Lecture Notes

Intermediation as a Coordination Device

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Abstract

Walrasian models are silent on the path goods travel from seller to buyer. These notes present the Rubinstein and Wolinsky [1987] model of intermediation in a search-theoretic framework. Middlemen emerge as coordination devices: they buy from producers and sell to consumers, earning a markup justified by the search frictions they alleviate. We characterize when middlemen are not only profitable but essential to sustaining trade.

1 Intermediation

Learning targets. After studying these notes, you should be able to:

1. Define intermediation and distinguish middlemen from brokers.
2. Write down value functions for consumers, producers, and middlemen in a search environment.
3. Characterize equilibria with and without active middlemen.
4. Identify conditions under which middlemen are essential to sustaining trade.

1.1 Outlook

The centralized exchange à la Walras is silent on the path goods travel. If Paul sells bananas and buys apples, and John buys bananas and sells apples, we can assume Paul gives the bananas directly to John in exchange for the apples. But Oliver—who neither increases nor decreases his fruit quantities through the market—might also be involved. All we know is the final allocation. The model is **silent on the exchange process**.

Rubinstein & Wolinsky (1987) motivate their work:

> "Despite the important role played by intermediation in most markets, it is largely ignored by the standard theoretical literature. This is because a study of intermediation requires a model that describes explicitly the trade frictions that give rise to the function of intermediation. But this is missing from the standard market models, where the actual process of trading is left unmodeled."

Intermediation is pervasive:

1. banks take money from depositors and loan it out,
2. resale firms obtain goods from producers and sell to customers,
3. employment agencies connect workers with firms,
4. concert and sport tickets are bought and resold by agencies,
5. exports and imports are handled by intermediaries instead of manufacturers,
6. used car dealers buy and sell cars,
7. real estate agents connect buyers and sellers,
8. publishers take written material from authors and deliver it to an audience,
9. priests mediate between the deity and the believer, and
10. university lecturers select and transmit material to students.

Several good reasons explain why intermediaries exist. They can

- **act as experts.** A used car seller may not know the state of crucial parts. Bringing the car to a dealer, who has reputation and expertise, provides verification ex-ante.
- **hand out guarantees.** A dealer can issue a 30-day warranty that private sellers cannot, because the legal infrastructure benefits from economies of scale. Guarantees substitute for reputation.
- **scale purchases and sales.** Banks pool many small deposits into large loans. Car dealers order dozens of cars transported by one truck; individual buyers would pay for individual transport. Townsend (1978) motivates trade through a middleman as a means to cut bilateral transaction costs.
- **reduce search and matching costs.** Buyers and sellers may have difficulty finding each other. Intermediaries centralize search and increase the likelihood of successful matches. Think shops!

- **screen and select participants.** Intermediaries evaluate the quality of counterparties (e.g. borrowers, workers, tenants) and filter out low-quality matches.

- **provide liquidity.** Intermediaries stand ready to buy or sell, bridging timing mismatches between buyers and sellers and allowing trades to occur more quickly.

- **absorb and pool risk.** By operating at scale, intermediaries can diversify idiosyncratic risk and offer insurance-like features that individual traders cannot. For example, a bank can lend to many borrowers and absorb a few defaults, whereas an individual lender would face the full loss.

- **standardize transactions.** Intermediaries impose common contracts, formats, and procedures, reducing the complexity of negotiation and exchange. For instance, real estate agents use standardized contracts so that buyers and sellers do not need to negotiate legal terms from scratch each time.

- **enforce and monitor agreements.** They help ensure compliance with contracts, either through formal mechanisms or through reputational discipline. For example, platforms like Airbnb monitor behavior and can exclude users who violate rules, thereby sustaining trust in the market.

- **save time and effort.** Participants outsource complex tasks (search, verification, negotiation) to intermediaries, reducing individual effort. For instance, a travel agency bundles flights and hotels, sparing customers from comparing and coordinating dozens of separate options.

- **curate and transmit information.** Publishers and lecturers select, organize, and communicate relevant material to an audience, reducing information overload.

- **mediate interpretation and legitimacy.** In more abstract settings, intermediaries such as priests interpret doctrine and mediate between the deity and the believer, providing guidance and legitimacy.

This section focuses on a general aspect of intermediation that has nothing to do with product quality or the skills of the actors. We present intermediation as a **coordination device**. Buyers and sellers could connect directly, but contacting a middleman and trading through her may be more efficient. We formalize this through contact probabilities between agents, conjecturing that middlemen have higher contact probabilities than other participants, so that the discoordination of direct trade is overcome by employing a middleman. The middleman exists because frictions are present.

