Professionals of trust: Intermediaries concentrate exchanges, creating incentives for reliability

Julien Lie-Panis
University of Guelph & MIT
jliep@protonmail.com

Jean-Baptiste André
Institut Jean Nicod - ENS Paris
jeanbaptisteandre@gmail.com

Helena Miton
Stanford Graduate School of Business
miton@stanford.edu

Abstract

Trade is most profitable when partners are distant, but also most fragile, because distance makes it harder to trust that others will keep their side of the bargain. When exchange stretches beyond local ties, societies often rely on intermediaries—merchants, brokers, auctioneers, and other professionals who stand between buyers and sellers. At first glance this solution is paradoxical: why would inserting a third party create trust? Intermediation adds another link in the chain—another stranger who can misrepresent quality, divert goods, or renege on payment. We propose that intermediation creates trust by concentrating exchanges onto fewer reputations, raising the cost of any single failure and strengthening incentives for reliable conduct. We formalize this idea in a model of reputation-based cooperation, involving buyers, suppliers, and intermediaries. The model yields two trade regimes: direct buyer–supplier exchange, where suppliers build reputations with buyers, and intermediated exchange, where intermediaries broker transactions and build reputations with buyers instead. Comparing the two, we show that intermediation expands the scope of trade—and that this extension can arise purely from scarcity: as intermediaries become fewer, each handles more transactions, raising the reputational cost of unreliable trade. Intermediaries, in this view, are professionals of trust: they can be relied on because they have the most to lose.

Keywords: intermediation, trade, trust, cooperation, reputation, game theory

There is a tension at the heart of trade. The gains from exchange are often largest when partners are far apart, because distance and difference bring complementarity: geographically, economically, or culturally distant others may have goods that we lack, or the ability to supply them at lower cost. But trade requires trust (Arrow, 1972)—confidence that goods will be delivered and payment will be made as promised, and that neither party will seize the opportunity to cheat. Such trust is easiest under social proximity: kin and interdependent partners have aligned interests (Hamilton, 1964; Roberts, 2005), while those in established relationships or overlapping networks face the cost of dishonesty—retaliation or damage to their good name (Alexander, 1987; Trivers, 1971). The largest gains lie where trust is most fragile. Scaling exchange therefore depends on mechanisms that generate trust among strangers (Miton, n.d.).

One recurring way to organize exchange at scale is through intermediaries—merchants, brokers, auctioneers, and other professionals who stand between buyers and sellers. Intermediaries have played a key role in the development of large trade networks across the world (Curtin, 1984; Greif, 1989; McMillan, 2003; Pomeranz & Topik, 2014), facilitating the exchange of goods and services as diverse as coffee (van Driel, 2003), indigo (Aldous, 2017), and credit (Carruthers, 2022). They remain central figures in contemporary trade, from the tuna auctions at Tsukiji in Tokyo (Bestor, 2001) to the chile trade along the U.S.-Mexico border (Álvarez Jr, 1998) to the many platforms that structure digital commerce (Tadelis, 2016).

At first glance, this solution is paradoxical. If long-distance trade is difficult because strangers cannot reliably trust one another, inserting an additional party between them seems like it should make matters worse. Intermediation adds another link in the chain—another stranger who can misrepresent quality, divert goods, or renege on payment. Why would adding a third party *create* trust?

We propose that intermediation creates trust by concentrating reputational incentives. By routing exchanges through a small number of third parties, intermediation strengthens incentives for reliable conduct. Intermediaries have more at stake than any of the agents they connect: those who fulfill their obligations preserve their reputation across their many relationships, while those who do not risk losing them all (see Figure 1).

To illustrate, imagine you want to buy fish for dinner. You can buy directly from a fisher selling off the day's

