*)]. \quad (7)$$

Volume depends on three margins—buyer adoption n_B^ , seller acceptance n_S^* , and transaction viability $1 - G(v^*)$. The third margin, absent in models with homogeneous transaction values, is what distinguishes this framework. The platform chooses $(\theta, \phi_0, \phi_1, \alpha, \beta)$ to maximise*

$$\pi = n_B^* n_S^* \mu_\alpha \int_{v^*}^{\infty} [\phi_0 + \phi_1 v - q_\theta(v)] g(v) dv - F_\theta, \quad (8)$$

with $q_\theta(v) = s_\theta + \tau_0^\theta + \tau_1^\theta v$ and F_θ the fixed infrastructure cost.

The platform's three instruments interact: ϕ_0 moves the minimum viable transaction v^* and adoption; ϕ_1 sets the per-transaction margin and, through interchange, funds the rewards that drive buyer adoption; θ determines the cost structure. The key comparative statics concern how a reduction in s_θ propagates through the three margins; the total-margin characterisation is derived in full in Online Appendix A.1.

3.6 Market Power, Pass-Through, and the Fixed Fee

The fee-floor mechanism is a price mechanism, not a mechanical cost mechanism. A lower switching cost expands the feasible set only if it lowers the user-facing fixed fee. Under market power, that pass-through is not automatic.

Proposition 1 (Fixed-fee markup under market power). *Fix ϕ_1 , rewards, and technology, and write equilibrium transaction volume as $\Lambda(\phi_0)$ with $\Lambda'(\phi_0) < 0$. Let $\bar{q}_0$ denote the fixed per-transaction component of marginal cost relevant to ϕ_0 . If the platform chooses an interior fixed fee and the semi-elasticity of volume with respect to the fixed fee is finite, then*

$$\phi_0^* - \bar{q}_0 = \frac{\Lambda(\phi_0^*)}{-\Lambda'(\phi_0^*)} > 0. \quad (9)$$

A fall in switching cost lowers the participation floor only to the extent that it is passed through into ϕ_0^ . If $\rho \equiv \partial\phi_0^*/\partial s_\theta$ is the fixed-fee pass-through rate, then the change in the relationship participation floor is*

$$\frac{\partial}{\partial s_\theta} \left(\frac{\phi_0^*}{m} \right) = \frac{\rho}{m}. \quad (10)$$

When $\rho = 0$, a switching-cost reduction has no extensive-margin participation effect; when $\rho > 0$, the floor falls in proportion to pass-through.

Proof. With ϕ_1 , rewards, and technology fixed, the part of operating profit affected by the fixed fee can be written as $(\phi_0 - \bar{q}_0)\Lambda(\phi_0)$ plus terms not varying with ϕ_0 . The first-order condition

for an interior optimum is

$$\Lambda(\phi_0) + (\phi_0 - \bar{q}_0)\Lambda'(\phi_0) = 0.$$

Since $\Lambda'(\phi_0) < 0$, rearranging gives (9). The participation floor for a relationship with surplus rate m is ϕ_0^*/m , so differentiating with respect to s_θ gives (10). The proposition does not assume full pass-through; it makes the extensive-margin effect conditional on the pass-through rate. $\square$

This result is the reason the calibration keeps cost savings, margin stakes, and feasible-flow effects separate. Lower processing cost is a resource saving on transactions that already occur. Lower fixed fees change the participation set. Market power determines how much of the former becomes the latter.

4 Main Results

The results characterise the response to fixed-fee and cost changes under the model of Section 3, operating on three margins: buyer adoption, seller acceptance, and transaction viability. Proposition 1 supplies the market-power channel; the remaining results separate cost savings from the participation effects of the fee floor.

4.1 Value-Independent Fixed-Fee Counterfactual

Assumption 3 (Value-independent fixed-fee rail). *In the counterfactual rail, the user-facing fixed component ϕ_H is determined by message-processing cost and does not vary with transferred value: $\partial\phi_H/\partial v = 0$. Institutional trust costs remain separate and may contain value-dependent components, including fraud, compliance, chargeback, sanctions, liquidity, and dispute-resolution costs. The assumption concerns the fixed-fee component of the price schedule, not total payment-system cost.*

This assumption is the cost-environment primitive for the fee-floor exercise. The economic results below do not follow merely from value independence. They follow from the interaction of that fixed fee with platform market power, pass-through, and the participation condition for low-flow relationships.

4.2 Minimum Viable Transaction

Proposition 2 (Comparative Statics of the Minimum Viable Transaction). *The minimum viable transaction value $v^* = \phi_0/(p_S - \phi_1)$ is:*

- (a) *Increasing in the per-transaction fee ϕ_0 .*
- (b) *Decreasing in the seller's net margin $(p_S - \phi_1)$.*
- (c) *Conditional on positive fixed-fee pass-through $\rho = \partial\phi_0^*/\partial s_\theta > 0$, increasing in s_θ : lower switching cost reduces v^* and expands the viable transaction set only through its effect on the user-facing fixed fee.*

Proof. (a) and (b): differentiation of $v^* = \phi_0/(p_S - \phi_1)$. (c): by the chain rule, $\partial v^*/\partial s_\theta = [1/(p_S - \phi_1)](\partial \phi_0^*/\partial s_\theta)$, so the sign is positive only when fixed-fee pass-through is positive. $\square$

Under the incumbent card architecture, $\phi_0 \approx \$0.10$ – $\$0.22$. With a merchant net margin of 3%, the naive single-transaction threshold is $v^* \approx \$10$ – $\$22$. Observed card data show that this threshold is not a literal floor on retail card payments: billions of sub-\$5 card transactions occur annually. That fact changes the interpretation rather than invalidating the mechanism. The binding object is not an isolated retail purchase that can be bundled with a wider customer relationship, but a standalone relationship flow with no larger basket, subscription, or repeat-customer margin against which the fixed fee can be absorbed. The model below therefore works with relationship flows rather than isolated retail transaction values. When the user-facing fixed fee falls, and only to the extent that it falls, this standalone relationship-flow constraint relaxes.

