Real-World Assets and Tokenization

Day 10 of 10

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MSc Seminar: Digital Finance

Spring 2026

MSc Seminar: Digital Finance

Week 2: Advanced Topics in Digital Finance

Final session: Where crypto meets the real economy.

- Tokenization: turning illiquid assets into tradable tokens
- Tokenized Treasuries: the $9B bridge between TradFi and DeFi
- RWA pricing: DCF with blockchain-specific risk premia
- Liquidity challenges: the gap between "tradable" and "liquid"
- Legal wrappers: SPVs, EU DLT Pilot, and what makes a token enforceable

A $500K Apartment Sold in 1,000 Pieces

Paris, 2024

A luxury apartment was tokenized and sold to 200+ investors worldwide.

The tokenization:

- 1,000 tokens at $500 each
- Investors from 15 countries
- None ever visited the apartment
- Tokens traded 24/7 on a secondary market

The economics:

- Monthly rental income: $8,333 total
- Per token: $8.33/month (distributed on-chain)
- Annual yield: $\$8.33 \times 12/\$500 = 20\%$ gross
- Token price: $500–$520 (fluctuates with yield expectations)

The question: If you can tokenize an apartment, what else can you tokenize? And should you?

The $600 Trillion Opportunity

Global asset values (approximate):

Asset Class	Value	Tokenizable?
Real estate	$330T	Yes (fractional ownership)
Fixed income (bonds)	$130T	Yes (coupons, settlement)
Equities	$95T	Yes (already dematerialized)
Commodities	$20T	Yes (warehouse receipts)
Art and collectibles	$2T	Yes (fractional shares)
Total addressable	**$600T+**	
Currently tokenized	**$15B**	0.0025% penetration

BCG projection: $2–4T tokenized by 2030 (still <1%).

The gap between $15B and $600T is the opportunity—and the challenge.

Traditional vs. Tokenized Asset Ownership

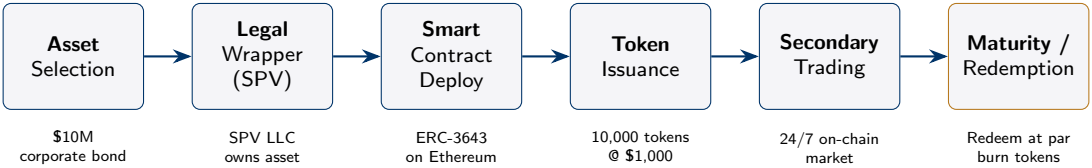
Property	Traditional	Tokenized
Minimum investment	\$100K–\$1M	\$10–\$100
Settlement time	T+1 to T+5	T+0 (instant)
Trading hours	9:30–4:00 (weekdays)	24/7/365
Transfer process	Lawyers, notaries, days	Smart contract, seconds
Dividend distribution	Manual wire transfers	Automated on-chain
Compliance	Manual KYC per platform	Embedded in token contract
Transparency	Quarterly reports	Real-time on-chain
Geographic access	Local investors	Global

The promise: Every asset becomes as tradable as a stock, as programmable as a smart contract, and as accessible as a stablecoin.

Today: Tokenization, Pricing, Liquidity, and Law

1. The Tokenization Process
2. Tokenized Treasuries: The $9B Market
3. RWA Pricing: DCF with Blockchain Risk Premia
4. Liquidity Challenges
5. Legal Wrappers and Regulation
6. Hands-On: RWA Valuation and Tokenization Debate

Tokenization Pipeline: Asset to Token



Critical insight: The token is *not* the asset. The token represents a *legal claim* on the asset, mediated by the SPV and the smart contract. Without the legal wrapper, the token is worthless.

Worked Example: Tokenizing a Corporate Bond

Asset: \$10M corporate bond, 5% annual coupon, 3-year maturity.

