Preferred Clearing and Post-Trade Costs

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We study fee competition between an incumbent and entrant central counterparty (CCP) under two regimes: interoperability (trades clear at their own CCP) and preferred clearing (trades clear at the incumbent CCP unless both buyer and seller decide otherwise). Preferred clearing creates network effects, forcing the entrant to undercut fees more aggressively while allowing the incumbent to sustain higher profits. Preferred clearing generates wider fee spreads, higher average trading costs, and greater industry profits. Interoperability improves welfare, unless switching costs are high. The incumbent favors preferred clearing; the entrant favors interoperability. Our results inform ongoing policy debates about CCP market structure.

Keywords: post-trade infrastructure, central clearing, network effects, market structure

JEL Codes: G11, G12, G14

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1 Introduction

> *"Ultimately, the EU should aim to create a single central counterparty platform (CCP) and a single central securities depository (CSD) for all securities trades."*
>
> – Mario Draghi, "The Future of European Competitiveness", September 2024

The European post-trade infrastructure evolved along national lines. Major exchanges in Paris, Frankfurt, or Amsterdam developed their own clearing houses (CCPs), closely tied to domestic settlement systems and regulatory frameworks. In 2007, the Markets in Financial Instruments Directive intensified competition by enabling multilateral trading facilities (MTFs) to challenge incumbent exchanges. New pan-European CCPs emerged, such as EMCF in 2007 or EuroCCP in 2013 — which was later rebranded as Cboe Clear in 2020. As of early 2026, European equity clearing remains fragmented across multiple CCPs, contrasting sharply with the United States or Canada where the Depository Trust and Clearing Corporation (DTCC) and the CDS Clearing and Depository Services, respectively, hold effective monopoly power.

Given this fragmented landscape, two CCP competition models emerged in Europe: interoperability and preferred clearing. Under interoperability, each leg of a trade clears at the trader's own CCP. Traders affiliated with different CCPs can transact freely; cross-CCP positions are reconciled through linked accounts and risk-sharing arrangements. Under preferred clearing, first introduced by BATS Europe in 2011, both counterparties must clear through the same clearinghouse. If their affiliations differ, trades default to a designated primary CCP, which is typically the national incumbent. In 2025, preferred clearing accounts for 22% of European equity volume, notably on Euronext exchanges (Paris, Amsterdam, Brussels, Lisbon, Milan) and Deutsche Börse in Germany, with 73% of volume clearing through interoperable arrangements.[1]

Which of the two clearing frameworks delivers lower costs to investors? In this paper, we

[1] See Cboe Clear Europe, Preferred Clearing, accessed January 2026.

build a model of clearinghouse competition with horizontally differentiated traders and network effects to compare post-trade costs under both regimes.

In our model, traders receive liquidity shocks at a common Poisson rate and pay per-trade clearing fees. Each trader chooses their CCP affiliation by comparing the present value of switching and operational costs plus the expected clearing fees across their trading horizon. We assume horizontal differentiation in the tradition of Hotelling (1929). Traders are uniformly distributed along a line representing jurisdictional and technological proximity to each CCP, as well as switching costs from migrating clearing infrastructure. For example, domestic institutional investors (e.g., pension funds, insurance companies, asset managers with local portfolios) value established relationships with national custodians, familiarity with domestic regulations, and integration with legacy back-office systems. In contrast, algorithmic trading firms executing cross-border arbitrage, proprietary desks at international banks, and quantitative hedge funds gravitate toward newer CCPs offering multi-market connectivity and modern APIs.

We find that, in both interoperability and preferred clearing regimes, equilibrium fees decline with trading frequency. High-frequency traders amortize one-time switching costs over more trades, making them more responsive to per-trade fee differences. This intensifies competition and forces both CCPs to reduce fees. The result provides a theoretical foundation for the volume discounts commonly observed in clearing markets: frequent traders effectively face lower per-trade costs.

The key distinction between the two competition regimes lies in network effects. Under interoperability, a trader's clearing fee depends only on their own CCP membership. A trader who switches to the entrant pays the entrant fee on every trade, regardless of counterparty affiliation. Competition between clearinghouses occurs purely on price, and CCPs face symmetric incentives to undercut. Under preferred clearing, however, network effects alter the competitive landscape. A trader affiliated with the entrant pays the entrant's low fee only when matched with another

entrant member. Otherwise, trades with incumbent members clear at the incumbent's higher fee. Fee savings are therefore proportional to the entrant's market share. This dilutes the entrant's competitive power: when the entrant's network is small, switching delivers minimal benefit even if the entrant's fee is substantially lower.

In equilibrium, the entrant must undercut far more aggressively under preferred clearing to compensate traders for diluted fee savings due to network effects. At the same time, the incumbent faces less competitive pressure. We find that preferred clearing generates wider fee spreads than interoperability, with the entrant providing steeper discounts and the incumbent charging more.

Despite the entrant's aggressive undercutting, average clearing costs are higher under preferred clearing. Volume is more concentrated under preferred clearing because the incumbent clears not only its own members' trades but also all cross-CCP trades. This network externality allows the incumbent to sustain elevated fees that dominate the entrant's discount in the volume-weighted average.

The incumbent CCP earns strictly higher profits under preferred clearing while the entrant is better off under interoperability. This is consistent with the pattern of European regulatory debates, where entrant platforms (such as Cboe Clear Europe) have pushed for mandated interoperability.[2]

From a welfare perspective, interoperability dominates across most of the parameter space. We measure welfare loss as the aggregate operational frictions and switching costs incurred when traders clear through CCPs further away from their jurisdictional and technological profiles – that is, the aggregate transportation costs in the Hotelling (1929) model. The efficient allocation would assign each trader to whichever CCP minimizes their operational and switching costs. Under preferred clearing, the entrant needs to undercut more aggressively to overcome network disadvantages, drawing in traders for whom operational cost savings would not otherwise justify the switch. The result is a larger misallocation: more traders clear through the entrant than is

[2]See Cboe Clear Europe, Europe Needs Clearing Competition, Not a Single CCP, October 24, 2024.

socially optimal, incurring unnecessary operational frictions.

Related literature. We contribute to a growing literature on post-trade infrastructure (Menkveld and Vuillemey, 2021, provide a comprehensive survey on recent findings in the economics of clearing). Closest to our paper, Benos, Huang, Menkveld, and Vasios (2024) document that clearing fragmentation in USD interest rate swaps generates a dead-weight loss of $80 million a day, while Duffie and Zhu (2011) argue that a single clearinghouse for correlated asset classes (e.g., interest rate swaps and credit derivatives) enables more efficient netting. We complement this literature by comparing different CCP competition models in fragmented markets.

Several studies investigate the impact of central clearing on asset prices and systemic risk. For example, Bernstein, Hughson, and Weidenmier (2019) examine the 1892 introduction of a clearinghouse on the New York Stock Exchange, finding that it reduced network contagion and counterparty risk. Similarly, Menkveld, Pagnotta, and Zoican (2015) document that the introduction of a CCP on Nordic equity markets in the wake of the global financial crisis helped to reduce price volatility. Duffie, Scheicher, and Vuillemey (2015) build a model to argue that mandatory central clearing can reduce the aggregate collateral demand relative to a bilateral system. In contrast, Menkveld (2017) argue that clearinghouses can themselves become exposed to a new form of systemic risk arising from "crowded trades," particularly when netting efficiencies are low. Huang, Menkveld, and Yu (2021) estimate that trade crowding contributes 17% to the aggregate CCP risk exposure. Biais, Heider, and Hoerova (2016) argue that the mutualization of risk in clearing houses might enhance moral hazard concerns. In our paper, we abstract from the risk management functions of CCPs and focus solely on their role as post-trade operators who compete in clearing fees and may benefit from an incumbent advantage and network effects. European equities settle T+1 or T+2 with limited collateral requirements, making clearing fees a larger component of post-trade costs.

Another strand of literature focuses on the optimal design and industrial organization of the post-trade environment. Degryse, Achter, and Wuyts (2022) argue that clearing fees should be charged based on a trade's marginal cost rather than a flat fee, given that same-broker trades are cheaper to process. Their model resembles ours in that it abstracts from risk considerations and views clearinghouses as trade processors that incur only marginal costs. In a similar vein, Khapko and Zoican (2020) analyze the optimal settlement time, contending that penalties for failures-to-deliver should be contingent on security borrowing costs. Meanwhile, Huang and Zhu (2024) examine the optimal auction design for defaulting CCP members and advocate for juniorization, whereby members submitting inferior bids have their guarantee funds drawn upon before those of members with superior bids.

Finally, we build on a rich literature in industrial organization and finance that examines incumbency and network externalities. Katz and Shapiro (1986) raise the possibility of multiple equilibria in markets with network effects, while Pagano (1989) show that if an asset is traded on two identical exchanges, market participants gravitate to a single exchange due to these effects, although multiple equilibria are also. We model incumbency by employing the attached consumer equilibrium concept from Biglaiser and Cremer (2020), which serves as an effective equilibrium selection tool and enables us to derive sharp predictions regarding the formation of turnover-based clienteles for clearing services. Similarly, Khomyn, Putnins, and Zoican (2024) use this equilibrium concept to analyze clienteles across same-index ETFs.