4.3 Welfare Decomposition

Proposition 3 (Welfare with Heterogeneous Transaction Values). *The welfare gain from switching architecture C to H, holding adoption fixed, decomposes as:*

$$\Delta W = \underbrace{n_B n_S \mu_\alpha \int_{v_C^*}^{\infty} [q_C(v) - q_H(v)] g(v) dv}_{\text{Intensive margin: cost saving on existing transactions}} + \underbrace{n_B n_S \mu_\alpha \int_{v_H^*}^{v_C^*} [v \cdot p_S - q_H(v)] g(v) dv}_{\text{Extensive margin: surplus from newly viable transactions}} \quad (11)$$

The intensive term is positive when $q_H(v) < q_C(v)$ for $v \geq v_C^$. The extensive term is positive when newly viable transactions have non-negative net social surplus under the low-fee rail, $v p_S \geq q_H(v)$ for $v \in [v_H^*, v_C^*]$.*

Proof. $W_\theta = n_B n_S \mu_\alpha \int_{v_\theta^*}^{\infty} [v \cdot p_S - q_\theta(v)] g(v) dv$ minus fixed and adoption costs. $\Delta W = W_H - W_C$ splits at v_C^* . $\square$

The intensive margin is the resource saving on transactions viable under both rails; it does not depend on pass-through. The extensive margin is the surplus from small transactions that become viable when per-transaction fees fall; it depends on pass-through because these transactions are induced by lower fees.

4.4 Natural Monopoly

Corollary 1 (Weakened Server-Cost Rationale). *Under the centralized architecture, average cost $K_C/\Lambda + m_C$ is sharply decreasing in Λ . Under the low-fee settlement rail, average cost $\kappa/(\lambda_1 \eta(M))$ is approximately constant, weakening one server-cost rationale for natural monopoly. This does not establish that entry would occur: interchange, fraud-detection scale, network effects, regulation, and brand trust are independent barriers (Section 5.11).*

5 Calibration

The calibration is presented results-first. It begins with the policy variable—the fixed fee—and asks how the feasible-flow envelope changes as that fee, the incumbent floor, and the lower-tail continuation are varied. Table 2 gives the main robustness message before the parameter details. Tables 3, 8, 9, and 10 then report the fee schedule, fee-floor sensitivity, lower-tail attenuation, and non-Pareto capped-tail checks. The central Pareto scenario is reported only after these bounds because it is one reproducibility benchmark inside the sensitivity architecture.

The calibration has three audit boundaries. Directly observed inputs are public fee schedules, Federal Reserve card-value bins, and Visa accounting categories. Model-implied objects are the relationship-flow tail, the fee-floor interval, and the feasible-flow envelope. The paper does not estimate adoption, realised demand, revenue, welfare, transaction count, or the number of firms, devices, or counterparties. This structure is deliberate: the industrial-organisation claim is the fixed-fee boundary; the numerical exercise measures how sensitive that boundary is to conservative empirical choices.

Table 2: Robustness findings before the central scenario

Exercise	Conservative change	Feasible-flow envelope implication
Low fixed-fee floor	Raise ϕ_H from \$0.000003 to \$0.001	Falls from 18.4 to 7.7 trillion dollars per year
Lower-tail attenuation	Retain only 10% of fitted lower-tail intensity	Falls to 0.7–2.0 trillion dollars per year across reported fee pairs
Non-Pareto lower tail	Cap density below \$1 rather than continue the Pareto form	Falls to 0.8 trillion dollars per year
Central Pareto scenario	Use fitted upper-tail continuation without attenuation	18.4 trillion dollars per year at the primary cell

Notes: Entries summarise the detailed calculations in Tables 8, 9, 10, and 11. The table is not a point estimate; it shows that the mechanism survives when the lower-tail continuation is made substantially less favourable.

5.1 Counterfactual Low-Fee Rail

The low-fixed-fee rail is a counterfactual price schedule, not a forecast of a particular entrant's adoption. The relevant parameter is the user-facing fixed fee ϕ_H , because Proposition 1 shows that lower switching cost affects the participation set only through pass-through into ϕ_0 . The central low-fee benchmark, \$0.000003 for a standard payment message, anchors an order-of-magnitude experiment. It is not a structural constant. The empirical conclusions use the fee-floor and robustness tables, not the central fee alone. Implementation-specific engineering evidence is kept in the online appendix and treated as a counterfactual cost input rather than as an adoption forecast.

Production overheads, redundancy, monitoring, governance, compliance, and dispute processes are not zero. They are allocated to the trust and operating-cost terms τ_H rather than to the mechanical switching component s_H . If some are reclassified as processing, the effective

s_H rises, but the fee-floor experiment remains the same: the extensive margin depends on the user-facing fixed fee, not on the engineering benchmark by itself. Online Appendix A.4 gives robustness for the switching-cost floor and Online Appendix A.5 discusses benchmark-versus-production cost.

5.2 Incumbent Cost Parameters

From Visa’s Q4 FY2024 Earnings Release: 233.8 billion processed transactions; total operating expenses \$12.3B (\$0.053/tx); network & processing expense \$778M (\$0.0033/tx). I use the reported “network and processing” line as the centralized switching cost $s_C = \$0.0033/\text{tx}$, a conservative measure that captures only the expense category Visa explicitly labels as processing infrastructure and excludes technology-related costs embedded in personnel, depreciation, or other lines. This is an accounting average, not a marginal cost; if the true marginal switching cost is lower, the welfare floor shrinks but the ratio of margin to switching cost rises, reinforcing the decomposition. The residual $\tau_C = \$0.053 - \$0.0033 = \$0.049/\text{tx}$ (personnel, marketing, G&A, depreciation, litigation) is treated as an *upper bound* on trust-related cost, since it includes activities unrelated to fraud prevention or compliance; total per-transaction cost is $q_C = \$0.053/\text{tx}$. The calibration varies the trust ratio τ_H/τ_C across its full range $[0, 1]$ rather than selecting a point; Online Appendix A.1 discusses which trust components (τ^{fraud} , τ^{comp} , τ^{disp}) plausibly change under the low-fee settlement rail. For comparison, ACH processed 31.5 billion payments in 2023 at \$0.006/tx (FedACH, combined origination and receipt), and Fedwire processed 204 million transfers at \$0.25–\$0.83/tx (midpoint \$0.54).

5.3 Demand and Fee-Structure Parameters

US non-cash payment volume: approximately 200 billion transactions/year (Federal Reserve Payments Study, 2022 Triennial). The transaction-value distribution $G(v)$ is needed for the extensive margin but is not calibrated in this paper; I present results under illustrative distributional assumptions and identify $G(v)$ calibration as a direction for future empirical work.