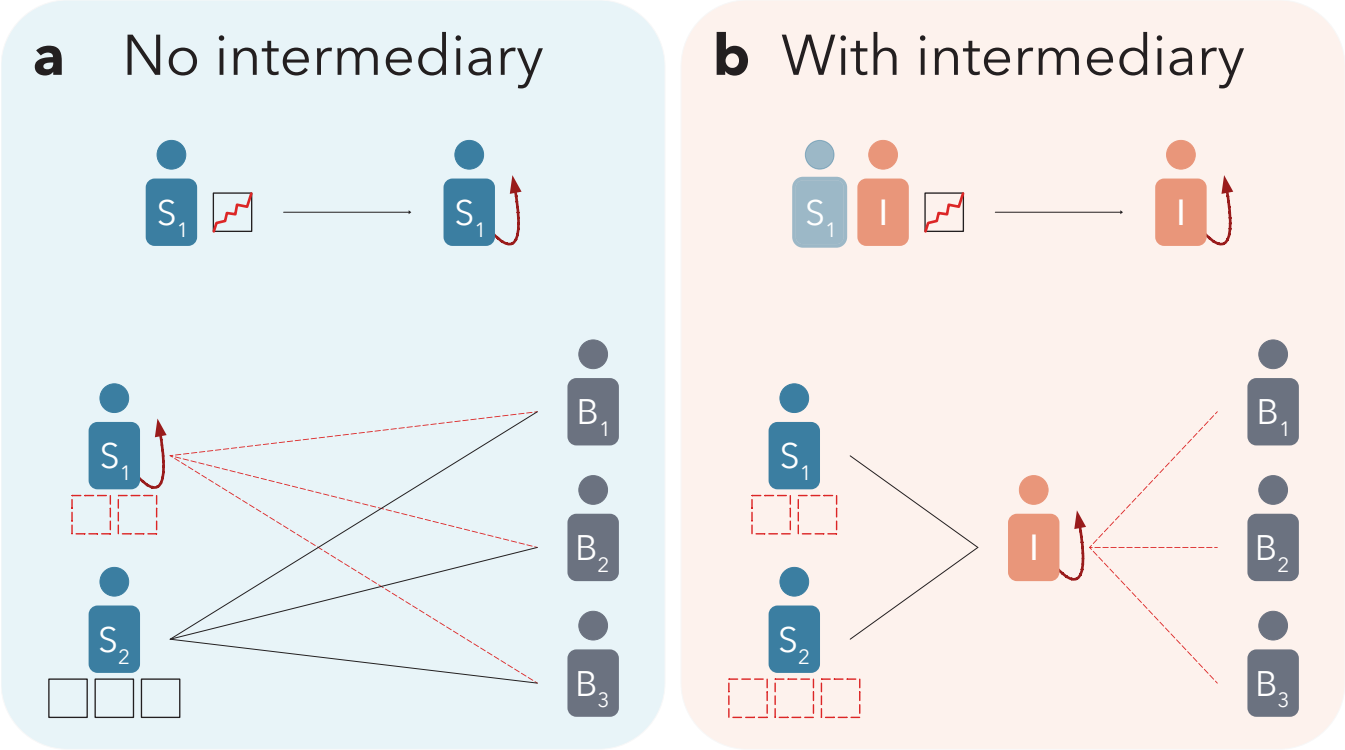

Fig. 1 | Intermediation amplifies reputational incentives. a, Direct exchange. When suppliers and buyers trade directly, a supplier who cuts corners and delivers a poor product risks harming their reputation—if buyers notice, they turn away, and the suppliers loses the ability to sell again. **b, Intermediated exchange.** When trade is intermediated, the intermediary is held responsible for product quality. An intermediary who fails to ensure quality and lets a poor product slip through risks damaging their reputation—if buyers notice, they withdraw their trust, and the intermediary loses the ability to mediate the sales of all the suppliers they represent. Because exchanges are concentrated in their hands, intermediaries have more at stake in any given interaction, making them comparatively easier to trust.

catch near the harbor, but this is risky: the fish may look good on ice and yet be older than claimed. Alternatively, you can buy from the nearby seafood shop that sources from many fishers. At first glance, this introduces new risks: a fisher might still pass off low-quality fish to the shop, and the shop itself could also misrepresent what it sells. But the shop has more to lose. One bad sale can tarnish its reputation and cost it business with the many customers it serves—many more than the typical fisher. As a result, it is easier to trust fish sold by the shop.

We formalize this with a model of reputation-based cooperation, involving buyers, suppliers, and intermediaries. Direct exchanges are trust games: as in the fish example above, buyers pay before they can verify quality, and suppliers weigh the short-run gains from cheating against the long-run value of a good reputation that attracts future business. Exchanges can also be intermediated: buyers purchase from intermediaries and hold them responsible for product quality, giving intermediaries an incentive to invest in quality control in the transactions they broker.

Our analysis identifies two trade regimes. In direct trade, suppliers transact with buyers and build reputations with them. In intermediated trade, suppliers route transactions through intermediaries, who build reputations with buyers instead. Comparing these regimes, we show that intermediation expands the domain of trade whenever intermediaries are fewer than suppliers, because this makes them easier to trust. Scarcity leads each intermediary to handle more transactions, increasing the reputational cost of any single failure.

Existing formal models explain intermediaries as specialists who reduce search and transaction costs (Rubinstein & Wolinsky, 1987), facilitate matching between diverse goods and diverse consumers (Johri & Leach, 2002), or evaluate product quality (Biglaiser, 1993; Li, 1998). Our model highlights a distinct mechanism. By treating exchange as a cooperation problem—in which trust must

be sustained at each link in the chain—we show that intermediation can expand trade purely through concentration, even without any specialized service. This mechanism operates independently of, and alongside, whatever informational or logistical advantages intermediaries may possess.

The logic extends far beyond trade: cooperation is often sustained by concentrating reputational exposure onto a small number of visible actors. Communities entrust enforcement to specialized monitors (Ostrom, 1990), legal systems route disputes through judges and mediators (Wiessner, 2020), and scientists rely on journals whose credibility is at stake with every paper they publish.

Model

Overview. Our model compares two ways of organizing trade: direct trade, in which suppliers sell to buyers and bear the reputational consequences, and intermediated trade, in which intermediaries broker transactions and bear those consequences instead. In both, buyers pay before they can verify quality and rely on their counterparty's reputation when deciding whether to purchase. Suppliers and intermediaries differ in how much they value future business.

Players. We consider a market with a large number n_S of suppliers, a large number n_I of intermediaries, and an infinite pool of buyers. Buyers make a single purchase decision before exiting the market; suppliers and intermediaries remain active and can build (or lose) reputations over time. Both suppliers and intermediaries have heterogeneous time preferences: they discount payoffs over time according to privately observed discount rates, $\rho_S > 0$ and $\rho_I > 0$ respectively, with more patient agents (lower discount rate) placing greater weight on future business (Lie-Panis & André, 2022). Discount rates ρ_S and ρ_I are drawn from separate distribution on $(0, \infty)$ with full support, allowing for any level of patience among suppliers and intermediaries.

Timing and decisions. Interactions unfold as shown in Figure 2. Initially, each supplier chooses once and for all between direct and intermediated trade.

In direct trade, each supplier is visited by buyers at average rate λ_S. Upon arrival, the buyer decides whether to purchase from the supplier at price P. If a purchase occurs, the supplier chooses whether to deliver high quality, incurring fulfillment cost C (with $C < P$), or to cheat and deliver low quality (incurring no cost). A high-quality product provides value V to the buyer (with $V > P$), whereas a low-quality product provides no value.

In intermediated trade, buyers arrive for a given supplier's product at average rate λ_I. Upon arrival, an intermediary is selected at random to broker the transaction, and the buyer decides whether to purchase from them at price P. If a purchase occurs, the intermediary keeps a commission τP (with $0 < \tau < 1$) and earmarks the remainder $(1-\tau)P$ for the supplier (with $(1-\tau)P > C$).