2 Clearing landscape in European equity markets

In September 2024, former European Central Bank President Mario Draghi advocated consolidating Europe's fragmented post-trade infrastructure: to create a single central counterparty platform.[3]

[3] European Commission, The Future of European Competitiveness, September 2024.

The United States provides the natural benchmark: the Depository Trust and Clearing Corporation (DTCC) holds effective monopoly power over equity clearing, consolidating all trades through a single infrastructure.

A regulated monopoly CCP maximizes netting efficiency (Duffie and Zhu, 2011). When all trades flow through a single clearinghouse, ofsetting positions are netted out in full, reducing settlement obligations and collateral requirements. At the same time, the monopoly model carries risks. For example, a single CCP creates systemic concentration, that is one point of failure for the entire market (Bignon and Vuillemey, 2020). Further, without competitive pressure, incentives to innovate in technology and margin models might weaken.

This paper does not focus on the relative merits of CCP monopoly and competition. We take Europe's fragmented clearing landscape as given and ask which of the two dominant competition models delivers lower costs? Figure 1 illustrates the preferred clearing mechanism: when both counterparties are affiliated with an alternative CCP, they can bypass the primary CCP; otherwise, the primary CCP clears the trade.

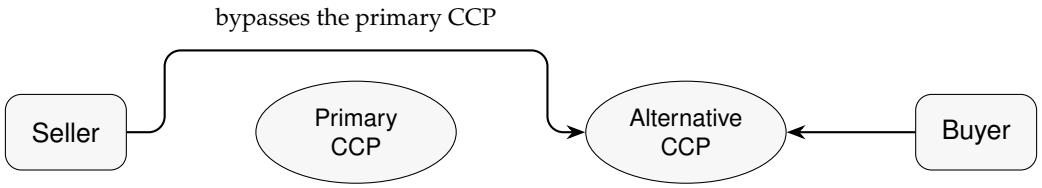


Figure 1: Preferred clearing mechanism.

Table 1 details clearing arrangements across European exchanges. Vertical integration dominates smaller markets (Athens, Prague, Warsaw, Stuttgart) where single-market CCPs face little competitive threat. Larger exchanges split between preferred clearing and full interoperability. Figure A.1 in the Appendix illustrates the cross-section of clearing arrangements overlaid on the European map.

Table 1: Clearing arrangements in European equity markets

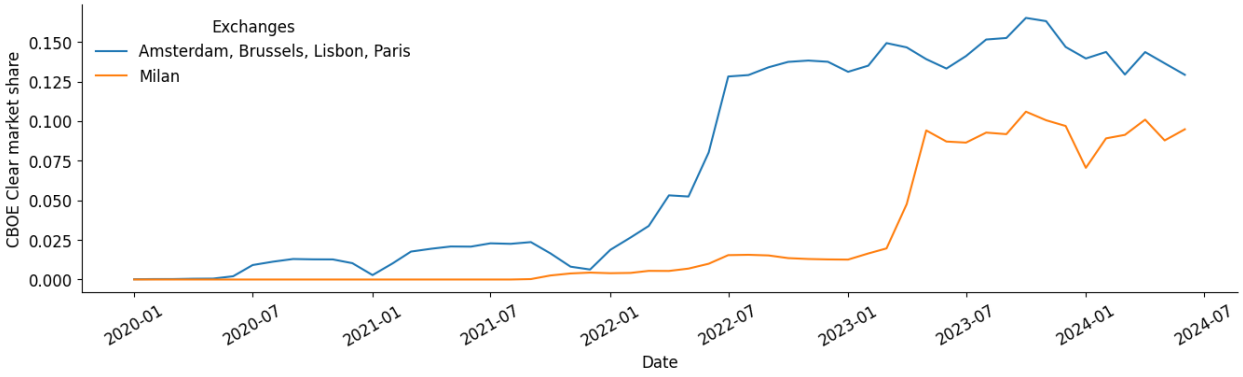
This table presents clearing arrangements in European equity markets by detailing the clearing model, country of operation, and the designated main and preferred clearing counterparties for each exchange.

Exchange	**Model**	**Country**	**Main CCP**	**Preferred CCP**
Athens Stock Exchange	Vertical	Greece	ATHEXClear	
Bolsas y Mercados Españoles	Vertical	Spain	BME Clearing	
Boerse Stuttgart	Vertical	Germany	Boerse Stuttgart Clearing	
Budapest Stock Exchange	Vertical	Hungary	KELER CCP	
Cyprus Stock Exchange	Vertical	Cyprus	in-house CCP	
London Stock Exchange (only International Order Book/ETF)	Vertical	UK	LCH Ltd	
Luxembourg Stock Exchange	Vertical	Luxembourg	in-house CCP	
Prague Stock Exchange	Vertical	Czech Republic	in-house CCP	
Vienna Stock Exchange	Vertical	Austria	CCP Austria	
Warsaw Stock Exchange	Vertical	Poland	KDPW_CCP	
Deutsche Börse	Preferred	Germany	Eurex Clearing AG	Cboe Clear
Euronext Milano	Preferred	Italy	Euronext Clearing	Cboe Clear and LCH.Ltd
Euronext Paris	Preferred	France	Euronext Clearing	Cboe Clear
Euronext Brussels	Preferred	Belgium	Euronext Clearing	Cboe Clear
Euronext Amsterdam	Preferred	Netherlands	Euronext Clearing	Cboe Clear
Euronext Lisbon	Preferred	Portugal	Euronext Clearing	Cboe Clear
Euronext Dublin	Preferred	Ireland	Euronext Clearing	Cboe Clear
SIX Swiss Exchange	Interoperable	Switzerland	SIX x-clear A	
Equiduct	Interoperable	-	Equiduct	
London Stock Exchange (SETS)	Interoperable	UK	LCH Ltd	
Nasdaq Helsinki	Interoperable	Finland	Nasdaq Clearing	
Nasdaq Stockholm	Interoperable	Sweden	Nasdaq Clearing	
Nasdaq Copenhagen	Interoperable	Denmark	Nasdaq Clearing	
Euronext Oslo	Interoperable	Norway	Euronext Clearing	
MTFs (CBOE, Turquoise, Aquis, Sigma X)	Interoperable	-	multiple	

Figure 2 illustrates network dynamics under preferred clearing. Cboe Clear Europe's market share on Euronext exchanges grows in sudden jumps rather than smooth expansion. This pattern is consistent with network externalities: When large or frequent traders switch to the entrant, they generate disproportionate benefits that induce additional traders to follow.

Figure 2: **Cboe Clear market share on preferred clearing markets**

This figure shows the dynamics of Cboe Clear's market share (in equity volume cleared) on Euronext exchanges in Amsterdam, Brussels, Lisbon, Paris, and Milan. Data source: Cboe Clear website.



Entrant CCPs undercut incumbents substantially, with deeper discounts under preferred clearing. A trader executing 100,000 equity transactions in 15 assets a month would pay 4 cents per trade at Euronext Clearing, but only 2.5 cents per trade at Cboe Clear. For 10,000,000 transactions a month, the fees drop to 1.85 and 0.35 cents, respectively. Under preferred clearing arrangements, Cboe offers an additional 25% fee discount, a strategy which our model helps rationalize.[4]

Cboe Clear Europe's participant base includes large international banks operating market-making and cross-border trading desks, such as Goldman Sachs, Morgan Stanley, Citigroup, or UBS.[5] These institutions execute across multiple European venues and benefit from consolidated clearing infrastructure.

[4]Sources: Cboe, Regulation Fees and Penalties in force since January 2024, and Euronext's Fee Schedule for CCP in force from 1 February 2026.

[5]Source: Cboe Clear Europe membership list, accessed February 2026.

3 A model of clearing competition

Asset and market. We consider a continuous-time economy in which a single asset is traded. The asset has a constant common value $v_t \equiv v > 0$ for all $t > 0$. To isolate the effects of post-trade infrastructure choices, we fix the trading price to be equal to the asset's common value (akin to Foucault, Kadan, and Kandel, 2013). This is equivalent to trading occurring in a single-tick limit order market with the unique price v.

Agents. There is a continuum of traders indexed by their location $x \in [0, 1]$, uniformly distributed. Two central counterparties (CCPs) compete to clear trades: an incumbent L (leader) located at $x_L = 0$ and an entrant F (follower) located at $x_F = \Delta$, where $\Delta \geq 1$. We interpret the leader clearinghouse as the incumbent CCP of a major national exchange (e.g., Euronext Clearing) and the follower as the "entrant" clearinghouse of an alternative trading venue or multilateral trading facility (e.g., Cboe Clear). Our assumption that $\Delta \geq 1$ places the entrant CCP further from the average trader than the incumbent, capturing switching costs such as documentation, legal review, connectivity setup, and staff retraining which create one-time frictions favoring the status quo.