The incumbent card network charges merchants a per-transaction authorisation fee $\phi_0^C \approx \$0.10$ –\$0.22 plus an ad valorem merchant discount rate $\phi_1^C \approx 0.015$ –0.025 of transaction value (interchange plus acquirer margin plus network assessment). The ad valorem component funds consumer rewards (cash back, points) through interchange; it is a pricing instrument, not a processing cost.

In the counterfactual rail, the fixed fee is assumed to be value-independent: the same message-processing fee applies to a low-value and a high-value transfer. The central benchmark is $\phi_H = \$0.000003$, with sensitivity reported over wider values in Table 3. The table is intentionally implementation-neutral. Its role is to show how far a low fixed fee can sit below the incumbent retail-card fixed fee, not to require a particular technology or governance arrangement.

Across this range, the low fixed-fee rail remains two to five orders of magnitude below the incumbent fixed-fee floor. Subsequent calculations report the central \$0.000003 benchmark for transparency, but the JIBE-relevant claim is not tied to that quotation. The tables below show how the feasible-flow envelope changes as the low fee rises by orders of magnitude. Additional

Table 3: Low fixed-fee benchmark and ratio to incumbent retail-card fee floor

Low fixed fee ϕ_H (USD/tx)	Ratio to incumbent \$0.10 floor	Participation floor at $m = 10\%$
\$0.000001	100,000:1	\$0.00001
\$0.000003	33,333:1	\$0.00003
\$0.000010	10,000:1	\$0.00010
\$0.000100	1,000:1	\$0.00100
\$0.001000	100:1	\$0.01000

implementation-specific conversion details are reported in the online appendix.

This structural difference—the low-fee rail has a value-independent fixed fee, while the incumbent merchant charge combines a fixed per-transaction component with an ad valorem component—is the model’s central empirical input beyond the switching-cost differential. It determines the minimum viable transaction through Proposition 2.

Table 4 adds a direct empirical anchor for the fixed-fee mechanism. The point is not that any one schedule defines a universal merchant price. It is that public payment schedules routinely contain fixed-dollar components, minimum fees, or per-item fees that create discontinuities at the lower tail. This turns the fixed-fee floor into an observed industrial-organisation object rather than a modelling artefact.

5.4 The Transaction-Value Distribution

The extensive margin depends on the distribution of transaction values, which the Federal Reserve Payments Study measures directly. Table 5 reports the 2022 distribution of US general-purpose card payments by transaction-value range.

Source: Federal Reserve Payments Study, NPIPS detailed data, November 2024 release, GP Card Payments by transaction-value range, calendar year 2022.

Two facts in this distribution are central to the model. First, small transactions are not absent under the incumbent architecture: 20.15 billion card payments under \$5 and 41.01 billion (26.7%) under \$10 occur annually. The minimum viable transaction is therefore *not* a hard threshold at \$10 or any other value; cards process tiny transactions at scale. Second, these small transactions carry a disproportionately small share of value: sub-\$5 transactions are 13.1% of card transactions by number but 0.51% by value (\$50 billion of \$9.76 trillion).

This second fact is the economically relevant one and corrects the model’s earlier treatment. The incumbent’s fee on a transaction is approximately $\phi_0 + \phi_1 v$, with a per-transaction component ϕ_0 and an ad valorem component $\phi_1 v$. On a \$2.31 transaction (the average in the sub-\$5 band), the per-transaction interchange and processing fees consume a large fraction of the transaction value, and where the fixed fee exceeds the merchant’s margin on the individual sale, the transaction is not individually profitable to route through the card network. Such transactions are consistent with cross-subsidisation across the customer relationship: refusing card acceptance forfeits the broader relationship, so the fixed per-transaction fee on the small sale is absorbed against the merchant’s larger transactions. This is a pattern consistent with the data, not a claim that every small card transaction is individually unprofitable; high-margin, basket,

Table 4: Observed fixed-fee components in public US payment schedules

Payment schedule	rail or	Public fixed-fee component	Fee-floor implication
Visa debit, Small Ticket	CPS	1.55% + \$0.041 for exempt Visa check-card transactions	Even a small-ticket rate retains a fixed-dollar component.
Visa regulated debit, card-present		0.05% + \$0.21 for regulated Visa check-card transactions	Regulated debit still contains a fixed per-transaction component.
Visa credit, retail performance threshold	retail	Percentage rate plus \$0.10 in multiple retail credit categories	The incumbent card schedule embeds fixed-dollar terms across mainstream retail categories.
FedACH pricing	service	Per-item fees measured in fractions of a cent to several mills, depending on item type and channel	Low-value bank rails show that fixed fees can be much lower than card-acceptance fees while remaining positive.
FedNow pricing	service	Public Federal Reserve priced-service schedules use a per-transfer fee for instant payments	Instant settlement is also priced with an explicit per-item fee rather than a pure ad valorem charge.

Notes: Visa entries are from the public Visa USA Interchange Reimbursement Fees schedule (Visa Inc., 2026). Federal Reserve entries summarise public Federal Reserve priced-service fee schedules (Board of Governors of the Federal Reserve System, 2024). The table is not a merchant-cost estimate and does not aggregate all acquirer, processor, assessment, fraud, or compliance charges. Its role is narrower: public payment schedules confirm that fixed components and per-item fees are institutional pricing variables.

retention, and subscription effects may render some profitable in isolation.

The low-fee rail fee is value-independent: under the central benchmark a standard payment message costs approximately \$0.000003 (Table 3), the same regardless of transaction value. The model’s relevant prediction is therefore not that small transactions “become viable” (they already occur), but that the cross-subsidy required to support them is eliminated. The welfare consequence is the removal of the deadweight loss from cross-subsidisation, plus whatever new relationship types become economic at a per-transaction fee several orders of magnitude below \$0.10—a category (machine-to-machine payments, metered data, per-call settlement) that does not appear in Table 5 because it cannot exist under the incumbent fee structure and is therefore unmeasured.

5.5 What Can and Cannot Be Quantified

The intensive margin can be quantified from verified data. The resource saving on existing transactions is $\Lambda_0 \times \Delta s$, where $\Delta s = s_C - s_H \approx \0.0033 and $\Lambda_0 \approx 200$ billion US non-cash transactions: approximately \$700 million annually. This holds regardless of the value distribution because the switching cost is value-independent under both rails.