The intermediary then decides whether to monitor the supplier, incurring monitoring cost M (with $M < \tau P$). Monitoring is observable and commits the intermediary to condition payment on verified quality. After observing the intermediary's decision, the supplier chooses whether to deliver or cheat, and the product is passed on to the buyer. Finally, the earmarked payment is transferred to the supplier—unless the intermediary chose to monitor and the supplier chose to cheat, in which case it is redirected to the buyer.

Reputations. Agents who sell to buyers—suppliers in direct trade and intermediaries in intermediated trade—have a public reputation that reflects the quality outcome of their most recent transaction. They start with an *unknown* reputation. After any transaction, an agent's reputation updates to *good* if the product was high quality and to *bad* if it was low quality.

Strategies. Buyers decide whether to purchase from an agent based on the agent's role (supplier or intermediary) and reputation. Suppliers decide: (i) whether to trade directly or through intermediaries based on their discount rate ρ_S; (ii) in direct trade, whether to deliver or cheat based on ρ_S and their reputation; and (iii) in intermediated trade, whether to deliver or cheat based on ρ_S and the intermediary's monitoring decision. Intermediaries decide whether to monitor based on their discount rate ρ_I and reputation.

Results

We identify equilibria in which trade occurs with positive probability (see Methods), focusing on those in which trade is routed through a single channel. Hybrid equilibria, in which some suppliers trade directly while others use intermediaries, are studied in the Supplementary Information and shown not to extend the domain of trade.

Direct trade. In *direct trade equilibria*, buyers transact directly with suppliers. Every supplier initially chooses direct trade, regardless of discount rate ρ_S. Buyers purchase from suppliers with an unknown or good reputation and avoid those with a bad reputation.

Patient suppliers ($\rho_S \leq \theta_S$) deliver high quality whenever they sell, while impatient suppliers ($\rho_S > \theta_S$) always cheat (regardless of reputation). The threshold θ_S separating suppliers who deliver from those who cheat is

$$\theta_S = \lambda_S \frac{P - C}{C}. \tag{1}$$

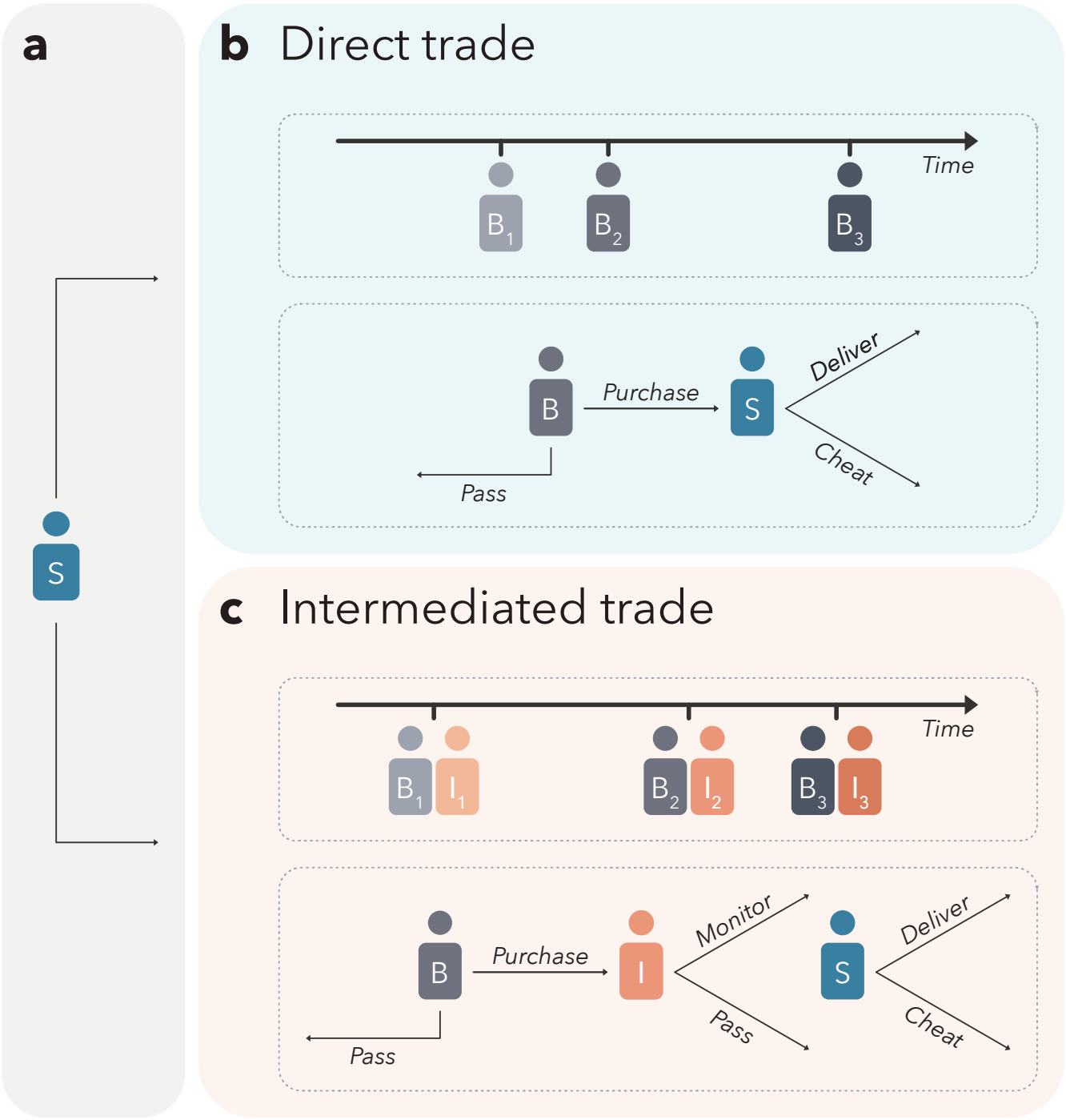

Fig. 2 | Model overview. **a,** Each supplier initially chooses once and for all between direct and intermediated trade. **b,** In direct trade, buyers arrive to a supplier over time and decide whether to purchase a product based on the supplier's reputation. If a purchase occurs, the supplier decides whether to deliver high quality or cheat. **c,** In intermediated trade, buyers arrive for a supplier's product over time and an intermediary brokers the transaction. Buyers decide whether to purchase based on the intermediary's reputation. If a purchase occurs, the intermediary decides whether to monitor; the supplier then decides whether to deliver or cheat after observing the monitoring decision.