We model trader heterogeneity using a spatial framework in the tradition of Hotelling (1929). A trader at location $x \in [0, 1]$ who is a member of CCP $j \in \{L, F\}$ incurs a one-time cost of $\theta|x - x_j|$.

The "location" parameter x captures a trader's operational and jurisdictional fit with each clearing house. Consider the landscape of market participants. At one extreme (x close to zero) are domestic institutional investors such as pension funds, insurance companies, and asset managers whose portfolios are concentrated in local equities and bonds. These traders value the incumbent CCP's established relationships with local custodians, familiarity with domestic regulatory requirements, and integration with existing back-office systems. A Nordic pension fund

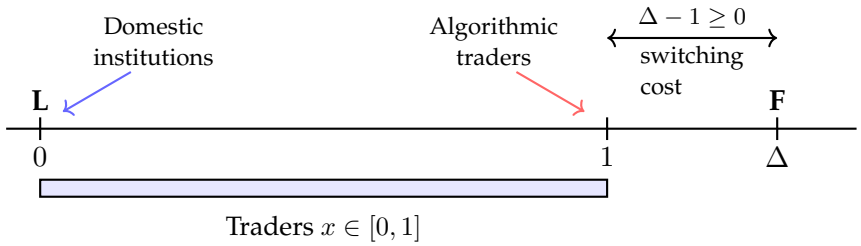
re-balancing its domestic equity portfolio, for instance, faces minimal friction clearing through the legacy Nordic CCP but would incur substantial operational costs adapting to a pan-European entrant's workflows and reporting standards.

At the other extreme (x approaching one) are globally-oriented, technologically sophisticated traders. Algorithmic trading firms executing cross-border arbitrage strategies, proprietary trading desks at international banks, and quantitative hedge funds naturally gravitate toward newer CCPs that offer multi-market connectivity and modern APIs. For a high-frequency trader simultaneously arbitraging price discrepancies between Euronext Paris and London Stock Exchange or Cboe, a CCP linked to multiple trading venues provides genuine operational value. Menkveld (2013) documents that high-frequency traders rely heavily on MTFs for cross-venue arbitrage and liquidity provision strategies, and argues that they would face significant operational costs from maintaining clearing infrastructure at multiple CCPs.

Figure 3 illustrates the horizontal differentiation model of CCP competition.

Figure 3: **Trader heterogeneity**

Traders are uniformly distributed on the unit interval according to their operational fit with each CCP.



Following Pagnotta and Philippon (2018) and Khomyn, Putnins, and Zoican (2024), traders experience liquidity shocks at random times, exponentially distributed with rate λ and are randomly matched to trade. A liquidity shock prompts a trader to buy or sell one unit of the asset with equal probability. Each trader discounts future payoffs at rate $\rho > 0$. Since there are infinitely many traders, individual choices do not impact equilibrium outcomes.

Each CCP j charges a per-trade clearing fee $f_j \geq 0$. We distinguish between two regulatory regimes that differ primarily in defining which CCP clears a trade when counterparties are affiliated to different CCPs.

Definition 1 (**Interoperability**). Under *interoperability* (IO), each leg of a trade clears at the trader's own CCP. A trader who is a member of CCP j pays fee f_j on all trades, regardless of counterparty affiliation.

In practice, interoperability requires CCPs to maintain linked accounts and risk-sharing arrangements, allowing positions to be netted across platforms. The European Market Infrastructure Regulation (EMIR) encouraged interoperability for cash equities. The first European CCP link was established in 2008 between LCH.Clearnet and SIX x-clear, serving the London Stock Exchange and SIX Swiss Exchange. Proponents argue that interoperability eliminates network effects as a barrier to entry for clearing houses.

Definition 2 (**Preferred Clearing**). Under *preferred clearing* (PC), the entire trade clears at a single CCP according to a deterministic priority rule. We assume trades between members of different CCPs clear at the incumbent L.

Under preferred clearing, each trade has a single CCP as counterparty to both legs. That is, a member of F pays f_F only when trading with other F members; trades with L members clear at L and incur fee f_L. The incumbent thus serves as the default venue for cross-CCP trades. BATS Europe launched the first preferred interoperable clearing model in 2011, allowing counterparties to choose among EuroCCP, LCH.Clearnet, and SIX x-clear.[6]

Timing. Figure 4 illustrates the sequence of events in the model. First, at $t = -2$, the leader and follower CCPs simultaneously set their clearing fees. Given fees, at $t = -1$ traders decide on

[6]See SIX Group, A History of Interoperability and Market Extension Outlook (July 20, 2023).

whether to stay with the leader clearinghouse or switch to the follower. Finally, continuous trading starts at $t = 0$. Table B.1 in the Appendix summarizes the model notation.

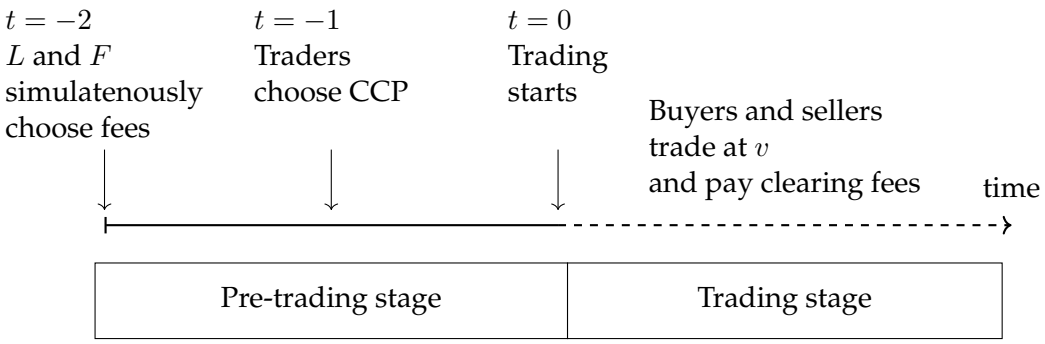


Figure 4: Model timing

4 Equilibrium

We study the interoperability and preferred clearing separately in Sections 4.1 and 4.2. In Section 4.3, we compare the two regimes, and we discuss welfare considerations in Section 4.4.

4.1 Clearing interoperability

Under interoperability, a trader's clearing costs depend only on their own CCP membership. Consider a trader at location x who is currently a member of L. The trader incurs a one-time cost θx reflecting the operational fit with the CCP. Trades arrive at Poisson rate λ, each incurring clearing

fee f_L. The present value of total costs from remaining with L is:[7]

$$\begin{aligned} C_L(x) &= \theta x + \int_0^\infty e^{-\rho t} \lambda f_L \, \mathrm{d}t \\ &= \theta x + \frac{\lambda f_L}{\rho}. \end{aligned} \tag{1}$$

Similarly, the present values of total costs when switching to F is

$$C_F^{IO}(x) = \theta \left(\Delta - x\right) + \frac{\lambda f_F}{\rho}. \tag{2}$$

Trader x switches to the entrant if and only if $C_F^{IO}\left(x\right) \leq C_L\left(x\right)$, which is equivalent to:

$$\theta \left(2x - \Delta\right) + \frac{\lambda}{\rho}\left(f_L - f_F\right) \geq 0 \Longleftrightarrow x \geq \hat{x}^{IO} \equiv \frac{\Delta}{2} - \frac{\lambda \left(f_L - f_F\right)}{2\rho\theta}. \tag{3}$$

The marginal trader $\hat{x}^{IO}$ is indifferent between the two CCPs. Traders with $x < \hat{x}^{IO}$ remain with the incumbent; those with $x \geq \hat{x}^{IO}$ switch to the entrant. A larger incumbent advantage Δ raises the switching cost for all traders, leading to an increase in the marginal trader's location $\hat{x}^{IO}$ and therefore shrinking the entrant's market share. A higher trading frequency λ works in the opposite direction: the one-time cost is amortized over more trades, such that fee savings accumulate faster and more traders find switching worthwhile. Finally, when the entrant undercuts on fees ($f_L > f_F$), traders are better compensated for choosing the entrant, which leads to a higher market share of F.

The market share of CCP F is:

$$\Phi_F^{IO} = \max\left\{0, 1 - \hat{x}^{IO}\right\} = \max\left\{0, 1 - \frac{\Delta}{2} + \frac{\lambda(f_L - f_F)}{2\rho\theta}\right\}. \tag{4}$$

[7]The present value calculation omits the gross surplus from trading. Since counterparties are randomly matched and trades arrive at rate λ independent of CCP membership, trading gains are identical across CCP choices. We therefore focus on transaction costs without loss of generality.