Table 5: US general-purpose card payments by transaction-value range, 2022

Value range	Number (B)	% of number	Cumulative %	Value (\$T)
Less than \$5.00	20.15	13.1%	13.1%	0.05
\$5.00–\$9.99	20.86	13.6%	26.7%	0.16
\$10.00–\$14.99	18.10	11.8%	38.6%	0.22
\$15.00–\$24.99	24.24	15.8%	54.4%	0.48
\$25.00–\$49.99	30.50	19.9%	74.3%	1.10
\$50.00–\$99.99	21.23	13.8%	88.1%	1.50
\$100.00–\$499.99	16.12	10.5%	98.6%	3.11
\$500.00–\$999.99	1.31	0.9%	99.5%	0.91
\$1000.00 or greater	0.81	0.5%	100.0%	2.23
Total	153.32	100%		9.76

Two distinct quantities are used in this paper and must not be conflated. The \$700 million floor is a *resource-cost* result: it compares the incumbent's reported switching *cost* (\$0.0033/tx) with the low-fee rail engineering cost, and measures real resources saved. The fee-floor result developed below is a *price* result: it compares the incumbent merchant *fee* floor (\$0.10–\$0.22/tx) with the low-fee rail fee (Table 3), and measures which relationships can afford to transact. The resource-cost saving accrues on transactions that already occur; the fee floor determines which transactions occur at all. The two are computed from different objects (cost versus fee) and are not combined. This intensive margin is not the economically significant effect: that is the set of transactions the incumbent fee structure excludes entirely.

Table 6 states the evidentiary boundary of the calibration. It separates what is observed directly from what is model-implied and from what the paper does not estimate. This table is part of the empirical design: it prevents the feasible-flow envelope from being read as measured demand, adoption, revenue, welfare, transaction count, or a forecast of machine-to-machine usage.

Table 6: Evidentiary boundary of the calibration

Category	Objects in the paper
Observed directly	Federal Reserve card transaction-value bins; public Visa and Federal Reserve fee schedules; Visa operating-expense categories, including the network-and-processing line; published non-cash payment volumes.
Model-implied	Relationship-flow tail; fee-floor participation interval; feasible-flow envelope excluded by the incumbent fixed fee and admitted by the low fixed fee; lower-tail attenuation bounds.
Not estimated	Realised adoption; welfare; revenue; transaction count; number of firms, devices, counterparties, or machine-to-machine relationships; actual demand for any particular low-fee rail.

Notes: The observed objects anchor the calibration. The model-implied objects are conditional on Assumption 5 and the lower-tail robustness exercises. The non-estimated objects are outside the paper's empirical claim.

5.6 The Fee Floor and the Existing Distribution

The intensive margin is not the economically significant effect. The significant effect is the transactions the incumbent fee structure excludes, which the remainder of this section models from the decisions of the transacting parties.

The starting observation is that the fixed per-transaction fee floor differs sharply across the incumbent and counterfactual rails. The incumbent card network's per-transaction fixed fee component is a representative low-end figure of approximately \$0.10–\$0.22; card pricing varies by card type, debit versus credit, merchant category, processor, routing, and contract, so this is a representative fixed component rather than a single universal floor.² The counterfactual low-fee rail is represented by a user-facing fixed fee of approximately \$0.000003. The ratio is approximately 33,000:1. Table 7 translates these fees into the smallest standalone relationship value each rail can serve, $v^* = \phi_0/m$, across surplus rates m ; the formula is derived below (Proposition 4).

Table 7: Smallest standalone relationship value ($v^* = \phi_0/m$) by architecture and surplus rate

Surplus rate m	Incumbent v^* ($\phi_0 = \$0.10$)	Horizontal v^* ($\phi_0 = \$0.000003$)
30%	\$0.33	\$0.00001
10%	\$1.00	\$0.00003
3%	\$3.33	\$0.0001
1%	\$10.00	\$0.0003

The Fed distribution (Table 5) shows that the existing card market already extends below the incumbent v^* values—sub-\$5 transactions occur at scale—in a manner consistent with cross-subsidisation of small transactions across a bundled customer relationship, especially where the fixed payment fee exceeds the merchant's margin on the individual sale. Such cross-subsidisation has a limit: it requires the small transaction to be bundled with larger ones. A standalone \$0.01 transaction between two parties with no larger relationship cannot be cross-subsidised and cannot occur on the incumbent rails. The model below derives the boundary of what can be settled, and the two channels through which the fee floor suppresses transactions, from primitives.

5.7 Modelling the Suppressed Category

The claim that a near-zero per-transaction cost creates a large market requires a model of why those transactions do not occur at a positive fee and what determines their number and value. I build one from the decisions of the transacting parties, deriving rather than assuming the two channels through which the fee floor suppresses transactions.

Primitive: a population of economic relationships. The primitive is not a distribution of transactions—that is an outcome—but a distribution of economic *relationships*, each generating a flow of value that can be settled on a payment rail. Index relationships by i . Relationship i generates value x_i over a period (a data feed between two machines, a metered compute or

²Per-transaction interchange components are published in the card networks' public interchange schedules. The \$0.10 figure used here is a low-end representative value; using a higher figure widens the gap.

bandwidth service, a toll road, a per-call API). Relationships are heterogeneous in size: let the value-per-period x be distributed with density $f(x)$ on $[\underline{x}, \infty)$, with many small flows and few large ones. Each relationship chooses whether to settle on the rail, and if so, how finely.