This threshold increases with arrival rate λ_S and decreases with the cost-to-margin ratio $C/(P-C)$. When buyers arrive frequently or fulfillment costs are low relative to the margin, a wider range of suppliers delivers high quality.

Direct trade equilibria exist if and only if

$$P \leq \mathbb{P}(\rho_S \leq \theta_S)\, V. \tag{2}$$

This condition ensures that purchasing from suppliers with an unknown reputation is worthwhile: buyers pay P and obtain V when the supplier is sufficiently patient to deliver, which occurs with probability $\mathbb{P}(\rho_S \leq \theta_S)$.

Intermediated trade. In *intermediated trade equilibria*, trade is routed through intermediaries. Every supplier initially chooses intermediated trade, regardless of discount rate ρ_S. Buyers purchase from intermediaries with an unknown or good reputation and avoid those with a bad reputation.

Patient intermediaries ($\rho_I \leq \theta_I$) monitor the supplier in every transaction, while impatient intermediaries ($\rho_I > \theta_I$) never monitor (regardless of reputation). The threshold θ_I separating intermediaries who monitor from those who do not is

$$\theta_I = \frac{n_S}{n_I}\lambda_I \frac{\tau P - M}{M}. \tag{3}$$

This threshold increases with the number of suppliers relative to intermediaries (n_S/n_I) and with arrival rate λ_I, which together determine how often each intermediary brokers a transaction, since an intermediary is randomly selected each time a buyer visits a supplier. The threshold also decreases with the cost-to-margin ratio $M/(\tau P - M)$. When intermediaries broker transactions frequently or monitoring costs are low relative to the margin, a wider range of intermediaries monitors.

Monitoring drives product quality: regardless of discount rate ρ_S, suppliers deliver when monitored and cheat otherwise.

Intermediated trade equilibria exist if and only if

$$P \leq \mathbb{P}(\rho_I \leq \theta_I)\, V. \tag{4}$$

This condition ensures that purchasing from intermediaries with an unknown reputation is worthwhile: buyers pay P and obtain V when the intermediary is sufficiently patient to monitor, which occurs with probability $\mathbb{P}(\rho_I \leq \theta_I)$.

Comparing direct and intermediated trade. In direct trade, high quality is delivered by the share $\mathbb{P}(\rho_S \leq \theta_S)$ of sufficiently patient suppliers; under intermediation, it is ensured by the share $\mathbb{P}(\rho_I \leq \theta_I)$ of sufficiently patient intermediaries who monitor suppliers. Comparing (2) and (4), intermediated trade has a larger domain than direct trade if and only if

$$\mathbb{P}(\rho_I \leq \theta_I) > \mathbb{P}(\rho_S \leq \theta_S). \tag{5}$$

Intermediation thus expands the domain of trade whenever monitoring is more prevalent than delivery. This can occur either because intermediaries tend to be more patient than suppliers, or because monitoring incentives are stronger, so that $\theta_I > \theta_S$, which holds if and only if

$$\frac{n_S}{n_I}\lambda_I \frac{\tau P - M}{M} > \lambda_S \frac{P - C}{C}. \tag{6}$$

This inequality highlights three additional channels—beyond intermediaries being more patient—through which intermediation can expand the domain of trade. First, verification may be more efficient than fulfillment, as reflected in a lower cost-to-margin ratio ($M/(\tau P - M) < C/(P-C)$). Second, buyers may arrive more frequently under intermediation ($\lambda_I > \lambda_S$), increasing the future value of maintaining a good reputation. Third, intermediaries may be less numerous than suppliers ($n_I < n_S$), concentrating transactions on fewer reputations.

Fewer intermediaries expand trade. We focus on the concentration mechanism: the effect of having fewer intermediaries than suppliers ($n_I < n_S$). To isolate this effect, we hold fixed three other determinants of trade: suppliers and intermediaries draw discount rates from the same distribution, face the same arrival rate ($\lambda_S = \lambda_I = \lambda$), and have identical cost-to-margin ratios for delivery and monitoring.

Figure 3 shows the share of successful exchanges—transactions in which the buyer purchases and receives high quality—under direct trade and under intermediated trade with progressively fewer intermediaries ($n_I = n_S$, $n_I = n_S/2$, and $n_I = n_S/4$). Along the horizontal axis, we vary the mean discount rate μ (higher μ corresponds to greater impatience); along the vertical axis, we vary the buyer arrival interval $1/\lambda$ (mean time between buyer arrivals).

In direct trade, successful exchanges are most common when suppliers are patient (low μ) and buyers arrive frequently (low $1/\lambda$): future business is valuable, so maintaining a reputation for high quality is worth the fulfillment cost. As suppliers become more impatient and arrivals become less frequent, successful exchanges become rarer—until buyers stop purchasing from unknown suppliers, and trade collapses.

By concentrating transactions on fewer reputations, intermediation can prevent this collapse. When intermediaries are as numerous as suppliers ($n_I = n_S$), outcomes match those under direct trade. As intermediaries become fewer, each one aggregates more transactions and faces stronger reputational incentives, expanding the domain of trade.