Both central counterparties set fees simultaneously at $t = -2$ to maximize their profits per unit of time

$$\pi_L^{IO} = \lambda(1 - \Phi_F^{IO}) f_L \text{ and } \pi_F^{IO} = \lambda \Phi_F^{IO} f_F, \text{ respectively.} \tag{5}$$

Proposition 1 (IO Equilibrium). *Under interoperability, if $\Delta < 4$, the unique equilibrium fees are:*

$$f_L^{IO} = \frac{\rho\theta}{\lambda} \cdot \frac{2+\Delta}{3}, \qquad f_F^{IO} = \frac{\rho\theta}{\lambda} \cdot \frac{4-\Delta}{3}. \tag{6}$$

The equilibrium market share of the entrant is:

$$\Phi_F^{IO} = \max\left\{0, \frac{4-\Delta}{6}\right\}. \tag{7}$$

The equilibrium CCP profits are:

$$\pi_L^{IO} = \frac{\rho\theta(2+\Delta)^2}{18}, \qquad \pi_F^{IO} = \frac{\rho\theta(4-\Delta)^2}{18}. \tag{8}$$

For $\Delta \geq 4$, the incumbent posts fee $f_L^{IO} = \frac{\rho\theta(\Delta-2)}{\lambda}$ and earns monopoly profit $\pi_L^m = \rho\theta(\Delta - 2)$. The follower does not enter the market.

Proof. See Appendix C. □

The equilibrium in Proposition 1 exhibits several intuitive properties. First, the incumbent always charges a higher fee than the entrant: $f_L^{IO} > f_F^{IO}$ for all $\Delta > 1$. When $\Delta = 1$, the CCPs are symmetrically positioned around the trader distribution, and standard Hotelling (1929) competition obtains: both clearinghouses charge $f = \frac{\rho\theta}{\lambda}$ and split the market equally. As Δ increases, the incumbent's locational advantage allows it to charge a premium while the entrant must offer a discount to attract traders away from the status quo.

Second, both fees are decreasing in the trading frequency λ. Frequent traders amortize the one-time cost over more transactions, making them more responsive to per-trade fee differences. CCPs therefore compete more aggressively when the investors trade more frequently. This provides a theoretical foundation for the volume discounts commonly observed in clearing markets: high-frequency participants face lower effective per-trade fees.

Third, investor heterogeneity θ is essential for sustaining positive fees. If $\theta = 0$, traders are homogeneous and competition collapses to a Bertrand model: both CCPs undercut fees to zero and earn no profits. Horizontal differentiation—reflecting heterogeneity in traders' operational models, jurisdictional preferences, and technological capabilities—is key to allow CCPs charging fees above cost. This underscores the role of trader heterogeneity in shaping market structure.

Finally, if the incumbent advantage is sufficiently large ($\Delta \geq 4$), the leader can effectively deter entry. That is, there needs to be sufficient mass of traders—algorithmic firms, cross-border arbitrageurs, multi-venue market makers—whose operational profile aligns closely enough with the entrant to make competition viable.

4.2 Preferred clearing

Under preferred clearing, the fee a trader pays depends not only on the CCP they are affiliated with, but also on their counterparty's identity. That is, a member of CCP L pays f_L on all trades. However, a member of F pays f_F on trades with other F members (with endogenous probability Φ_F, the market share of the follower CCP) and f_L on trades with L members (with probability $1 - \Phi_F$). The expected per-trade fee for an F member is:

$$\bar{f}_F \equiv \Phi_F f_F + (1 - \Phi_F) f_L. \tag{9}$$

While the cost of choosing CCP L is the same as in equation (1), the cost of switching to F becomes:

$$C_F^{PC}(x) = \theta(\Delta - x) + \frac{\lambda \bar{f}_F}{\rho} = \theta(\Delta - x) + \frac{\lambda}{\rho}\left[\Phi_F f_F + (1 - \Phi_F) f_L\right]. \tag{10}$$

Under preferred clearing, trader x switches if and only if $C_F^{PC}(x) \leq C_L(x)$, which yields the marginal trader location:

$$x \geq \hat{x}^{PC} \equiv \frac{\Delta}{2} - \frac{\lambda \Phi_F (f_L - f_F)}{2\rho\theta}. \tag{11}$$

The key difference from interoperability is immediate: the fee savings from switching are scaled by Φ_F, the probability of trading with another F member. Under interoperability, a trader who switches captures the full fee differential on every trade. Under preferred clearing, the fee savings materialize only on the fraction Φ_F of trades that occur with other F members; cross-CCP trades still clear at L at fee f_L.

We use the *attached consumers* (AC) equilibrium concept from Biglaiser and Cremer (2020) to model the investor switching process. The AC equilibrium is a refinement of Nash equilibrium particularly suited to settings where incumbency advantages matter and consumers face coordination frictions in sequential price competition. In our context, investors cannot easily coordinate to select the lowest-fee clearinghouse.

At $t = -1$, all investors are initially affiliated with the leader CCP, L, and may choose to migrate to the follower CCP, F. The migration process unfolds iteratively over an arbitrary number of steps. Investors evaluate their utility from remaining with L or switching to F, assuming no other investor moves. This assumption captures the coordination frictions inherent in clearinghouse selection under the preferred regime.

Investors are ranked by their individual gains from switching, from highest to lowest: that is, investors with higher x switch first. If some investors *strictly* benefit from migrating to F, a small measure of those with the highest gains switches first. The process repeats until no investor strictly

prefers to move. At the start of the process, when $\Phi_F = 0$, the switching threshold is $\hat{x}^{PC} = \frac{\Delta}{2}$. For migration to begin, the investor furthest from L (at $x = 1$) must strictly prefer F, which requires $\Delta < 2$. Once a positive mass joins F, fee savings lower the threshold, inducing further migration. The process continues until convergence to the fixed point of

$$\Phi_F = 1 - \hat{x}^{PC} = 1 - \frac{\Delta}{2} + \frac{\lambda \Phi_F (f_L - f_F)}{2\rho\theta}, \tag{12}$$

which yields the unique entrant market share Φ_F^{PC}:

$$\Phi_F^{PC} = \frac{(2 - \Delta)\rho\theta}{2\rho\theta - \lambda(f_L - f_F)}. \tag{13}$$

As under interoperability, the entrant's market share increases in the fee differential $f_L - f_F$ and decreases in the incumbent advantage Δ. However, the market share elasticity with respect to fees is different. Under interoperability, the entrant market share increases linearly in the fee differential. Under preferred clearing, the responsiveness is:

$$\frac{\partial \Phi_F^{PC}}{\partial (f_L - f_F)} = \frac{(\Phi_F^{PC})^2 \lambda}{(2 - \Delta)\rho\theta}. \tag{14}$$

The sensitivity is proportional to Φ_F^2: when the entrant's market share is small, fee cuts have little effect because few trades benefit from the lower fee. This network effect is the source of the trader coordination problem under preferred clearing, which implies that entrant CCPs need to offer deeper fee discounts to attract the same mass of participants.

Further, profit functions are different under preferred clearing as they do not map one-to-one with membership market shares as under interoperability. The entrant CCP F clears only F-F trades, which occur with probability Φ_F^2. CCP L clears all remaining trades: both L-L trades and cross-CCP trades, which collectively occur with probability $1 - \Phi_F^2$. Clearinghouse profits are

therefore equal to:

$$\pi_F^{PC} = \lambda \Phi_F^2 f_F, \tag{15}$$

$$\pi_L^{PC} = \lambda (1 - \Phi_F^2) f_L. \tag{16}$$

Proposition 2 (PC Equilibrium). *Under preferred clearing, if $\Delta < 2$, the unique equilibrium fees are:*

$$f_L^{PC} = \frac{2\rho\theta}{\lambda} \cdot \left(1 - \left(\frac{2-\Delta}{4}\right)^{\frac{2}{3}}\right), \qquad f_F^{PC} = \frac{2\rho\theta}{\lambda} \cdot \left(\frac{2-\Delta}{4}\right)^{\frac{2}{3}}. \tag{17}$$

The equilibrium market share of the entrant is:

$$\Phi_F^{PC} = \max\left\{0, \left(\frac{2-\Delta}{4}\right)^{\frac{1}{3}}\right\}. \tag{18}$$

The equilibrium CCP profits are:

$$\pi_L^{PC} = \frac{2\rho\theta}{\lambda} \cdot \left(1 - \left(\frac{2-\Delta}{4}\right)^{\frac{2}{3}}\right)^2, \qquad \pi_F^{PC} = \frac{2\rho\theta}{\lambda} \cdot \left(\frac{2-\Delta}{4}\right)^{\frac{4}{3}}. \tag{19}$$

For $\Delta \geq 2$, the follower does not enter the market: no investor switches even if $f_F \leq 0$ because all trades clear at L when $\Phi_F = 0$. The incumbent faces no competitive threat and charges a monopoly fee pinned only by traders' participation constraint.

Proof. See Appendix C. □

Proposition 2 yields two main insights. First, as under interoperability, the leader charges a higher fee than the follower: $f_L^{PC} > f_F^{PC}$ holds whenever $\left(\frac{2-\Delta}{4}\right)^{2/3} < \frac{1}{2}$, or equivalently, $\Delta > 2 - \sqrt{2} \approx 0.59$: this is always true in our model since we assume $\Delta \geq 1$. The follower must undercut to attract members, but competition is asymmetric: fee reductions benefit F members only on the

fraction Φ_F of trades that clear at F. This dilution of competitive pressure allows the incumbent to sustain a premium. Consequently, the leader also obtains higher profits than the follower CCP.