The settlement decision. A relationship settling flow x over the period produces transactions at a per-transaction fee ϕ . The decision is two-stage, and the stages are sequential rather than jointly optimised. *Stage one, participation* (the extensive margin): the relationship settles its flow at all only if the surplus from settling covers the fee, $mx \geq \phi$, where m is the surplus rate. This viability test is on the participation surplus $mx - \phi$ alone and does not reference settlement frequency; a relationship for which $mx < \phi$ does not settle and takes the zero outside option, regardless of any timing considerations. *Stage two, conditional frequency* (the intensive margin): *conditional on having participated*, the relationship chooses how finely to settle. Finer settlement (frequency $n > 1$) yields an additional timing and liquidity benefit, increasing and concave, written $bx \log n$, against the incremental fee cost of the extra transactions; the participant solves

$$\max_{n \geq 1} [bx \log n - (n - 1)\phi], \quad (12)$$

the surplus on the additional $n - 1$ transactions beyond the single settling transaction already paid for at stage one. The sequential structure is stated as an assumption rather than left implicit:

Assumption 4 (Sequential Settlement). *Participation and settlement frequency are decided sequentially. A relationship first decides whether to settle at all, on the viability condition that its base surplus covers the first settlement fee, $mx \geq \phi$. Conditional on participating, it then chooses settlement frequency $n \geq 1$ to maximise timing/liquidity surplus net of incremental settlement fees, $bx \log n - (n - 1)\phi$. The timing/liquidity term does not enter the participation decision.*

The economic content of Assumption 4 is that timing and liquidity value is a benefit of settling *more often* a flow that is already being settled, not a reason to begin settling a flow whose base surplus does not cover a single transaction's fee. A relationship that cannot profitably clear one transaction does not transact, and the convenience of finer settlement is then moot. Under this assumption the participation floor is ϕ/m for every b : viability is a property of m and ϕ alone, and b governs only the settlement frequency of relationships that already clear. This is what makes the excluded interval below well-defined without observing b .

The surplus rate m is the counterpart of the net margin $(p_S - \phi_1)$ in Section 3: reducing the ad valorem rate ϕ_1 raises m and lowers the participation floor, consistent with $v^* = \phi_0/(p_S - \phi_1)$. The two formulations are not in conflict. For relationships whose whole-period flow x is below the per-transaction fee ϕ itself, no ad valorem reduction can render them viable, since $mx < x < \phi$ for any $m \leq 1$: the fixed per-transaction fee is the binding constraint at the bottom of the distribution, and only reducing ϕ admits these relationships. The ad valorem rate matters for the margin on payments that already clear; the fixed fee determines which relationships clear at all.

Two derived channels, and a refuted simple form. The transaction count integrates the per-relationship frequency over the participating set $\{x \geq \phi/m\}$; the closed form, derived in Online Appendix A.2, depends on whether the interiority cutoff ϕ/b lies below or above the participation floor. Either way the decomposition exhibits two channels, derived rather than posited: an

extensive (participation) channel—as ϕ falls the floor ϕ/m falls and relationships whose flow lay below the old fee begin to settle, genuinely new value—and an *intensive (divisibility) channel*, each interior relationship settling its flow more finely. The simplest form carries a refuted implication: in the interior regime every relationship settles to size ϕ/b , so interior transactions share one value; the Federal Reserve spread of transaction values (Table 5) rejects this homogeneous- b form, requiring heterogeneity in b (or a non-trivial corner region) that I do not calibrate, the data to identify the distribution of b not existing. I therefore claim no fitted transaction distribution. What survives without any parametric assumption is the comparative-static core:

Proposition 4 (Fee Floor and the Suppressed Set). *For any relationship distribution f , any $b > 0$, and any surplus rate $m \in (0, 1)$:*

- (a) *The participation floor is $v^*(\phi) = \phi/m$, with $\partial v^*/\partial \phi = 1/m > 0$. A strictly positive per-transaction fee excludes every relationship whose whole-period value is below ϕ/m .*
- (b) *For relationships with an interior settlement solution $n^*(x) = bx/\phi > 1$ (those large enough to settle more than once), the optimal transaction slice is ϕ/b , increasing in ϕ . Relationships at the corner $n = 1$ (those settling once) have transaction value equal to their full flow x , not ϕ/b . The average transaction value is therefore ϕ/b only on the interior; the full-distribution average requires the distribution of x and the interiority cutoff $x > \phi/b$.*
- (c) *Both the participation floor and the interior transaction slice are strictly increasing in ϕ and vanish only as $\phi \rightarrow 0$.*

Proof. (a) By Assumption 4, participation is decided on the viability condition $mx - \phi \geq 0$ alone, independently of the frequency choice and hence of b . Thus a relationship participates iff $x \geq \phi/m$, and $\partial v^*/\partial \phi = 1/m > 0$. The stage-two timing benefit (12) is a conditional refinement available only to participants and cannot move the floor. (b) For a participant, the stage-two first-order condition $bx/n - \phi = 0$ gives $n^*(x) = bx/\phi$ when this exceeds one, yielding slice $x/n^* = \phi/b$; when $bx/\phi \leq 1$ the constraint $n \geq 1$ binds, the relationship settles once, and the slice is its full flow x . The average transaction value is therefore ϕ/b only on the interior ($x > \phi/b$); the full-distribution average requires the distribution of x and the interiority cutoff. (c) Immediate from (a) and (b). None depends on f . $\square$

The fee-floor comparison. Proposition 4 settles the comparison without requiring a free parameter on the participation margin. The relevant object is the user-facing fixed fee ϕ , not the ad valorem rate and not the switching cost by itself. For very small relationships, the fixed fee is the binding discontinuity; reducing the ad valorem component cannot admit relationships for which even one fixed fee exceeds relationship surplus. The incumbent merchant fixed-fee component is represented by \$0.10, while the counterfactual low-fee rail uses \$0.000003. The two differ by a factor of approximately 33,000 in the participation floor. Other low-marginal-cost designs—central-bank rails, closed-loop wallets, prepaid or telecom-billing ledgers, and in-app credits—may also achieve low fixed fees. The claim is therefore not that a single architecture is uniquely necessary, but that a near-zero value-independent fixed fee changes the feasible set of standalone relationship flows.

5.8 The Identifiable Instance and Its Magnitude

Proposition 4 identifies which relationships the fee floor excludes. The next subsection estimates how large that excluded market is, by specifying and fitting the relationship-flow distribution, and then locates its largest observable instance.

5.9 Estimating the Feasible-Flow Envelope

The participation floor identifies which relationships are excluded. Estimating the scale of that excluded set requires a relationship-flow distribution $f(x)$ and an explicit account of what is observed. The empirical object of this section is therefore not a point estimate. It is a bounds architecture around the fixed-fee comparative static.

Specification. Flows of economic value, like firm sizes, city sizes, and incomes, are widely documented to follow power laws (Gabaix, 1999; Axtell, 2001; Gabaix, 2009). I model the relationship-flow population by a Pareto intensity measure

$$\mu(dx) = A x^{-(\theta+1)} dx, \quad x \geq x_{\min} > 0, \quad (13)$$

with tail index θ and scale A . This is an intensity measure over relationship flows, not a probability density. It is calibrated to binned transaction densities and integrated over the strictly positive interval $[\phi_H/m, \phi_C/m]$ to recover a feasible-flow envelope.