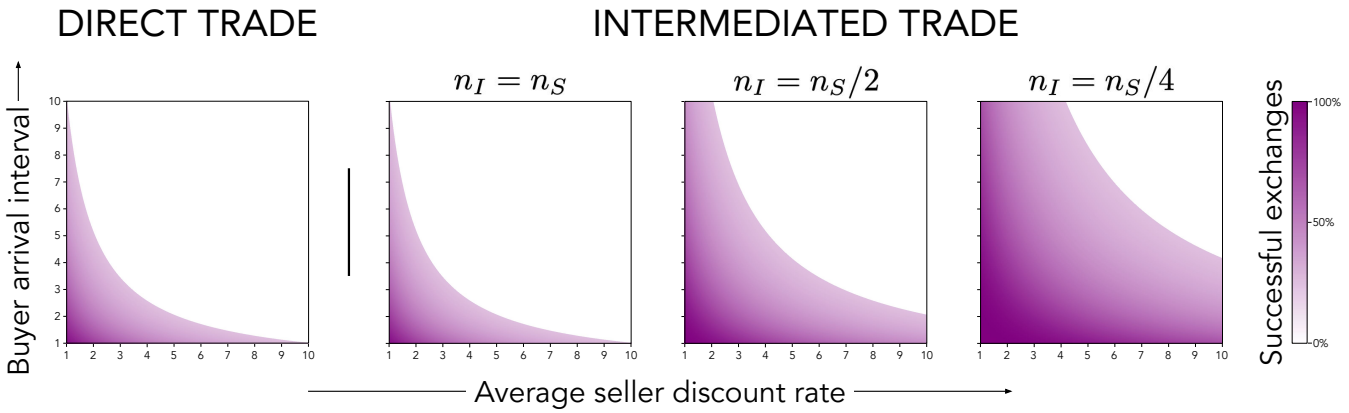

Fig. 3 | Fewer intermediaries expand the domain of successful exchange. Color indicates the share of successful exchanges (buyer purchases and receives high quality); white indicates parameter values for which trade is unsustainable. Results are presented across four scenarios (panels from left to right): direct trade, and intermediated trade with progressively fewer intermediaries ($n_I = n_S$, $n_I = n_S/2$, $n_I = n_S/4$). Supplier and intermediary discount rates are drawn from an exponential distribution with rate $1/\mu$ (mean μ). The x-axis varies the mean discount rate μ, and the y-axis varies the buyer arrival interval $1/\lambda$. All other parameters are fixed: $P = 1$; $C = 1/4$; $V = 4$; $\tau = 1/4$; $M = 1/16$; $n_S = 1000$.

We conclude by examining the strongest concentration case. Figure 4 compares intermediated and direct trade when $n_I = n_S/4$: the left panel reports changes in the share of successful exchanges, and the right panel reports changes in suppliers' payoffs. Intermediation increases successful exchanges throughout, but it comes at a cost because intermediaries charge a commission τP that is borne by suppliers. Accordingly, suppliers' payoffs fall in regions where direct exchange is already sustainable, but rise where direct trade collapses and intermediation restores trade. Suppliers should thus favor intermediation precisely where direct trust would otherwise fail.

Discussion

How can intermediation create trust, rather than simply adding another point of failure? To answer this question, we model mutually beneficial exchanges between buyers, suppliers, and intermediaries as trust games: buyers pay before they can verify quality, relying on their counterparty's public reputation to decide whether to purchase.

Two regimes can sustain trade. In direct trade, suppliers build reputations with buyers, who purchase from them directly. Patient suppliers deliver high-quality goods to preserve future business, while impatient suppliers cut corners. In intermediated trade, buyers purchase through intermediaries, who build public reputations. Patient intermediaries monitor suppliers to ensure high quality and protect future business, while impatient intermediaries do not monitor, allowing suppliers to cheat.

Comparing the two regimes, we show that intermediation expands the scope of trade whenever intermediaries are safer to trust for buyers. Our model identifies several routes through which this can happen: intermediation facilitates trade whenever intermediaries attract more buyers than suppliers do, whenever they are more patient, and whenever quality verification is more efficient than quality delivery.

None of these comparative advantages is required, however. Even when intermediaries are identical to suppliers in every other respect, they can expand trade simply by being less numerous. Scarcity concentrates more transactions on each intermediary, raising the reputational cost of any single failure.

Intermediation, we suggest, can be understood as a social technology: a way of organizing exchange that reshapes the reputational incentives governing it. By channeling trade through fewer hands, intermediaries generate the trust that sustains exchange where direct trade would otherwise fail.

Empirical predictions. Our model predicts that intermediaries should be most common where direct exchange is hardest to sustain. When the immediate gains from cheating outweigh the expected loss of future business, agents cannot safely trust one another and should be willing to exchange through intermediaries, incurring fees to increase the likelihood of reliable exchange.

Intermediation should thus be especially attractive where reputational incentives are weakest, and where courts and contracts do not provide an alternative ba-