Second, and in contrast to interoperability, the equilibrium exhibits a discontinuity at $\Delta = 2$. For $\Delta < 2$, the entrant captures a positive market share and is able to discipline incumbent pricing. For $\Delta \geq 2$, the leader successfully deters entry *irrespective* of the fee discount. This novel result is a consequence of the network structure of preferred clearing. In standard Hotelling (1929) competition, a disadvantaged firm can always secure positive demand through sufficient price concessions. Under preferred clearing, this logic fails: when $\Phi_F = 0$, a member of F pays f_L on all trades regardless of f_F. The entrant's price is strategically irrelevant until it acquires members, but it cannot acquire members without a price advantage. The incumbent CCP is fully protected from competitive pressure, permitting monopoly pricing constrained only by investors' participation constraints.

4.3 Comparative statics

Corollary 1 (Fee comparison). *The leader L charges more and the follower F charges less under preferred clearing than under interoperability:*

$$f_L^{PC} > f_L^{IO} \quad \textit{and} \quad f_F^{PC} < f_F^{IO}. \tag{20}$$

Proof. See Appendix C. □

Corollary 1 implies that the fee spread is strictly larger under preferred clearing: $f_L^{PC} - f_F^{PC} > f_L^{IO} - f_F^{IO}$. The result reflects the asymmetric nature of competition under the two regimes.

Under interoperability, a fee reduction by either CCP applies to all of that CCP's members' trades. Undercutting attracts marginal investors, and both CCPs face symmetric incentives to compete for market share.

Preferred clearing breaks this symmetry. The follower's fee is levied only on trades between F members. The asymmetry in fee incidence softens competition: the follower CCP must undercut aggressively to attract members, while the leader faces diminished pressure to respond. The result is a wider fee spread, with the follower pricing below and the leader pricing above their interoperability levels.

Proposition 3 (Average Fee). *The volume-weighted average clearing fee is higher under preferred clearing:*

$$\bar{f}^{PC} > \bar{f}^{IO}. \tag{21}$$

Proof. See Appendix C. □

Preferred clearing leads to a redistribution across investor types: Algorithmic traders and firms using alternative clearing venues benefit from lower fees at the follower CCP; institutional investors and domestic pension funds that remain with the incumbent face higher fees.

Proposition 3 provides a clear cost ranking across the two regimes: the volume-weighted average clearing fee is unambiguously higher under preferred clearing. The follower's discount does not compensate for the incumbent's premium and investors on average pay more to clear their trades than under interoperability.

The intuition follows from the concentration of volume shares. Under interoperability, clearing volume tracks membership: each CCP clears its own members' trades. Under preferred clearing, clearing volume is more concentrated since the incumbent clears all cross-trades in addition to within-network trades. This raises the average cost despite the follower's aggressive undercutting.

Corollary 2 (Industry Profit). *For $\Delta \in (1, 2)$:*

(i) Total industry profit is higher under preferred clearing: $\pi_L^{PC} + \pi_F^{PC} > \pi_L^{IO} + \pi_F^{IO}$.

(ii) The leader earns higher profit under preferred clearing: $\pi_L^{PC} > \pi_L^{IO}$.

(iii) The follower earns lower profit under preferred clearing: $\pi_F^{PC} < \pi_F^{IO}$.

Proof. See Appendix C. □

Corollary 2 yields clear predictions about regulatory lobbying. The incumbent CCP strictly prefers preferred clearing; the follower strictly prefers interoperability. These incentives align with observed behavior in European regulatory debates. Incumbent exchanges (often vertically integrated with their own CCPs) have resisted open access provisions, while entrant platforms such as Cboe Clear have advocated for interoperability mandates.[8]

Figure 5: **Equilibrium fees and profits under interoperability and preferred clearing**

This figure plots equilibrium outcomes as functions of incumbent advantage (switching cost) Δ. Panel (A) plots clearing fees, Panel (B) plots average clearing fees, and Panel (C) plots CCP profits under both interoperability and preferred clearing regimes. All values are normalized at $\frac{\rho\theta}{\lambda} = 1$.

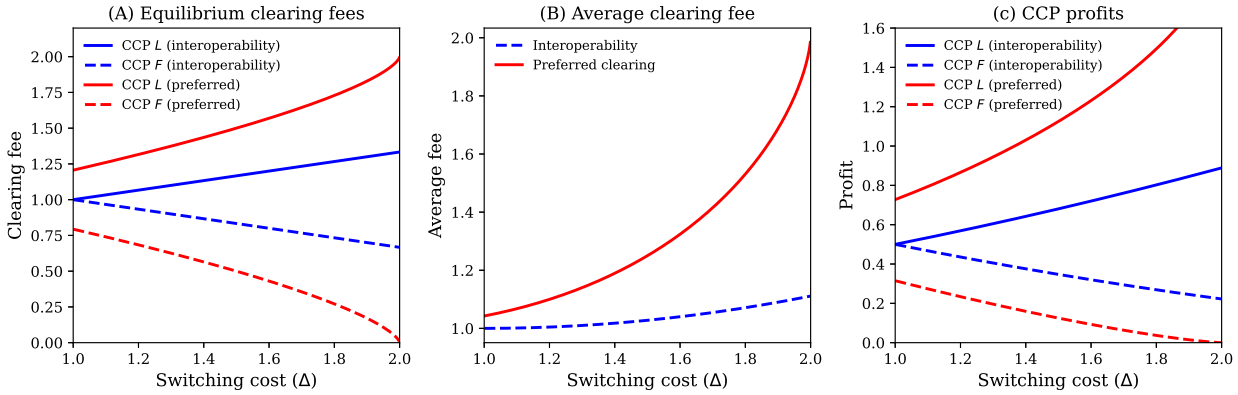


Figure 5 illustrates the equilibrium comparative statics. Panel (A) shows that under preferred clearing, the leader charges more ($f_L^{PC} > f_L^{IO}$) and the follower charges less ($f_F^{PC} < f_F^{IO}$)

[8]See Markets Media, Europe's Incumbent Exchanges Continue to Kick Their Heels on Clearing Interoperability (September 20, 2012) and Cboe, Europe Needs Clearing Competition, Not a Single CCP (October 24, 2024). As Jeffrey King of Citi Global Transaction Services observed, "who would want to interoperate with an organisation that is cheaper?" (IPE, Unclear on Clearing, September 2008). Our model suggests that entrant CCPs are particularly cheaper under preferred clearing precisely because aggressive undercutting is required to overcome the network disadvantage.

than under interoperability. The fee spread widens with Δ, reflecting the follower's increasingly aggressive undercutting as its locational disadvantage grows. Panel (B) shows that despite the follower's lower fee, the average clearing fee is uniformly higher under preferred clearing. This gap widens with Δ: as the follower's network shrinks, a greater share of trades clears at the incumbent's elevated fee. Finally, Panel (C) displays CCP profits. The leader earns strictly more under preferred clearing throughout the parameter range, while the follower earns strictly less.

4.4 Welfare analysis

We focused so far on equilibrium fees and profits. However, since fees are merely transfers between investors and CCPs, they are not a proxy for aggregate welfare. To measure welfare, we turn to the efficiency of investor-clearing house matching: are investors clearing through the CCP that minimizes their total costs?

In our model, investors differ in their jurisdictional proximity to each CCP. The total transportation costs, aggregated across all investors, measure the deadweight loss from misallocation:

$$\begin{aligned} TC(\Phi) &= \int_0^{1-\Phi} \theta x \, \mathrm{d}x + \int_{1-\Phi}^{1} \theta(\Delta - x) \, \mathrm{d}x \\ &= \theta \left[\Phi^2 + (\Delta - 2)\Phi + \frac{1}{2} \right] \end{aligned} \tag{22}$$

Proposition 4 (Welfare). *Let $\Delta^\star$ be the unique solution of $\Phi_F^{PC} = \Phi_F^{IO}$ on $\Delta \in [1, 2]$. The total transportation costs for investors:*

(i) are higher under preferred clearing than under interoperability for $\Delta \leq \Delta^\star$ and

(ii) are higher under interoperability than under preferred clearing for $\Delta > \Delta^\star$;

The welfare ranking therefore depends on the magnitude of incumbent advantage. Interoperability dominates from a welfare perspective over most of the parameter space. The intuition is as

follows. Under preferred clearing, the entrant CCP F undercuts aggressively, attracting marginal investors who would be more efficiently served by the incumbent. These investors switch not because F is closer, but because F is cheaper. This results in higher transportation costs.

When Δ is very large, implying a high switching cost from incumbent to entrants, even aggressive undercutting cannot overcome the switching costs for most investors. The network effect compounds the problem: with few members on F, fee savings are small, discouraging even those investors for whom F is the efficient choice. Preferred clearing thus restrains entry below the interoperability level.