1. **Legal wrapping:** Create "MediumCorp Bond SPV LLC." SPV purchases the bond; its sole liabilities are the tokens.
2. **Smart contract:** Deploy ERC-3643 token (permissioned ERC-20 with compliance module). Total supply: 10,000 tokens at \$1,000 face.
3. **Issuance:** Alice buys 50 tokens for \$50,000 via regulated platform.
4. **Coupon distribution:** Every quarter, SPV receives \$125,000. Smart contract distributes \$12.50 per token in USDC. Alice receives $50 \times \$12.50 = \$625$ automatically.
5. **Trading:** Alice sells 20 tokens at \$1,015 each (1.5% premium). Proceeds: \$20,300. Capital gain: \$300.
6. **Maturity:** At year 3, smart contract redeems \$1,000 per token. Tokens burned. SPV dissolved.

Token Standards for Real-World Assets

Standard	Chain	Features
ERC-20	Ethereum	Basic fungible token. No compliance.
ERC-3643 (T-REX)	Ethereum	Permissioned transfers, on-chain identity registry, compliance modules, forced transfers.
ERC-1400	Ethereum	Security token with partitions (tranches), transfer restrictions, document management.
ERC-1155	Ethereum	Multi-token standard. Used by Polymarket for conditional tokens.

ERC-3643 is the leading standard for regulated tokenized securities:

- Only whitelisted (KYC-verified) addresses can hold tokens

What Is Being Tokenized Today

Asset Class	Examples	On-Chain Value
US Treasuries	BlackRock BUIDL, Ondo, Franklin	\$9B+
Private credit	Maple, Goldfinch, Centrifuge	\$9B+
Real estate	RealT, Lofty, Propy	\$500M+
Commodities	Paxos Gold (PAXG), Tether Gold	\$1B+
Carbon credits	Toucan, KlimaDAO	\$300M+
Art and collectibles	Masterworks, Maecenas	\$200M+
Total		**\$15B+**

Tokenized Treasuries and private credit dominate. Real estate and commodities are growing but face significant liquidity and legal challenges.

Checkpoint: Tokenization Basics

Quick Question

You tokenize a $1M painting into 1,000 tokens. A collector buys 100 tokens. The painting is then damaged, losing 30% of its value. What happens to the token holder?

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Answer

The token holder's 100 tokens now represent 10% of a painting worth \$700K = \$70,000 (down from \$100,000). The loss is borne proportionally by all token holders. **But:** who insures the painting? Who handles the insurance claim? These operational questions highlight why the *legal wrapper* is as important as the *smart contract*.

Why US Treasuries Are the Killer App for Tokenization

US Treasuries are the world's safest asset. Tokenizing them solves two problems simultaneously:

For TradFi investors:

- 24/7 trading (vs. market hours)
- T+0 settlement (vs. T+1)
- Lower minimums ($100 vs. $100K+)
- Transparent holdings (on-chain)

For DeFi protocols:

- *Yield-bearing collateral* (5% on Aave/Maker)
- Replaces idle USDC in treasuries
- Safer than stablecoin yield farms
- Programmable: auto-compound, auto-rebalance

The bridge: Tokenized Treasuries are where TradFi yield meets DeFi composability. This is the most natural intersection of the two worlds.

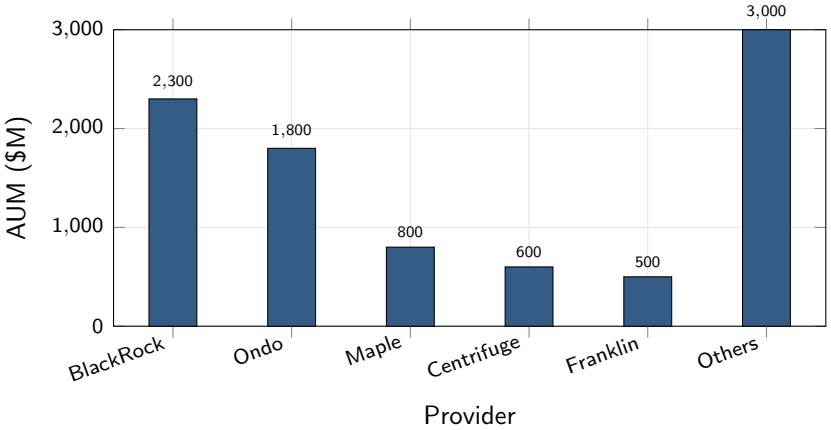
BlackRock BUIDL: Institutional Validation [ ]