We follow the seminal paper by Rubinstein & Wolinsky (1987). We replace their bargaining solution with Kalai bargaining, which is easier to expose but equivalent in the solution.

Definition 1. An intermediary or middleman is an economic agent who specializes in buying and selling the same good at the same time.

A middleman differs from a **broker** (e.g. real estate agents, employment agencies). A broker does not buy and sell outright but connects buyers and sellers for a fee, acting on behalf of one party.

Other related figures can be distinguished as follows:

- **Market maker.** Quotes bid and ask prices and stands ready to trade on both sides of the market, providing liquidity (e.g. financial intermediaries in asset markets).
- **Platform.** Provides an environment that facilitates matching and interaction between users, often with rules and reputation systems (e.g. online marketplaces).
- **Aggregator.** Pools demand or supply to exploit economies of scale (e.g. banks pooling deposits, wholesalers bundling orders).
- **Certifier.** Verifies quality or authenticity without directly participating in the transaction (e.g. rating agencies, auditors, publishers).
- **Agent.** Acts on behalf of one party with delegated authority, often with fiduciary responsibility (e.g. travel agents, talent agents).

These distinctions reflect differences in (i) ownership of the good, (ii) exposure to risk, (iii) control over the matching process, and (iv) the extent to which the intermediary creates or processes information.

1.2 Continuous-time value functions

We model search frictions by assuming that events—such as meeting a trading partner—occur with probability λ per period. In discrete time, the value of being in state x when the event switches the agent to state x' and yields flow payoff $u(x)$ is

$$V(x) = \beta u(x) + \lambda \beta V(x') + (1 - \lambda)\beta V(x)$$

where $\beta = \frac{1}{1+\rho}$. Rearranging:

$$\rho V(x) = u(x) + \lambda\big(V(x') - V(x)\big)$$

This form—the **continuous-time Bellman equation**—is the workhorse for the remainder of this section. A detailed derivation from first principles appears in Appendix A.1.

1.3 The model

1.3.1 The environment

Time is infinite and divided into rounds. All agents discount time at rate r. There are three types of agents: consumers (C), producers (P), and middlemen (M). There are n_i agents of type $i \in \{C, P, M\}$.

A perfectly divisible, non-storable good serves as the **payment**. Anyone can produce ($c(q) = q$) and enjoy ($u(q) = q$) this good linearly. Since utility is quasilinear, there are no gains from trade in the payment good: one agent's gain is a direct loss for the other.

Gains from trade arise from a different good that is indivisible and storable: type C consumes it for utility $u > 0$, and type P produces it at no cost. Type M does neither but can obtain it from P and give it to C in exchange for a payment transfer.

Holding the good yields a return $\rho_P \leq 0$ for P and $\rho_M \leq 0$ for M. A C-type does not pay holding costs because she consumes the good immediately.

Only a fraction of producers and middlemen are **active**. A fraction $\epsilon \in [0, 1]$ of all producers produce, and a fraction $\tau \in [0, 1]$ of all middlemen participate. Both fractions are determined endogenously.

Agents hold at most one unit of the good. A middleman either holds one good or nothing, $a \in \{0, 1\}$. Let m denote the fraction of active middlemen holding a good.

An agent of type i meets a j-type bilaterally with probability α_{ij}.

1.3.2 Trading

Direct trade: In PC matches, P gives the good to C for transfer q_{PC}.

Retail trade: In MC matches where M has the good ($a = 1$), M gives it to C for q_{MC}.

Wholesale trade: In MP matches where M lacks the good ($a = 0$), only active middlemen accept the good, transferring q_{MP} to P.

Transfers q_{ij} are determined by Kalai bargaining with an even split of welfare. Since one good enters linearly in utility, the Nash and Kalai solutions coincide: with quasilinear utility and equal bargaining power, both maximize total surplus and split it evenly.

1.3.3 Equilibrium definition

Definition 2 (Equilibrium)**.** A **pure-strategy, asymmetric equilibrium** specifies, for each agent, whether she is active or not. Agents do not mix—but ex-ante similar agents need not take the same action.

Two types of equilibria are interesting: one without active middlemen, and one with them. We start with the former.

1.3.4 No middlemen

Assume only producers and consumers are active. What determines whether a producer finds it worthwhile to produce? The answer depends on how often she meets a customer, how much she earns per trade, and how costly it is to hold inventory. We capture these forces in the value functions.

The value function of a **consumer** in continuous time is

$$rV_C = \alpha_{CP}\epsilon\,(u - q_{CP})$$

where ϵ accounts for mismatch: a consumer may meet a producer who does not produce.