Figure 6: **Market shares and welfare under interoperability and preferred clearing**

This figure plots market shares and transportation costs as functions of incumbent advantage (switching cost) Δ. Panel (A) plots entrant market share under interoperability (blue), preferred clearing (red), and the efficient allocation (dashed). Panel (B) displays total transportation costs, that is the welfare loss from misallocation. All values are normalized at $\frac{\rho\theta}{\lambda} = 1$.

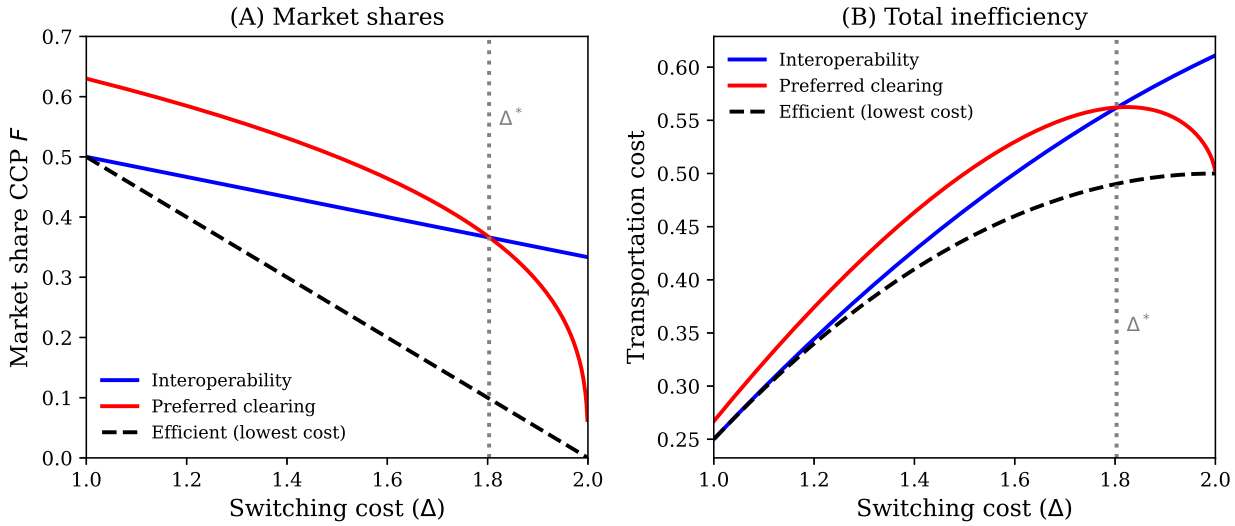


Figure 6 illustrates the welfare implications of the two clearing regimes. The dashed line in Panel (A) represents the efficient allocation: each investor clears through the CCP with lowest transportation cost. This efficient allocation rule leads to an entrant share that declines linearly

in the switching cost, that is $\Phi_F^* = 1 - \Delta/2$. As switching costs are larger, fewer investors are efficiently served by the entrant.

Both regimes generate excessive entry, and therefore higher transportation costs, relative to this benchmark. Under interoperability, symmetric fee competition induces undercutting that attracts marginal investors beyond the efficient cutoff. Under preferred clearing, the follower undercuts more aggressively to compensate for the diluted fee savings, drawing in investors for whom the transport cost savings do not justify the switch.

A regulator seeking to minimize transportation costs has several levers. First, mandating or encouraging a centrally-located CCP: a pan-European clearinghouse, for instance, would reduce the aggregate effective distance to market participants. Second, regulators could strive to reduce the switching costs that sustain incumbent advantage: streamlining membership transitions, harmonizing margin methodologies, and standardizing legal frameworks across jurisdictions.

5 Conclusion

We contribute to a lively policy debate on the optimal market structure of the clearing and settlement system. While some jurisdictions, such as the United States, leverage the natural monopoly characteristics of CCPs and mandate a single central counterparty, other markets — notably in Europe — encourage competition among multiple clearinghouses. Empirical evidence suggests that nearly three-quarters of traders clear through interoperable systems, allowing free CCP selection, whereas a significant share (22%) use the preferred system, first introduced by BATS in 2011. This divergence highlights a gap in incentives: large incumbent CCPs tend to favor the preferred model, while newer entrants advocate for interoperability.

We model CCP competition with horizontally differentiated traders to compare costs across regimes. Preferred clearing creates network effects absent under interoperability. That

is, a trader affiliated with the entrant captures fee savings only when matched with other entrant members. This forces the entrant to undercut more aggressively to compensate for diluted benefits, while allowing the incumbent to sustain higher fees. In equilibrium, preferred clearing generates wider fee spreads, higher volume-weighted average fees, and greater total industry profits than interoperability. The incumbent earns higher profits under preferred clearing; the entrant earns higher profits under interoperability, which helps explain observed lobbying patterns.

From a welfare perspective, preferred clearing increases trader-CCP matching inefficiency across most parameter values. The rationale is that the entrant CCP needs to undercut fees so aggressively that it attracts traders inefficiently far from its operational profile.

Our analysis abstracts from several important features of real clearing markets. For example, we focus on fees and ignore collateral requirements or netting efficiencies, which are primarily important in derivatives markets. Extensions incorporating these features would enrich the analysis but would not overturn the central mechanism: network effects under preferred clearing protect incumbents from competitive pressure, raising costs to investors.

Our results have direct policy implications. If Europe maintains its fragmented structure, mandating full interoperability would improve outcomes. Alternatively, European CCPs could further consolidated into a regulated monopoly to maximize netting efficiency. However, a monopoly eliminates competitive discipline entirely, creating dependence on regulatory oversight to constrain fees and encourage innovation.

References

Benos, Evangelos, Wenqian Huang, Albert Menkveld, and Michalis Vasios, 2024, The cost of clearing fragmentation, *Management Science* 70, 3581–3596.

Bernstein, Asaf, Eric Hughson, and Marc Weidenmier, 2019, Counterparty risk and the establishment of the new york stock exchange clearinghouse, *Journal of Political Economy* 127, 689–729.

Biais, Bruno, Florian Heider, and Marie Hoerova, 2016, Risk-sharing or risk-taking? counterparty risk, incentives, and margins, *The Journal of Finance* 71, 1669–1698.

Biglaiser, Gary, and Jacques Cremer, 2020, The value of incumbency when platforms face heterogeneous customers, *American Economic Journal: Microeconomics* 12, 229–269.

Bignon, Vincent, and Guillaume Vuillemey, 2020, The failure of a clearinghouse: Empirical evidence, *Review of Finance* 24, 99–128.

Degryse, Hans, Mark Van Achter, and Gunther Wuyts, 2022, Plumbing of securities markets: The impact of post-trade fees on trading and welfare, *Management Science* 68, 635–653.

Duffie, Darrell, Martin Scheicher, and Guillaume Vuillemey, 2015, Central clearing and collateral demand, *Journal of Financial Economics* 116, 237–256.

Duffie, Darrell, and Haoxiang Zhu, 2011, Does a central clearing counterparty reduce counterparty risk?, *The Review of Asset Pricing Studies* 1, 74–95.

Foucault, Thierry, Ohad Kadan, and Eugene Kandel, 2013, Liquidity cycles and make/take fees in electronic markets, *The Journal of Finance* 68, 299–341.

Hotelling, Harold, 1929, Stability in competition, *The Economic Journal* 39, 41–57.

Huang, Wenqian, Albert J Menkveld, and Shihao Yu, 2021, Central counterparty exposure in stressed markets, *Management Science* 67, 3596–3617.

Huang, Wenqian, and Haoxiang Zhu, 2024, CCP auction design, *Journal of Economic Theory* 217, 105826.

Katz, Michael L, and Carl Shapiro, 1986, Technology adoption in the presence of network externalities, *Journal of Political Economy* 94, 822–841.

Khapko, Mariana, and Marius Zoican, 2020, How fast should trades settle?, *Management Science* 66, 4573–4593.

Khomyn, Marta, Talis Putnins, and Marius Zoican, 2024, The value of ETF liquidity, *The Review of Financial Studies* 37, 3092–3148.

Menkveld, Albert J., 2013, High frequency trading and the new market makers, *Journal of Financial Markets* 16, 712–740.

Menkveld, Albert J, 2017, Crowded positions: An overlooked systemic risk for central clearing parties, *The Review of Asset Pricing Studies* 7, 209–242.

Menkveld, Albert J., Emiliano Pagnotta, and Marius A. Zoican, 2015, Does central clearing affect price stability? evidence from nordic equity markets, *SSRN Electronic Journal*.

Menkveld, Albert J., and Guillaume Vuillemey, 2021, The economics of central clearing, *Annual Review of Financial Economics* 13, 153–178.