BlackRock USD Institutional Digital Liquidity Fund (BUIDL):

- **Chain:** Ethereum (primary), bridges to Polygon, Arbitrum, Optimism
- **Token:** ERC-20, 1 BUIDL $\approx$ \$1 NAV
- **Underlying:** Short-term US T-bills ($<$3 months)
- **Yield:** 5.0% annualized (minus 0.2% management fee)
- **Redemption:** T+0 (instant USDC), vs. T+1 for traditional MMFs
- **AUM:** \$2.3B (Q1 2025)

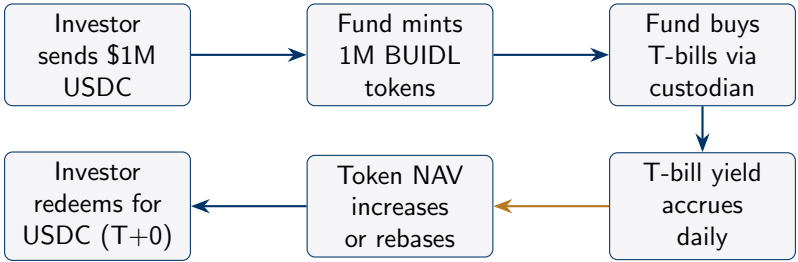
Why it matters: BlackRock (\$10T+ AUM) entering on-chain finance signals institutional acceptance. "If BlackRock does it, everyone follows."

Tokenized Treasury Market: $9B+ (2025)



Total: $9B+, up from near-zero in 2022. Growth driven by (1) DeFi demand for yield-bearing collateral, (2) institutional interest in 24/7 settlement, (3) regulatory clarity from EU DLT Pilot Regime.

Tokenized Treasury Mechanics



DeFi composability: BUIDL tokens can be used as:

- Collateral on Aave or MakerDAO (earn T-bill yield + borrowing spread)
- Liquidity provision on AMMs (paired with USDC)
- Treasury management for DAOs (yield on idle funds)

Tokenized vs. Traditional Treasury Purchase

Feature	Traditional T-Bill	Tokenized (BUIDL)
Minimum	\$100K+ (direct)	\$100K (BUIDL)
Settlement	T+1	T+0 (instant)
Trading hours	Market hours	24/7/365
Custody	Broker/dealer	Self-custody or custodian
DeFi composability	No	Yes (Aave, Maker)
Programmability	No	Yes (auto-compound)
Transparency	Quarterly	Real-time on-chain
Counterparty risk	Broker + DTCC	Smart contract + custodian

The key advantage is *composability*: a tokenized T-bill earns yield *while* being used as collateral. In traditional finance, these are mutually exclusive.

RWA Pricing: Extended DCF Model

Definition 1 (RWA Valuation with Blockchain Risk Premia)

$$V = \sum_{t=1}^{T} \frac{CF_t}{(1 + r_f + \lambda_{\text{credit}} + \lambda_{\text{sc}} + \lambda_{\text{liq}} + \lambda_{\text{reg}})^t}$$

Component	Symbol	Source of Risk
Risk-free rate	r_f	Same as traditional
Credit risk	λ_{credit}	Issuer default (same as traditional)
Smart contract risk	λ_{sc}	Bugs, exploits, upgradability
Liquidity risk	λ_{liq}	Thin secondary markets, wide spreads
Regulatory risk	λ_{reg}	Uncertain legal treatment

Key insight: Tokenized assets trade at a *discount* to their traditional equivalents due to the additional blockchain-specific risk premia.

Worked Example: Tokenized Bond Pricing

Asset: 3-year corporate bond, 5% annual coupon, face value \$1,000.