The link between observed transactions and relationship flows. The model primitive is relationship flow x . Federal Reserve data measure observed transaction values, which equal x/n for a relationship settling at frequency n . They coincide with relationship flows only when $n = 1$. Identification of (θ, A) from transaction data therefore requires an explicit assumption:

Assumption 5 (Calibration link). *In the upper observed range used for calibration ($x \geq \$15$), relationships settle once, or the cross-sectional distribution of settlement frequencies in that range does not distort the Pareto tail of the relationship-flow distribution. Under this assumption the observed transaction-value tail in that range has the same tail index as the relationship-flow distribution, and identifies θ .*

The assumption is plausible for the upper range because the value of finer settlement, $bx \log n$, is bounded and a positive per-transaction fee makes fragmentation costly. It is still the binding limitation of the exercise. For that reason the central Pareto continuation is treated as one scenario inside a set of fee-floor, attenuation, and non-Pareto robustness checks.

Feasible-flow formula. A relationship of flow x participates iff $x \geq \phi/m$. The relationship flow excluded by the incumbent fixed fee ϕ_C but admitted by the low fixed fee ϕ_H lies in $[\phi_H/m, \phi_C/m]$. Under (13), its total flow value is

$$V_{\text{supp}} = \int_{\phi_H/m}^{\phi_C/m} x \mu(dx) = \frac{A}{\theta - 1} [(\phi_H/m)^{-(\theta-1)} - (\phi_C/m)^{-(\theta-1)}], \quad (14)$$

for $\theta \neq 1$. At $\theta = 1$ this becomes

$$V_{\text{supp}}|_{\theta=1} = A \log\left(\frac{\phi_C}{\phi_H}\right). \quad (15)$$

Both expressions are finite at any strictly positive low fixed fee. As the low fee approaches zero, the count diverges faster than the flow value; for $\theta \geq 1$ the flow value also diverges. The calibration therefore never takes a zero-fee limit.

Bounds first. Table 8 starts with the policy variable itself: the low fixed-fee floor. Holding the central tail estimate and $m = 10\%$ fixed, the envelope is recomputed for alternative low fixed fees. The exercise shows that the extensive margin is governed by the fixed-fee floor itself. It does not require treating the central low fee as a structural constant.

Table 8: Fee-floor sensitivity bounds for feasible relationship flow

Low fixed fee ϕ_H	Ratio to \$0.10 incumbent floor	Feasible-flow envelope (\$T/year)
\$0.000001	100,000:1	20.6
\$0.000003	33,333:1	18.4
\$0.000010	10,000:1	16.1
\$0.000100	1,000:1	11.8
\$0.001000	100:1	7.7

Notes: Values use $\theta = 1.02$, $\hat{A} = 1.59 \times 10^3$, $m = 10\%$, and incumbent fixed fee $\phi_C = \$0.10$. The figures are model-implied flow envelopes, not realised demand, revenue, transaction count, or welfare.

Table 9 applies a stricter bounds exercise. It varies both the fee-floor pair and the unobserved lower-tail intensity. Let $\rho \in \{1, 0.50, 0.25, 0.10\}$ multiply the fitted lower-tail intensity only inside $[\phi_H/m, \phi_C/m]$. The case $\rho = 1$ is the upper-tail continuation. The case $\rho = 0.10$ treats only one tenth of the fitted lower-tail relationship flow as economically present or addressable.

Table 9: Bounds under alternative fee floors and lower-tail attenuation

Fee-floor pair (ϕ_C, ϕ_H)	$\rho = 1.00$	$\rho = 0.50$	$\rho = 0.25$	$\rho = 0.10$
\$0.05 vs. \$0.001000	6.6	3.3	1.6	0.7
\$0.10 vs. \$0.001000	7.7	3.8	1.9	0.8
\$0.10 vs. \$0.000100	11.8	5.9	2.9	1.2
\$0.10 vs. \$0.000003	18.4	9.2	4.6	1.8
\$0.22 vs. \$0.000003	19.7	9.8	4.9	2.0

Notes: Entries are trillions of dollars per year. Values use $\theta = 1.02$, $\hat{A} = 1.59 \times 10^3$, and $m = 10\%$. The attenuation factor ρ multiplies the fitted relationship-flow intensity in the unobserved lower-tail interval. The table is a bounds exercise, not a point estimate.

Table 10 breaks the pure Pareto lower tail. Below a cutoff x_c , the relationship-flow intensity is capped at the Pareto density evaluated at x_c . This capped-density continuation substantially reduces the envelope, but it leaves the mechanism intact: a lower fixed fee admits a positive extensive margin that incumbent card statistics do not observe.

Table 10: Non-Pareto lower-tail robustness: capped-intensity continuation

Lower-tail continuation	Cap cutoff x_c	Feasible-flow envelope (\$T/year)
Pure Pareto continuation	none	18.4
Capped density below \$0.001	\$0.001	12.7
Capped density below \$0.01	\$0.01	8.5
Capped density below \$0.10	\$0.10	4.6
Capped density below \$1.00	\$1.00	0.8

Notes: Values use $\phi_C = \$0.10$, $\phi_H = \$0.000003$, $m = 10\%$, $\theta = 1.02$, and $\hat{A} = 1.59 \times 10^3$. The capped continuation replaces the lower-tail Pareto density by $\hat{A}x_c^{-(\theta+1)}$ for $x < x_c$ and leaves the fitted upper tail unchanged.

The policy implication survives these stress tests in bounded form. The precise magnitude changes substantially, which is expected because the lower tail is unobserved. The qualitative result remains: the fixed component of the payment price schedule is an extensive-margin policy variable. It can move relationship flow from infeasible to feasible without implying that all feasible flow will be realised.

Central specification. The central Pareto cell is reported after the bounds because it is a reproducibility benchmark. Fitting (13) to the Federal Reserve card distribution (Table 5) over $x \geq \$15$ gives, under Assumption 5,

$$\hat{\theta} = 1.02 \quad (R^2 = 0.99), \quad \hat{A} = 1.59 \times 10^3 \text{ (billions of relationships per dollar at } x = \$1).$$

The fitted tail index varies with the calibration window: $\hat{\theta} = 0.92$ for $x \geq \$10$, 1.13 for $x \geq \$25$, and 1.23 for $x \geq \$50$. Figure 1 plots the fit. Observations below the calibration range lie below the fitted upper-tail extrapolation. That is consistent with fee-floor truncation, but it is not dispositive because lower-tail misspecification could generate the same pattern.