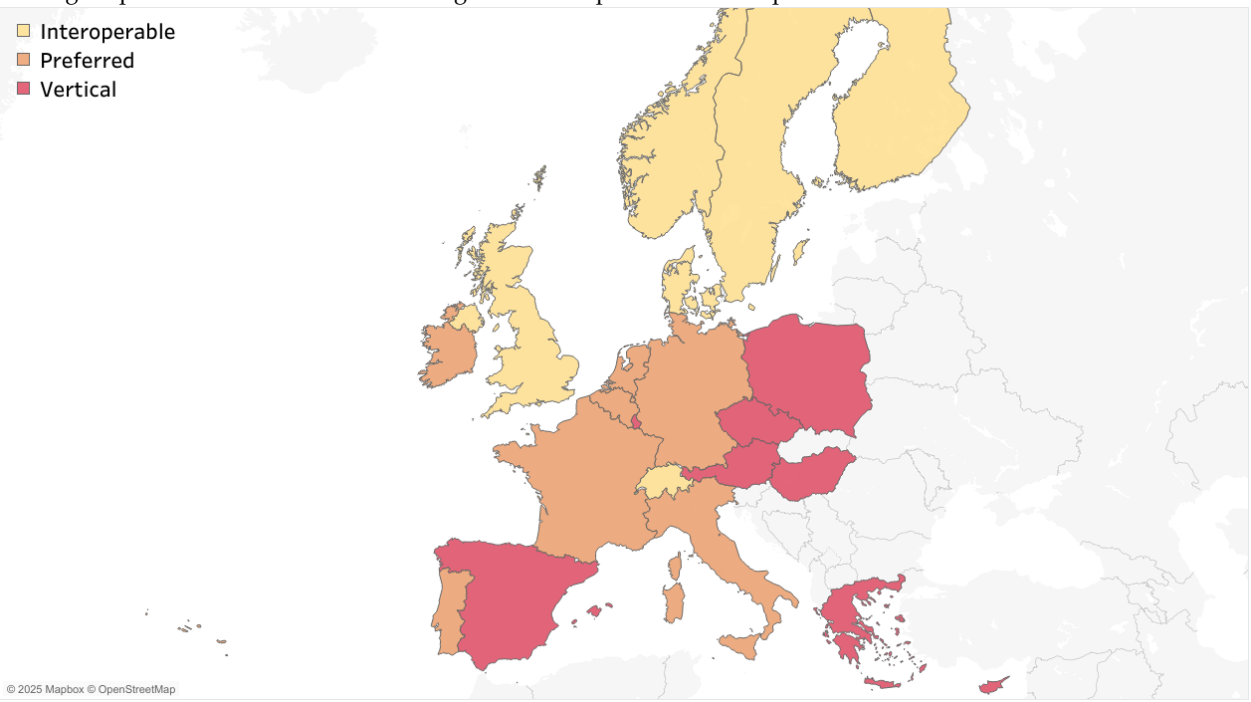
Pagano, Marco, 1989, Trading volume and asset liquidity*, *The Quarterly Journal of Economics* 104, 255–274.

Pagnotta, Emiliano S., and Thomas Philippon, 2018, Competing on speed, *Econometrica* 86, 1067–1115.

A Additional figures

Figure A.1 provides a geographic overview of clearing models across Europe. Preferred clearing (orange) concentrates in France, Germany, Benelux, and Italy. Interoperability (yellow) dominates in Nordic countries, Switzerland, and the UK. Vertical integration (red) persists in smaller markets lacking competitive pressure.

Figure A.1: **Overview of clearing arrangements in European equity markets**
This figure provides an overview of clearing models adopted across European countries.



B Notation Summary

Table B.1: Model notation

Exogenous parameters	
Parameter	Definition
$x \in [0,1]$	Investor location (operational fit with a CCP)
$\Delta > 1$	Entrant CCP location ($\Delta - 1$ stands in for pure switching cost)
θ	Transportation cost per unit operational distance
ρ	Discount rate for traders.
λ	Market arrival rate for traders
Endogenous quantities	
Variable	Definition
$f_j, j \in \{L, F\}$	Clearing fee charged by CCP j
Φ_F	Entrant market share (fraction of investors)
$\hat{x}$	Location of marginal investor
$\pi_j, j \in \{L, F\}$	Profit of CCP j
TC	Total transportation costs (welfare loss)
Regime labels	
Label	Definition
IO	Interoperability: cross-CCP trades clear at trader's own CCP
PC	Preferred clearing: cross-CCP trades clear at incumbent CCP
Agent labels	
Label	Agent
L	Leader (incumbent) CCP located at $x = 0$
F	Follower (entrant) CCP located at $x = \Delta$

C Proofs

Proposition 1

Proof. CCP F maximizes $\lambda f_F \cdot \Phi_F^{IO}$ and CCP L maximizes $\lambda f_L \cdot (1 - \Phi_F^{IO})$. From the market share equation (4), the first-order conditions are:

$$1 - \frac{\Delta}{2} + \frac{\lambda(f_L - 2f_F)}{2\rho\theta} = 0, \tag{C.1}$$

$$\frac{\Delta}{2} - \frac{\lambda(2f_L - f_F)}{2\rho\theta} = 0. \tag{C.2}$$

Solving simultaneously yields:

$$f_L^{IO} = \frac{(2+\Delta)\rho\theta}{3\lambda}, \qquad f_F^{IO} = \frac{(4-\Delta)\rho\theta}{3\lambda}. \tag{C.3}$$

Substituting into the market share equation gives $\Phi_F^{IO} = \frac{4-\Delta}{6}$. Equilibrium profits follow directly:

$$\pi_L^{IO} = \lambda \cdot \frac{2+\Delta}{6} \cdot \frac{\rho\theta(2+\Delta)}{3\lambda} = \frac{\rho\theta(2+\Delta)^2}{18}, \tag{C.4}$$

and similarly $\pi_F^{IO} = \frac{\rho\theta(4-\Delta)^2}{18}$.

For $\Delta \geq 4$, the entrant cannot attract any traders even at $f_F = 0$. The incumbent deters entry by setting the highest fee such that $\hat{x}^{IO} \geq 1$:

$$\frac{\Delta}{2} - \frac{\lambda f_L}{2\rho\theta} \geq 1 \implies f_L \leq \frac{\rho\theta(\Delta - 2)}{\lambda}. \tag{C.5}$$

The entry-deterring fee is therefore $f_L^m = \frac{\rho\theta(\Delta-2)}{\lambda}$, yielding profit $\pi_L^m = \rho\theta(\Delta - 2)$. At $\Delta = 4$, both regimes coincide: $f_L^{IO} = f_L^m = \frac{2\rho\theta}{\lambda}$ and $\pi_L^{IO} = \pi_L^m = 2\rho\theta$. □

Proposition 2

Proof. Under preferred clearing, CCP F clears only F-F trades (probability Φ_F^2) while L clears the remainder (probability $1-\Phi_F^2$). Profits are:

$$\pi_F = \lambda \Phi_F^2 f_F, \qquad \pi_L = \lambda(1-\Phi_F^2) f_L. \tag{C.6}$$

Differentiating (13), we obtain

$$\frac{\partial \Phi_F}{\partial f_F} = -\frac{(2-\Delta)\rho\theta\lambda}{D^2} = -\frac{\Phi_F \lambda}{D} = -\frac{\Phi_F^2 \lambda}{(2-\Delta)\rho\theta}, \tag{C.7}$$

where $D = 2\rho\theta - \lambda\left(f_L - f_F\right)$. By symmetry, $\partial \Phi_F / \partial f_L = \Phi_F^2 \lambda / [(2-\Delta)\rho\theta]$.

CCP F maximizes $\pi_F = \lambda \Phi_F^2 f_F$ with respect to f_F. The first-order condition is:

$$\Phi_F^2 + 2\Phi_F f_F \frac{\partial \Phi_F}{\partial f_F} = 0 \implies \Phi_F^2 = \frac{2\Phi_F^3 f_F \lambda}{(2-\Delta)\rho\theta}, \tag{C.8}$$

where the last step follows from (C.7). The follower CCP fee is:

$$f_F = \frac{(2-\Delta)\rho\theta}{2\Phi_F \lambda}. \tag{C.9}$$

Similarly, CCP L maximizes $\pi_L = \lambda(1-\Phi_F^2) f_L$. The first-order condition is:

$$1 - \Phi_F^2 = 2\Phi_F f_L \frac{\partial \Phi_F}{\partial f_L} = \frac{2\Phi_F^3 f_L \lambda}{(2-\Delta)\rho\theta}, \tag{C.10}$$

which yields:

$$f_L = \frac{(1-\Phi_F^2)(2-\Delta)\rho\theta}{2\Phi_F^3 \lambda}. \tag{C.11}$$

Subtracting (C.9) from (C.11):

$$f_L - f_F = \frac{(2-\Delta)\rho\theta}{2\Phi_F^3\lambda}\left(1-\Phi_F^2-\Phi_F^2\right) = \frac{(2-\Delta)\rho\theta(1-2\Phi_F^2)}{2\Phi_F^3\lambda}. \tag{C.12}$$

Substituting into (13):

$$\Phi_F = \frac{(2-\Delta)\rho\theta}{2\rho\theta - \frac{(2-\Delta)\rho\theta(1-2\Phi_F^2)}{2\Phi_F^3}}. \tag{C.13}$$