The **producer**'s welfare is

$$rV_P = \alpha_{PC}q_{CP} + \rho_P$$

because the producer replaces production upon meeting a customer and pays the holding cost $-\rho_P$.

The **direct trade payment** q_{CP} follows from Kalai bargaining with an even split:

$$u - q_{CP} = \frac{1}{2}\,(u - q_{CP} + q_{CP}) = \frac{1}{2}u \quad\Leftrightarrow\quad q_{CP} = \frac{1}{2}u$$

Should a consumer ever be inactive? No:

$$rV_C = \alpha_{CP}\epsilon\frac{u}{2} \geq 0$$

always holds.

How many producers are active? There are **three possible cases.**

No producers active ($\epsilon = 0$): production does not pay, i.e., $V_P < 0$. This requires

$$-\rho_P > \alpha_{PC}\frac{u}{2}$$

so that holding costs exceed the expected return from trade.

All producers active ($\epsilon = 1$): the condition reverses,

$$-\rho_P < \alpha_{PC}\frac{u}{2}$$

Interior solution ($\epsilon \in (0,1)$): the marginal producer is indifferent,

$$-\rho_P = \alpha_{PC}\frac{u}{2}$$

1.3.5 What about the middlemen?

The conditions above characterize an equilibrium without middlemen. **But when is it a best response for a middleman not to participate?** We now ask whether a hypothetical middleman would find it profitable to enter. This requires value functions for a middleman with and without the good, and the terms of trade in wholesale and retail transactions.

We need $V_0 < 0$ for a hypothetical middleman who enters to buy and sell.

Define $D = V_1 - V_0$. The value without the good is

$$rV_0 = \alpha_{MP}\epsilon\,(D - q_{MP})$$

and the value with the good is

$$rV_1 = \rho_M + \alpha_{MC}\,(q_{MC} - D)$$

Combining and solving:

$$D = \frac{\alpha_{MC}q_{MC} + \alpha_{MP}\epsilon q_{MP} + \rho_M}{r + \alpha_{MC} + \alpha_{MP}\epsilon}$$

The **wholesale payment** (producer to middleman) is

$$q_{MP} = \frac{1}{2}D$$

and the **retail payment** (middleman to consumer) is

$$q_{MC} = \frac{1}{2}\,(u + D)$$

The **markup, or spread**, is

$$q_{MC} - q_{MP} = \frac{u}{2}$$

Substituting prices into D and solving in terms of primitives:

$$D = \frac{\alpha_{MC}u + 2\rho_M}{2r + \alpha_{MC} + \alpha_{MP}\epsilon}$$

The value functions in terms of primitives are

$$rV_0 = \frac{\alpha_{MP}\epsilon\,(\alpha_{MC}u + 2\rho_M)}{2\,(2r + \alpha_{MC} + \alpha_{MP}\epsilon)}$$

and

$$rV_1 = \frac{(2r + \alpha_{MP}\epsilon)\,(\alpha_{MC}u + 2\rho_M)}{2\,(2r + \alpha_{MC} + \alpha_{MP}\epsilon)}$$

Middlemen are not active when

$$0 > rV_0 \quad \Leftrightarrow \quad -\rho_M > \alpha_{MC}\frac{u}{2}$$

Reversing this condition tells us when middlemen will be active.

1.3.6 When are middlemen essential?

When middlemen are active, the **producer**'s value function expands:

$$rV_P = \alpha_{PC}q_{CP} + \alpha_{PM}\tau\left(1-m\right)q_{MP} + \rho_P$$

The term $\alpha_{PM}\tau\left(1-m\right)q_{MP}$ is non-negative, so **the presence of middlemen does not inhibit entry for producers**.

In steady state with all producers active ($\epsilon = 1$), the inflow of middlemen acquiring the good equals the outflow of middlemen selling it:

$$n_M\tau\left(1-m\right)\alpha_{MP}\epsilon = n_M\tau m\alpha_{MC}$$

Setting $\epsilon = 1$ and solving:

$$m = \frac{\alpha_{MP}}{\alpha_{MC}+\alpha_{MP}}$$

Substituting known prices:

$$rV_P = \alpha_{PC}\frac{u}{2} + \alpha_{MP}\tau\frac{\alpha_{MP}}{\alpha_{MC}+\alpha_{MP}}\frac{1}{2}\frac{\alpha_{MC}u+2\rho_M}{2r+\alpha_{MC}+\alpha_{MP}\epsilon} + \rho_P$$

Producers are active when $rV_P > 0$, which can be rearranged as

$$-\rho_P = \text{const} + \text{slope}\cdot\rho_M$$

where $\text{const} = \alpha_{PC}\frac{u}{2} + \frac{\tau}{2}\frac{\alpha_{MP}\alpha_{MC}u}{2r+\alpha_{MC}+\alpha_{MP}\epsilon} > 0$ and $\text{slope} = \frac{\alpha_{MP}\tau}{2r+\alpha_{MC}+\alpha_{MP}\epsilon} > 0$.