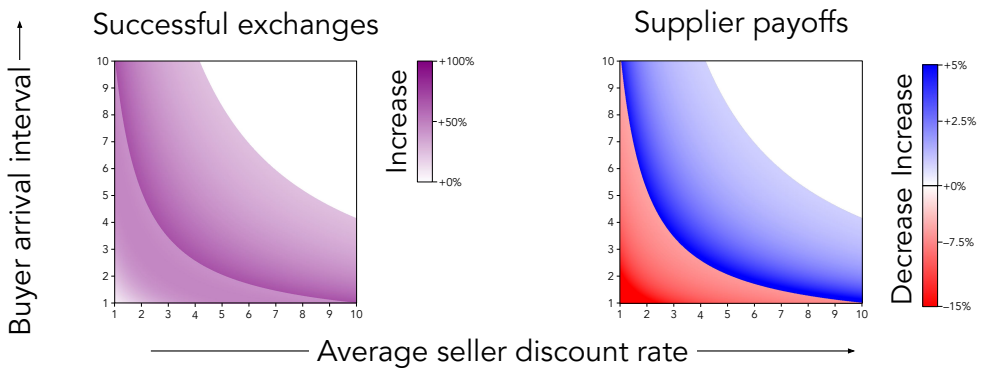

Fig. 4 | Fewer intermediaries increase successful exchanges but can reduce supplier payoffs. Changes under intermediation relative to direct trade when $n_I = n_S/4$. The left panel shows increases in the share of successful exchanges (in shades of purple). The right panel shows changes in suppliers' payoffs (with increases in shades of blue and decreases in shades of red), normalized by the direct trade payoff at $\mu = 1$ and $1/\lambda = 1$ (the maximum possible payoff in the plotted domain). Axes, discount rate distribution, and all other parameters match Fig. 3.

sis for trust. Accordingly, intermediaries are common in long-distance and anonymous trade (e.g., Aldous & Coyle, 2021; Curtin, 1984), where reputational information diffuses poorly and partners are unlikely to meet again; in markets for experience and credence goods (e.g., Bestor, 2001; van Driel, 2003), where quality is difficult to verify and misconduct hard to observe; in thin or volatile markets (e.g., Aldous, 2017; Álvarez Jr, 1998), where rare exchanges, high turnover, or exit risk shorten horizons and weaken the weight of future business; and where no legal recourse exists, as in illegal trade (Gambetta, 1993).

Our model also predicts that concentrating exchanges onto fewer intermediaries should itself expand the domain of reliable trade: all else equal, markets served by fewer intermediaries, each handling greater volumes, should sustain more reliable trade than markets with many intermediaries—helping explain why exchange so often consolidates onto a small number of dominant intermediaries, from medieval merchant guilds to modern digital platforms (although concentration also confers market power; see Limitations).

Relation to existing explanations. In existing formal models, intermediaries emerge because they offer specialized services that buyers and sellers cannot efficiently provide for themselves. Intermediaries forge extensive trade networks, hold diverse inventories of goods, and develop specialized expertise about markets and product quality, allowing them to reduce search and transaction costs (Gehrig, 1993; Rubinstein & Wolinsky, 1987), improve matching between buyers and sellers (Johri & Leach, 2002; Shevchenko, 2004), and certify the quality of traded goods (Biglaiser, 1993; Biglaiser & Friedman, 1994; Diamond, 1984; Li, 1998). Our model identifies a distinct mechanism that operates alongside these specialized functions: by concentrating exchanges onto fewer reputations, intermediation strengthens incentives for reliable conduct even when intermediaries possess no informational or logistical advantage.

In practice, these forces operate simultaneously: intermediaries often provide specialized services while also concentrating reputational incentives. Consider Airbnb's review and enforcement system. By standardizing listings and broadcasting feedback from past guests, the platform reduces search costs and mitigates asymmetric information. But this informational role only works if Airbnb itself cooperates: it could underinvest in verification, quietly suppress negative reviews, or selectively enforce its rules. Why rely on its ratings anyway? Because Airbnb intermediates a vast volume of exchange. A reputation for biased or lax enforcement would jeopardize future business across the platform. Concentrating transactions in one place makes credibility costly to lose—and therefore more rational to maintain.

Limitations. An important limitation of our model is the absence of market power. Intermediaries cannot set fees, restrict access to buyers or sellers, or manipulate information. As a result, concentration can only improve outcomes. In practice however, concentration also confers market power, creating a trade-off between stronger reputational incentives and greater ability to extract rents (e.g., Chiba-Okabe & Plotkin, 2025).

Beyond trade. More generally, our model shows that the organization of cooperation determines how reputational incentives are distributed. By concentrating responsibility onto fewer actors, social groups can sustain cooperation when it would otherwise break down—one distinct mechanism through which institutions facili-

tate cooperation (see e.g., Chiba-Okabe & Plotkin, 2024; Kessinger & Plotkin, 2025; Lie-Panis et al., 2024; Mohlin et al., 2023; Radzvilavicius et al., 2021; Sigmund et al., 2010).

Accordingly, cooperation frequently relies on specialized roles. To protect shared resources from overuse, communities entrust enforcement to a handful of specialized monitors who build a reputation for identifying rule-breakers (Ostrom, 1990, p. 96). To resolve disputes, they rely on recognized mediators whose status depends on keeping the peace (Wiessner, 2020). And when the gains and burdens of cooperation must be divided, groups turn to leaders and scrutinize their decisions for fairness (Garfield et al., 2020, 2025).

Conclusion

In sum, our model isolates a simple way intermediation can create trust: by concentrating exchange, it concentrates the reputational costs of failure. Intermediation is therefore not only a matter of logistics or information; it is a way of reallocating reputational exposure that can stabilize exchange when direct trade would otherwise unravel.

Methods

Players. We model transactions occurring in continuous time ($t > 0$) in a large market with $n_S \gg 1$ suppliers, $n_I \gg 1$ intermediaries, and an infinite pool of buyers. Buyers are short-lived: they engage in a single transaction before exiting the market. Suppliers and intermediaries are long-lived: they remain active and discount payoffs over time according to a privately known discount rate $\rho > 0$. A long-lived individual with discount rate ρ earns lifetime payoff

$$U(\rho) \equiv \int_0^\infty e^{-\rho t}\, \pi(t)\, dt,$$

where $\pi(t)$ denotes expected instantaneous payoff at time t. Supplier discount rates ρ_S and intermediary discount rates ρ_I are independently drawn from distributions on $(0, \infty)$ with full support.

Sequence of play. At $t = 0$, each supplier chooses once and for all between direct and intermediated trade.