Multiplying numerator and denominator by $2\Phi_F^3$:

$$\Phi_F = \frac{2(2-\Delta)\rho\theta\Phi_F^3}{4\rho\theta\Phi_F^3 - (2-\Delta)\rho\theta(1-2\Phi_F^2)}. \tag{C.14}$$

Simplifying:

$$4\rho\theta\Phi_F^3 - (2-\Delta)\rho\theta(1-2\Phi_F^2) = 2(2-\Delta)\rho\theta\Phi_F^2. \tag{C.15}$$

Dividing by $\rho\theta$ and rearranging:

$$4\Phi_F^3 = (2-\Delta)(1-2\Phi_F^2+2\Phi_F^2) = 2-\Delta. \tag{C.16}$$

Therefore:

$$\Phi_F^{PC} = \left(\frac{2-\Delta}{4}\right)^{1/3}. \tag{C.17}$$

Substituting back into (C.9) and using $\Phi_F^3 = (2-\Delta)/4$:

$$f_F^{PC} = \frac{(2-\Delta)\rho\theta}{2\Phi_F\lambda} = \frac{4\Phi_F^3\rho\theta}{2\Phi_F\lambda} = \frac{2\rho\theta}{\lambda}\Phi_F^2 = \frac{2\rho\theta}{\lambda}\left(\frac{2-\Delta}{4}\right)^{2/3}. \tag{C.18}$$

Similarly:

$$f_L^{PC} = \frac{2\rho\theta}{\lambda}(1-\Phi_F^2) = \frac{2\rho\theta}{\lambda}\left(1-\left(\frac{2-\Delta}{4}\right)^{2/3}\right). \tag{C.19}$$

Profits follow directly:

$$\pi_F^{PC} = \Phi_F^2 \cdot f_F^{PC} = \frac{2\rho\theta}{\lambda}\left(\frac{2-\Delta}{4}\right)^{4/3}, \tag{C.20}$$

$$\pi_L^{PC} = (1-\Phi_F^2) \cdot f_L^{PC} = \frac{2\rho\theta}{\lambda}\left(1-\left(\frac{2-\Delta}{4}\right)^{2/3}\right)^2. \tag{C.21}$$

For $\Delta \geq 2$, the seed condition fails: $\hat{x}^{PC}|_{\Phi_F=0} = \Delta/2 \geq 1$, so no investor switches. □

Corollary 1

Proof. Both inequalities reduce to a common condition. For the leader:

$$f_L^{PC} > f_L^{IO} \iff \frac{2\rho\theta}{\lambda}(1-\phi^2) > \frac{(2+\Delta)\rho\theta}{3\lambda} \iff 6(1-\phi^2) > 2+\Delta, \tag{C.22}$$

where $\phi \equiv \Phi_F^{PC} = \left(\frac{2-\Delta}{4}\right)^{1/3}$. For the follower:

$$f_F^{PC} < f_F^{IO} \iff \frac{2\rho\theta}{\lambda}\phi^2 < \frac{(4-\Delta)\rho\theta}{3\lambda} \iff 6\phi^2 < 4-\Delta. \tag{C.23}$$

These conditions are equivalent: $6(1-\phi^2) > 2+\Delta$ rearranges to $6\phi^2 < 4-\Delta$. The equation $6\left(\frac{2-\Delta}{4}\right)^{2/3} - 4 + \Delta$ has a single real root at $\Delta = -2$ and is positive elsewhere, which concludes the proof. □

Proposition 3

Proof. The average fee under each regime is:

$$\bar{f}^{IO} = \Phi_F^{IO} f_F^{IO} + (1-\Phi_F^{IO}) f_L^{IO} = \frac{2\rho\theta}{\lambda}\left[(\Phi_F^{IO})^2 + (1-\Phi_F^{IO})^2\right], \tag{C.24}$$

$$\bar{f}^{PC} = (\Phi_F^{PC})^2 f_F^{PC} + (1-(\Phi_F^{PC})^2) f_L^{PC} = \frac{2\rho\theta}{\lambda}\left[(\Phi_F^{PC})^4 + (1-(\Phi_F^{PC})^2)^2\right]. \tag{C.25}$$

Define $m \equiv \Phi_F^{IO}$ and $s \equiv (\Phi_F^{PC})^2$ as the follower's member share under IO and clearing share under PC, respectively. Then:

$$\bar{f}^{IO} = \frac{2\rho\theta}{\lambda}\left[m^2 + (1-m)^2\right], \tag{C.26}$$

$$\bar{f}^{PC} = \frac{2\rho\theta}{\lambda}\left[s^2 + (1-s)^2\right]. \tag{C.27}$$

The function $g(\sigma) = \sigma^2 + (1-\sigma)^2$ is strictly convex with minimum at $\sigma = \frac{1}{2}$. Thus $\bar{f}^{PC} > \bar{f}^{IO}$ if and only if $|s - \frac{1}{2}| > |m - \frac{1}{2}|$. Since $m \leq \frac{1}{2}$ and $s < \frac{1}{2}$ for $\Delta \in (1, 2)$, this reduces to $s < m$.

Substituting $x \equiv 2 - \Delta \in (0, 1)$:

$$s < m \iff \left(\frac{x}{4}\right)^{2/3} < \frac{2+x}{6} \iff h(x) \equiv 2 + x - \frac{6x^{2/3}}{4^{2/3}} > 0. \tag{C.28}$$

Differentiating: $h'(x) = 1 - \frac{4^{1/3}}{x^{1/3}} = 1 - \left(\frac{4}{x}\right)^{1/3}$. For $x \in (0, 1)$, we have $\frac{4}{x} > 4$, so $h'(x) < 0$. Thus h is strictly decreasing on $(0, 1)$.

Since $h(1) = 3 - 6 \cdot 4^{-2/3} \approx 0.62 > 0$ and h is decreasing, $h(x) > h(1) > 0$ for all $x \in (0, 1)$. □

Corollary 2

Proof. Under both regimes, CCP profits take the form $\pi_j = \frac{2\rho\theta}{\lambda}\sigma_j^2$, where σ_j is the relevant share. Specifically:

$$\pi_F^{IO} = \frac{2\rho\theta}{\lambda}m^2, \qquad \pi_L^{IO} = \frac{2\rho\theta}{\lambda}(1-m)^2, \tag{C.29}$$

$$\pi_F^{PC} = \frac{2\rho\theta}{\lambda}s^2, \qquad \pi_L^{PC} = \frac{2\rho\theta}{\lambda}(1-s)^2, \tag{C.30}$$

where $m \equiv \Phi_F^{IO}$ and $s \equiv (\Phi_F^{PC})^2$.

Part (i). Total profit equals total clearing revenue:

$$\pi_L + \pi_F = \bar{f}. \tag{C.31}$$

The result follows immediately from Proposition 3.

Parts (ii) and (iii). Both comparisons reduce to the same condition:

$$\pi_L^{PC} > \pi_L^{IO} \iff (1-s)^2 > (1-m)^2 \iff s < m, \tag{C.32}$$

$$\pi_F^{PC} < \pi_F^{IO} \iff s^2 < m^2 \iff s < m. \tag{C.33}$$

The inequality $s < m$ was established in the proof of Proposition 3. □

Proposition 4

Proof. Total transportation costs as a function of entrant share Φ are:

$$TC(\Phi) = \int_0^{1-\Phi} \theta x \, dx + \int_{1-\Phi}^{1} \theta(\Delta - x) \, dx = \theta \left[\Phi^2 + (\Delta - 2)\Phi + \frac{1}{2} \right]. \tag{C.34}$$

Since $\frac{\partial^2 TC}{\partial \Phi^2} = 2\theta > 0$, transportation costs are strictly convex, minimized at $\Phi^* = 1 - \Delta/2$.

Both regimes generate excessive entry: $\Phi_F^{IO}, \Phi_F^{PC} > \Phi^*$ for $\Delta \in (1, 2)$. By convexity, the regime with share closer to Φ^* has lower transportation costs.

Setting $\Phi_F^{PC} = \Phi_F^{IO}$:

$$\left(\frac{2-\Delta}{4} \right)^{1/3} = \frac{4-\Delta}{6}. \tag{C.35}$$

Substituting $u = \frac{2-\Delta}{4}^{1/3}$:

$$6u = 2 + 4u^3 \implies 2u^3 - 3u + 1 = 0 \implies (u-1)(2u^2 + 2u - 1) = 0. \tag{C.36}$$

The relevant root is $u = (-1 + \sqrt{3})/2$. Back-substituting yields $\Delta^* = 2 - 4u^3 \approx 1.80$.

For $\Delta < \Delta^*$: $\Phi_F^{PC} > \Phi_F^{IO} > \Phi^*$, so $TC^{PC} > TC^{IO}$.

For $\Delta > \Delta^*$: $\Phi_F^{IO} > \Phi_F^{PC} > \Phi^*$, so $TC^{IO} > TC^{PC}$. □