Figure 1 sketches the equilibrium types in the parameter space $\{-\rho_P, -\rho_M\}$.

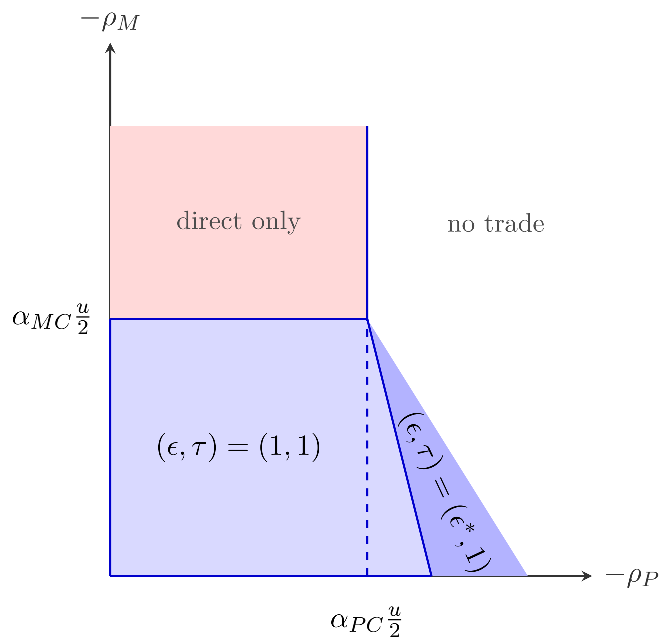

Figure 1: Equilibrium types in the intermediation model. Intermediation becomes essential to the right of $\alpha_{PC}\frac{u}{2}$.

1.3.7 A numerical example

Set $u = 10$, $r = 0.05$, $\alpha_{PC} = 0.1$, $\alpha_{MC} = 0.3$, $\alpha_{MP} = 0.2$, $\rho_P = -0.3$, and $\rho_M = -0.5$.

Are middlemen active? The condition for middlemen to stay out is $-\rho_M > \alpha_{MC}\frac{u}{2}$, i.e., $0.5 > 0.3 \times 5 = 1.5$. This fails, so $V_0 > 0$ and middlemen **enter**.

Are producers active without middlemen? The condition is $-\rho_P < \alpha_{PC}\frac{u}{2}$, i.e., $0.3 < 0.1 \times 5 = 0.5$. This holds, so all producers are active ($\epsilon = 1$) even without middlemen.

Are middlemen essential? Middlemen are essential when producers would not be active without them, which requires $-\rho_P > \alpha_{PC}\frac{u}{2} = 0.5$. Here $-\rho_P = 0.3 < 0.5$, so middlemen are **not essential**—producers trade directly. But middlemen still enter because they earn a positive surplus from intermediation.

Welfare comparison. Without middlemen, $rV_P = \alpha_{PC}\frac{u}{2} + \rho_P = 0.5 - 0.3 = 0.2$. With middlemen (assuming $\alpha_{PM} = \alpha_{MP}$), $m = 0.2/(0.3 + 0.2) = 0.4$ and $D = (\alpha_{MC}u + 2\rho_M)/(2r + \alpha_{MC} + \alpha_{MP}) = 2/0.6 \approx 3.33$, so $q_{MP} = D/2 \approx 1.67$. The producer's welfare rises to $rV_P = 0.5 + \alpha_{PM}(1 - m)q_{MP} + \rho_P = 0.5 + 0.2 \times 0.6 \times 1.67 - 0.3 = 0.4$. Middlemen **double the producer's welfare** in this example.

If instead $\rho_P = -0.8$, then $-\rho_P = 0.8 > 0.5$ and producers would exit without middlemen. In this case, middlemen become essential to sustaining trade.

1.4 Conclusion

Middlemen, like money, facilitate exchange. They allow trade to occur when it would not happen otherwise—when producers have limited access to customers, poor storage technology, or lower bargaining power. Middlemen can be **essential** to an economy.