In direct trade, each supplier is visited by buyers according to a Poisson process with rate λ_S. Upon arrival, the buyer decides whether to purchase by paying price $P > 0$ to the supplier. If a purchase occurs, the supplier chooses either to deliver high quality—incurring cost C, where $0 < C < P$, so that the buyer obtains value $V > P$—or to cheat and deliver low quality (incurring no cost to provide no value to the buyer).

In intermediated trade, each supplier is visited by buyers according to a Poisson process with rate λ_I. Upon arrival, an intermediary is selected at random to handle the transaction, and the buyer decides whether to purchase by paying price P to the intermediary. If a purchase occurs, the intermediary keeps commission τP, where $0 < \tau < 1$, and earmarks the remainder $(1 - \tau)P$ for the supplier, where $(1 - \tau)P > C$.

The intermediary then chooses whether to monitor, incurring cost $M < \tau P$. The monitoring decision is observable and commits the intermediary to condition payment on verified quality. After observing this decision, the supplier chooses whether to deliver or cheat, and the product is passed on to the buyer. Finally, the earmarked payment $(1-\tau)P$ is transferred to the supplier unless the intermediary monitors and detects cheating, in which case it is withheld and redirected to the buyer.

Reputations. Agents who sell to buyers—suppliers in direct trade and intermediaries in intermediated trade—acquire a public reputation $\omega \in \Omega$ reflecting the quality outcome of their last sale. There are only three cases: $\omega =$ unknown if buyers have never purchased from the agent; $\omega =$ good if the agent last sold a high-quality product; and $\omega =$ bad if the agent last sold a low-quality product.

Strategies and beliefs. A buyer strategy specifies whether to purchase as a function of the counterparty's role (supplier or intermediary) and reputation ω. Buyers hold common beliefs mapping each role–reputation pair to likelihoods over discount rates $\rho \in (0, \infty)$.

A supplier strategy specifies: (i) the initial choice between direct and intermediated trade as a function of own discount rate; (ii) in direct trade, whether to deliver or cheat as a function of own discount rate and reputation; and (iii) in intermediated trade, whether to deliver or cheat as a function of own discount rate and the intermediary's monitoring decision.

An intermediary strategy specifies whether to monitor as a function of own discount rate and reputation.

Equilibrium analysis

Equilibrium concept. We study the model's Perfect Bayesian Equilibria (PBEs) in pure strategies. A PBE is a set of strategies and beliefs such that no player has a profitable deviation at any information set (on or off the equilibrium path), and beliefs are updated according to Bayes' rule whenever possible (Fudenberg & Tirole, 1991). PBE is the standard solution concept for sequential games with incomplete information, and aligns with evolutionary simulations in related settings (Hoffman et al., 2018; Lie-Panis & Hilbe, 2026).

Trade equilibria. We focus on *trade* PBEs, in which mutually beneficial transactions occur with positive prob-

ability. This requires that buyers purchase from suppliers with an unknown reputation and/or from intermediaries with an unknown reputation. Otherwise—if buyers purchase from neither—no seller can ever make an initial sale and all sellers retain $\omega =$ unknown forever.

A PBE is a *direct trade equilibrium* if buyers purchase from suppliers with an unknown reputation but do not purchase from intermediaries with an unknown reputation—enabling only direct exchanges. A PBE is an *intermediated trade equilibrium* if buyers purchase from intermediaries with an unknown reputation but not from suppliers with an unknown reputation; a PBE is a *hybrid trade equilibrium* if buyers purchase in both cases.

In the Supplementary Information, we characterize all the model's PBEs. In particular, we show that in our main parameter case of interest (ρ_S and ρ_I from same distribution; $\lambda_S = \lambda_I$; $C/(P-C) = M/(\tau P - M)$), hybrid trade equilibria exist under a more restricted domain than direct trade equilibria (regardless of the total number of suppliers n_S). In other words, the beneficial effect of intermediaries on the domain of trade is seen in intermediated trade equilibria, not hybrid trade equilibria.

Numerical solution

We numerically evaluate the domain conditions for direct (2) and intermediated trade (4) on a parameter grid. These conditions are stated in terms of probabilities over discount rates; to evaluate them, we assume that both supplier and intermediary discount rates are drawn from an exponential distribution with rate $1/\mu$ (mean μ; support $(0, \infty)$). We vary mean discount rate μ and buyer arrival interval $1/\lambda$, holding other parameters fixed as in the figure captions. When direct or intermediated trade is sustainable, we compute the share of successful exchange and supplier payoffs to derive Figures 3 and 4 (we return 0 where trade is unsustainable).

References

Aldous, M. (2017). Rehabilitating the intermediary: Brokers and auctioneers in the nineteenth-century anglo-indian trade. *Business History*, *59*(4), 525–553. https://doi.org/10.1080/00076791.2016.1220939

Aldous, M., & Coyle, C. (2021). Examining the role of a private-order institution in global trade: The liverpool cotton brokers' association and the crowning of king cotton, 1811–1900. *Business History Review*, *95*(4), 671–702. https://doi.org/10.1017/S0007680520000872

Alexander, R. D. (1987). *The biology of moral systems*. Aldine de Gruyter.

Álvarez Jr, R. R. (1998). La maroma, or chile, credit and chance: An ethnographic case of global finance and middlemen entrepreneurs. *Human Organization*, *57*(1), 63–73.

Arrow, K. J. (1972). Gifts and exchanges. *Philosophy & Public Affairs*, 343–362.

Bestor, T. C. (2001). Supply-side sushi: Commodity, market, and the global city. *American Anthropologist*, *103*(1), 76–95.

Biglaiser, G. (1993). Middlemen as experts. *The RAND Journal of Economics*, *24*(2), 212–223. https://doi.org/10.2307/2555758

Biglaiser, G., & Friedman, J. W. (1994). Middlemen as guarantors of quality. *International Journal of Industrial Organization*, *12*(4), 509–531.