Table 11 reports the central Pareto grid. At the primary calibration ($\theta = 1.02$) and a 10% surplus rate, the envelope is approximately \$18 trillion annually. This value is not the empirical conclusion. It is an extrapolated scenario inside the bounds architecture.

Table 11: Central Pareto scenario for feasible relationship-flow envelope (\$ trillion per year)

Surplus rate m	$\theta = 0.92$	$\theta = 1.02$ (primary)	$\theta = 1.13$	$\theta = 1.23$
30%	10.3	18.8	40.5	88.6
10%	11.2	18.4	35.1	68.8
3%	12.4	17.9	30.0	52.2

The corresponding count of excluded relationships is not reported as a headline quantity. Under the fitted intensity measure with $\theta \approx 1$, the count integral is dominated by the lower endpoint and is extremely sensitive to the low fixed fee. It is also not a count of firms, devices, or counterparties; it is a count of elementary settlement relationships under the calibrated intensity measure. Online Appendix A.2 gives the count integral and its floor-sensitivity. The flow value V_{supp} is finite at any strictly positive low fixed fee and is less floor-sensitive than the corresponding count.

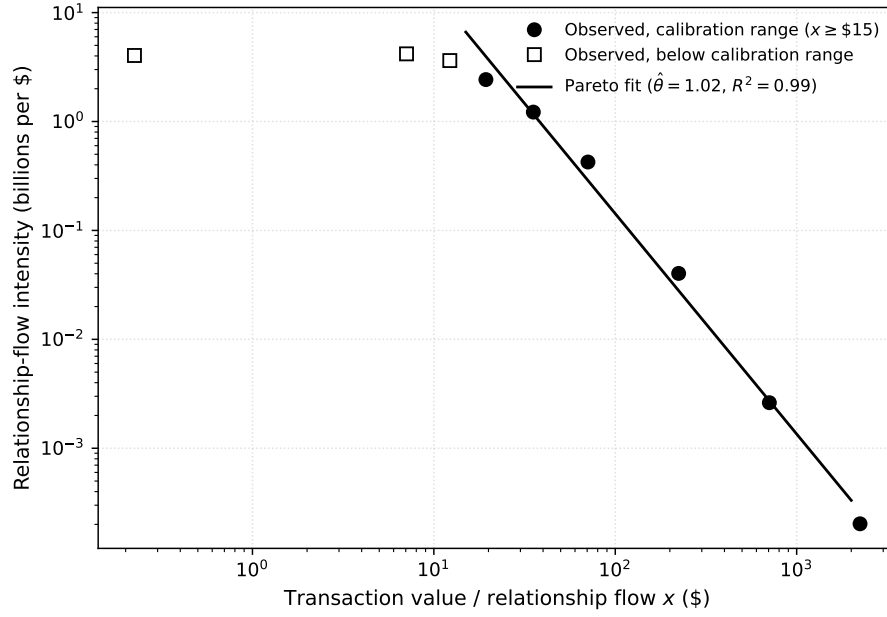


Figure 1: Relationship-flow distribution. Filled circles are observed general-purpose card transaction-flow intensities in the calibration range ($x \geq \$15$); open squares are observed intensities below it. The line is the Pareto intensity fit (13) estimated on the calibration range under Assumption 5 ($\hat{\theta} = 1.02$, $R^2 = 0.99$). The fitted R^2 is descriptive fit to binned Federal Reserve data, not sampling precision from microdata.

Largest observable instance. The largest readily observable candidate endpoint population in the excluded region is machine-to-machine settlement: devices transacting for data, compute, bandwidth, or sensor readings at flows below \$0.10. IoT Analytics reports 21.1 billion connected devices at the end of 2025, projected to reach 39 billion by 2030.³ The device count identifies a candidate endpoint universe, but it does not estimate realised payment demand or the number of economic relationships. It neither confirms nor sizes the feasible-flow envelope, which comes from the calibrated flow distribution under Assumption 5.

The model-implied flow value in this section is a *feasible-flow envelope*. A near-zero per-transaction fee is necessary for these relationships to settle, but not sufficient for them to do so. In two-sided payment markets, adoption and routing respond to rewards, steering, brand trust, acceptance incentives, and regulation. The realised share remains governed by those participation forces.

³IoT Analytics, “State of IoT 2025”: 18.5 billion connected IoT devices in 2024, 21.1 billion projected for end-2025, 39 billion projected for 2030 at a 13.2% CAGR. These are device-connection counts.

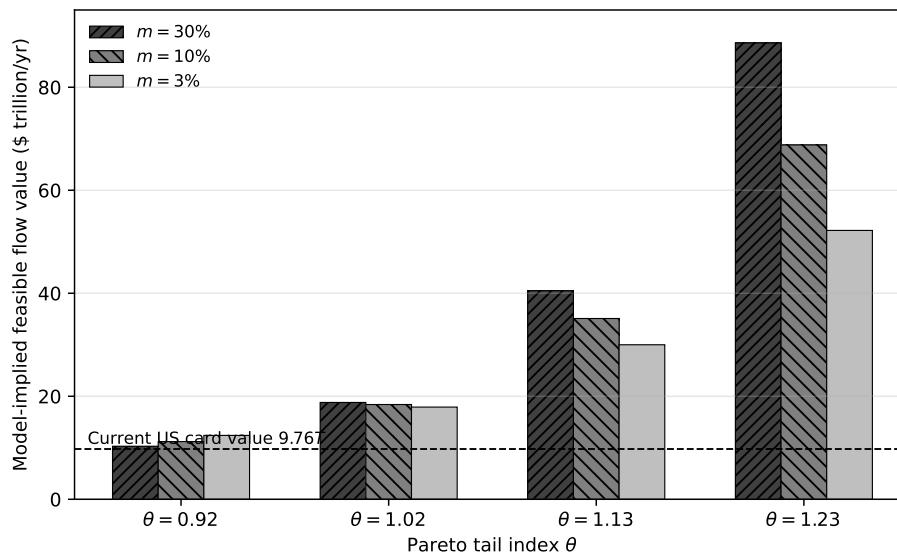


Figure 2: Central Pareto scenario for feasible relationship-flow envelope (\$ trillion per year), by surplus rate m and tail index θ , comparing incumbent fee \$0.10 with low-fee rail fee \$0.000003. The dashed line is the \$9.76 trillion total value of current US card payments. The figure illustrates sensitivity to tail assumptions; it is not a point estimate of demand, revenue, welfare, adoption, or transaction count.