Middlemen require a markup, even when they are not essential and even with zero holding costs. The fees they obtain are justified by the coordination service they provide.

A regulator who forbids middlemen faces a trade-off: producers sell **less frequently** and at a **higher price** without intermediation. Li [1998] extends this analysis to a monetary search environment, showing that middlemen and money can coexist as complementary exchange technologies.

Key takeaways.

- Middlemen buy from producers and sell to consumers, earning a markup of $u/2$.
- Middlemen are active when their holding costs are low relative to their access to consumers ($-\rho_M < \alpha_{MC}\frac{u}{2}$).
- Middlemen are *essential* when producers would not trade without them—when producer holding costs are high or direct access to consumers is poor.
- The middleman's role is coordination: she overcomes the discoordination of direct trade through higher contact probabilities. No expertise or product quality advantage is required.

1.5 Exercises

1. In the numerical example above, compute the wholesale payment q_{MP}, the retail payment q_{MC}, and the middleman's markup $q_{MC} - q_{MP}$. Verify that the markup equals $u/2$.
2. Show that the steady-state fraction of middlemen holding the good, m, is independent of the discount rate r and the number of middlemen n_M. Interpret this result.
3. For a more advanced exercise on intermediation in financial markets, see the OTC markets problem set based on Duffie et al. [2005].

A Appendix

A.1 From discrete to continuous time

In discrete time, an agent in state x who switches to state x' upon an event (which occurs with probability λ) and receives flow payoff $u(x)$ each period has value function

$$V(x) = \beta u(x) + \lambda \beta V(x') + (1-\lambda)\beta V(x)$$

Rearranging:

$$\rho V(x) = u(x) + \lambda\big(V(x') - V(x)\big) \tag{1}$$

where $\beta = \frac{1}{1+\rho}$. This is already the continuous-time form. The caveat is that λ must lie in $[0, 1]$, and only one event can occur per period.

In continuous time, we replace the probability-per-period formulation with a waiting time drawn from the exponential distribution.[1] The value function becomes

$$V(x) = \int_0^\infty \lambda e^{-\lambda t} \left[\int_0^t e^{-\rho\tau} u(x)\, d\tau + e^{-\rho t} V(x') \right] dt$$

The outer integral averages over all possible event times t, weighted by the exponential density $\lambda e^{-\lambda t}$ (with $\mathbb{E}[t] = 1/\lambda$). The inner integral discounts the flow payoff $u(x)$ until the event occurs at time t, after which the agent transitions to $V(x')$.

Evaluating the inner integral and simplifying:

$$\begin{aligned}
V(x) &= \int_0^\infty \lambda e^{-\lambda t} \left[\frac{u(x)}{\rho}\left(1 - e^{-\rho t}\right) + e^{-\rho t} V(x') \right] dt \\
&= \frac{\lambda u(x)}{\rho} \underbrace{\int_0^\infty e^{-\lambda t} dt}_{=1/\lambda} - \frac{\lambda u(x)}{\rho} \int_0^\infty e^{-(\lambda+\rho)t} dt + \lambda V(x') \int_0^\infty e^{-(\lambda+\rho)t} dt \\
&= \frac{u(x)}{\rho} - \frac{\lambda u(x)}{\rho(\lambda+\rho)} + \frac{\lambda}{\lambda+\rho} V(x') \\
&= \frac{u(x)}{\lambda+\rho} + \frac{\lambda}{\lambda+\rho} V(x') \\
\Leftrightarrow \quad (\lambda+\rho) V(x) &= u(x) + \lambda V(x') \\
\Leftrightarrow \quad \rho V(x) &= u(x) + \lambda\big(V(x') - V(x)\big)
\end{aligned} \tag{2}$$

This matches (1).

[1] This arrival process is a Poisson process. Exponential waiting times are memoryless: the probability of an event in the next minute is always the same, regardless of how long we have waited.

An alternative route uses a Taylor approximation. For a small time period Δ,

$$\beta(\Delta) \approx e^{-\rho\Delta}, \qquad \lambda(\Delta) \approx \Delta\lambda, \qquad u(x)(\Delta) \approx \Delta\, u(x)$$

Substituting and dividing by Δ:

$$\frac{1 - e^{-\rho\Delta}}{\Delta} V(x) = u(x) + \lambda e^{-\rho\Delta}\big(V(x') - V(x)\big) + \frac{o(\Delta)}{\Delta}$$

Taking $\Delta \to 0$ and applying L'Hôpital's rule ($\frac{1-e^{-\rho\Delta}}{\Delta} \to \rho$) yields the continuous-time Bellman equation.

References

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