Carruthers, B. G. (2022). *The economy of promises: Trust, power, and credit in America*. Princeton University Press.

Chiba-Okabe, H., & Plotkin, J. B. (2025). The evolution of trust under institutional moral hazard. *arXiv preprint arXiv:2511.21875*.

Chiba-Okabe, H., & Plotkin, J. B. (2024). Can institutions foster cooperation by wealth redistribution? *Journal of the Royal Society Interface*, *21*(212), 20230698. https://doi.org/10.1098/rsif.2023.0698

Curtin, P. D. (1984, May 25). *Cross-cultural trade in world history*. Cambridge University Press.

Diamond, D. W. (1984). Financial intermediation and delegated monitoring. *The Review of Economic Studies*, *51*(3), 393–414.

Fudenberg, D., & Tirole, J. (1991). *Game theory*. MIT Press.

Gambetta, D. (1993). *The Sicilian Mafia: The business of private protection*. Harvard University Press.

Garfield, Z. H., Syme, K. L., & Hagen, E. H. (2020). Universal and variable leadership dimensions across human societies. *Evolution and Human Behavior*, *41*(5), 397–414. https://doi.org/10.1016/j.evolhumbehav.2020.07.012

Garfield, Z. H., von Rueden, C. R., & Hagen, E. H. (2025). The multi-capital leadership theory: An integrative framework for human leadership diversity. *Human Nature*, *36*, 424–459. https://doi.org/10.1007/s12110-025-09503-y

Gehrig, T. (1993). Intermediation in search markets. *Journal of Economics & Management Strategy*, *2*(1), 97–120. https://doi.org/10.1111/j.1430-9134.1993.00097.x

Greif, A. (1989). Reputation and coalitions in medieval trade: Evidence on the Maghribi traders. *The Journal of Economic History*, *49*(4), 857–882.

Hamilton, W. D. (1964). The genetical evolution of social behaviour. II. *Journal of Theoretical Biol-*

ogy, *7*(1), 17–52. https://doi.org/10.1016/0022-5193(64)90039-6

Hoffman, M., Hilbe, C., & Nowak, M. A. (2018). The signal-burying game can explain why we obscure positive traits and good deeds. *Nature Human Behaviour*, *2*, 397–404.

Johri, A., & Leach, J. (2002). Middlemen and the allocation of heterogeneous goods. *International Economic Review*, *43*(2), 347–361.

Kessinger, T. A., & Plotkin, J. B. (2025). Institutions of public judgment established by social contract and taxation. *Proceedings of the National Academy of Sciences*, *122*(26), e2506537122. https://doi.org/10.1073/pnas.2506537122

Li, Y. (1998). Middlemen and private information. *Journal of Monetary Economics*, *42*(1), 131–159.

Lie-Panis, J., & André, J.-B. (2022). Cooperation as a signal of time preferences. *Proceedings of the Royal Society B*, *289*(1973), 20212266.

Lie-Panis, J., Fitouchi, L., Baumard, N., & André, J.-B. (2024). The social leverage effect: Institutions transform weak reputation effects into strong incentives for cooperation. *Proceedings of the National Academy of Sciences*, *121*(51), e2408802121.

Lie-Panis, J., & Hilbe, C. (2026). Cooperation investments: Building capacity and signaling intent. *PsyArXiv*.

McMillan, J. (2003). *Reinventing the bazaar: A natural history of markets*. W.W. Norton & Company.

Miton, H. (n.d.). *The cultural and cognitive scaffolding of global exchanges*.

Mohlin, E., Rigos, A., & Weidenholzer, S. (2023). Emergence of specialized third-party enforcement. *Proceedings of the National Academy of Sciences*, *120*(24), e2207029120. https://doi.org/10.1073/pnas.2207029120

Ostrom, E. (1990). *Governing the commons: The evolution of institutions for collective action*. Cambridge University Press.

Pomeranz, K., & Topik, S. (2014). *The world that trade created: Society, culture and the world economy, 1400 to the present*. Routledge.

Radzvilavicius, A. L., Kessinger, T. A., & Plotkin, J. B. (2021). Adherence to public institutions that foster cooperation. *Nature Communications*, *12*, 3567. https://doi.org/10.1038/s41467-021-23783-9

Roberts, G. (2005). Cooperation through interdependence. *Animal Behaviour*, *70*(4), 901–908. https://doi.org/10.1016/j.anbehav.2005.02.006

Rubinstein, A., & Wolinsky, A. (1987). Middlemen*. *The Quarterly Journal of Economics*, *102*(3), 581–593. https://doi.org/10.2307/1884218

Shevchenko, A. (2004). Middlemen*. *International Economic Review*, *45*(1), 1–24. https://doi.org/10.1111/j.1468-2354.2004.00115.x

Sigmund, K., De Silva, H., Traulsen, A., & Hauert, C. (2010). Social learning promotes institutions for governing the commons. *Nature*, *466*(7308), 861–863. https://doi.org/10.1038/nature09203

Tadelis, S. (2016). Reputation and feedback systems in online platform markets. *Annual Review of Economics*, *8*, 321–340. https://doi.org/10.1146/annurev-economics-080315-015325

Trivers, R. L. (1971). The evolution of reciprocal altruism. *The Quarterly Review of Biology*, *46*(1), 35–57. https://doi.org/10.1086/406755

van Driel, H. (2003). The role of middlemen in the international coffee trade since 1870: The dutch case. *Business History*, *45*(2), 77–101.

Wiessner, P. (2020). The role of third parties in norm enforcement in customary courts among the enga of papua new guinea. *Proceedings of the National Academy of Sciences of the United States of America*, *117*(50), 32320–32328. https://doi.org/10.1073/pnas.2012932117