5.10 The Three Effects in Summary

The paper reports three effects, which are deliberately not combined:

1. *Resource-cost saving on existing transactions*: about \$700 million per year under the reported switching-cost proxy and the US non-cash transaction-volume base. This is a real resource-saving benchmark, not an estimate of total avoidable payment cost.
2. *Platform-margin surplus stake*: about \$20 billion per year in producer-to-user surplus stakes if the incumbent network margin were competed away. This is an upper-bound transfer stake, not a welfare gain unless the deadweight-loss share is separately identified.
3. *Feasible-flow envelope outside the current fixed-fee floor*: a model-implied lower-tail envelope, reported through the central Pareto cell, alternative fee floors, lower-tail attenuation, and a capped-density non-Pareto check. It is not realised demand, revenue, transaction count, or welfare.

The contribution of the paper is to show that the fee-floor effect is conceptually distinct from resource-cost savings and margin transfers. A positive fixed fee changes the feasible set of exchange. The calibration then asks how large the excluded relationship-flow interval could be under an explicit Pareto extrapolation.

5.11 Upper-bound market-power counterfactual

The calibration above holds market structure fixed: the incumbent keeps its margin and only the cost base changes. A separate counterfactual asks the upper bound on welfare gains if the incumbent's margin were also competed away. Visa's FY2024 operating margin is approximately \$0.101 per transaction, roughly thirty times its reported network-and-processing cost (\$0.0033/tx); on 200 billion US non-cash transactions the implied producer-to-user surplus stakes are on the order of \$20 billion per year. This margin is not automatically deadweight loss—it includes return on capital, risk compensation, network investment, and rent—so the figure is a surplus-transfer upper bound, not a welfare gain, and the paper does not estimate the deadweight-loss share. The \$700 million resource-saving floor and the \$20 billion margin are not additive: the first is a real resource saving on existing transactions, the second a transfer on those same transactions, and neither is the feasible-flow envelope, which concerns relationships outside the current feasible set. A low switching cost does not by itself predict entry: interchange-funded rewards, fraud-detection scale, two-sided network effects, regulatory access, the ACH precedent, and brand trust all remain barriers. Online Appendix A.6 gives the full accounting decomposition, the surplus-stakes table, and the six entry barriers in detail.

6 Discussion

The paper makes a conditional platform-pricing claim. A low switching cost can produce a resource saving on existing transactions. It changes the participation set only if the user-facing fixed fee falls. Under market power, Proposition 1 shows why that pass-through cannot

be assumed. The paper therefore does not predict that a low-cost rail will replace incumbent payment networks. Adoption, regulation, interchange design, fraud governance, rewards, brand trust, and routing incentives remain outside the calibrated exercise.

The largest empirical limitation is identification of the relationship-flow distribution. The model primitive is relationship flow, while the Federal Reserve data measure observed transaction values. Assumption 5 links the observed upper transaction-value tail to the relationship-flow tail. That assumption is explicit because it is doing identifying work. For that reason the calibration is organised around fee-floor sensitivity, lower-tail attenuation, and a capped-density non-Pareto check. The central estimate quantifies a possible scale; the bounds architecture is what supports the industrial-organisation claim.

Relative to Budish (2025), the contribution is one of scope. Budish's linear security-cost scaling concerns anonymous proof-of-work trust. The present model concerns legally governed payment settlement with identified operators and separable switching and trust costs. The mechanism developed here does not require proof-of-work to be cheap or anonymous consensus to scale. It requires only that a payment rail can charge a low value-independent fixed fee while trust costs are supplied through institutional mechanisms. Whether any actual rail can do so at production scale is an implementation and regulatory question, not a maintained conclusion of the model.

The policy implication is not that regulators should mandate a specific technology. It is that regulation of payment platforms should distinguish ad valorem fees, fixed fees, switching costs, trust costs, and platform rents. Fixed-fee caps or regulated access to low-fixed-fee settlement rails affect the extensive margin differently from interchange caps, which mainly redistribute surplus over observed transactions. For entrants, the result implies that low processing cost is not a platform strategy unless it is converted into a low user-facing fixed fee and paired with adoption, trust, fraud-control, and routing mechanisms.

7 Conclusion

Payment networks do more than process observed transactions. By setting fixed per-transaction fees, they determine which relationship flows can enter the payment system at all. This paper models that fixed fee as a participation floor in a two-sided payment market. The central result is that a relationship with period flow x and surplus rate m participates only if $mx \geq \phi$. The fixed fee therefore defines a missing lower tail of exchange.

The market-power result is essential. A lower switching cost does not automatically remove the participation floor. An interior profit-maximising platform sets the fixed fee above fixed marginal cost whenever transaction volume has finite fee sensitivity. The floor falls only through fixed-fee pass-through, competition, or regulation. For this reason the paper separates the resource-cost saving on existing transactions from the feasible-flow effect of a lower fixed fee.

The calibration reports three separate objects rather than one combined welfare number. Existing-payment switching-cost savings are about \$700 million annually under the reported cost proxy. Incumbent network-margin stakes are on the order of \$20 billion annually, but that figure is a surplus-transfer upper bound rather than a welfare gain. The lower-tail exer-

cise reports a feasible-flow envelope outside the incumbent fixed-fee floor through a bounds architecture, not a point estimate. Its purpose is to show how the fixed-fee boundary changes the feasible set of exchange, not to measure demand, revenue, welfare, adoption, or transaction count.

The paper's contribution is therefore an industrial-organisation claim about platform pricing and missing markets. Observed payment data record what clears. They do not record relationships priced out by the fixed fee. Once that participation boundary is modelled explicitly, the economically relevant question is not only how much cost can be saved on existing transactions, but how fixed-fee pricing, pass-through, competition, and regulation define the boundary between feasible and missing markets.

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Data availability: The article uses publicly reported aggregate data and theoretical calibration. A replication supplement containing source-data tables, calibration code, and generated output CSV files is supplied with this submission and can be deposited in an open repository upon acceptance.

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