Traditional pricing: $r = r_f + \lambda_{\text{credit}} = 2\% + 3\% = 5\%$

$$V_{\text{trad}} = \frac{50}{1.05} + \frac{50}{1.05^2} + \frac{1{,}050}{1.05^3} = 47.62 + 45.35 + 907.03 = \$1{,}000.00$$

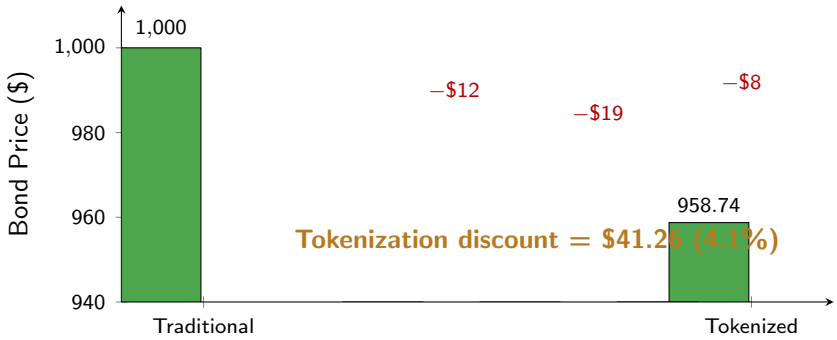
Tokenized pricing: Additional premia: $\lambda_{\text{sc}} = 0.50\%$, $\lambda_{\text{liq}} = 0.75\%$, $\lambda_{\text{reg}} = 0.25\%$

$$r_{\text{token}} = 5\% + 0.50\% + 0.75\% + 0.25\% = 6.50\%$$

$$V_{\text{token}} = \frac{50}{1.065} + \frac{50}{1.065^2} + \frac{1{,}050}{1.065^3} = 46.95 + 44.08 + 867.71 = \boxed{\$958.74}$$

Tokenization discount: \$1,000 − \$958.74 = \$41.26 (4.1% below par).

Decomposing the Tokenization Discount



Each risk premium can be analyzed and potentially reduced independently. As the ecosystem matures, the discount narrows—this compression *is* the investment opportunity.

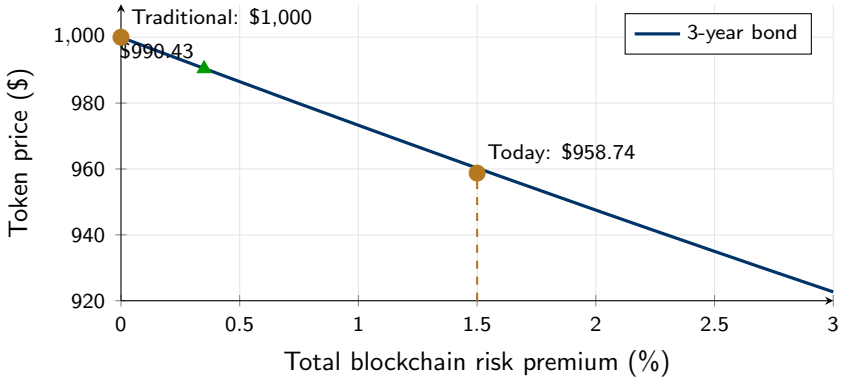
Calibrating Blockchain Risk Premia

Risk Premium	Today (2025)	Mature (2030E)	Calibration Source
λ_{sc}	0.50%	0.10%	DeFi exploit rate / TVL
λ_{liq}	0.75%	0.20%	Bid-ask spreads, Amihud ratio
λ_{reg}	0.25%	0.05%	Jurisdictional clarity index
Total extra	1.50%	0.35%	
Bond price	\$958.74	\$990.43	
Discount	4.1%	1.0%	

Smart contract risk (λ_{sc}):

- Blue-chip protocols (Aave, Compound): $\sim$0.1–0.5%
- Newer protocols: 1–5%
- Calibration: total DeFi exploits / total DeFi TVL per year

Sensitivity: How Risk Premia Affect Token Price



As blockchain risk premia compress from 1.5% to 0.35%, the token price converges toward the traditional bond price. Early investors capture this convergence.

Checkpoint: RWA Pricing

Exercise

A 5-year tokenized government bond has a 4% annual coupon and face value \$1,000. The risk-free rate is 3%, credit risk is 0% (government), and blockchain risk premia total 0.80%.

Calculate the token price and the tokenization discount.

Checkpoint: RWA Pricing

Exercise

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Calculate the token price and the tokenization discount.

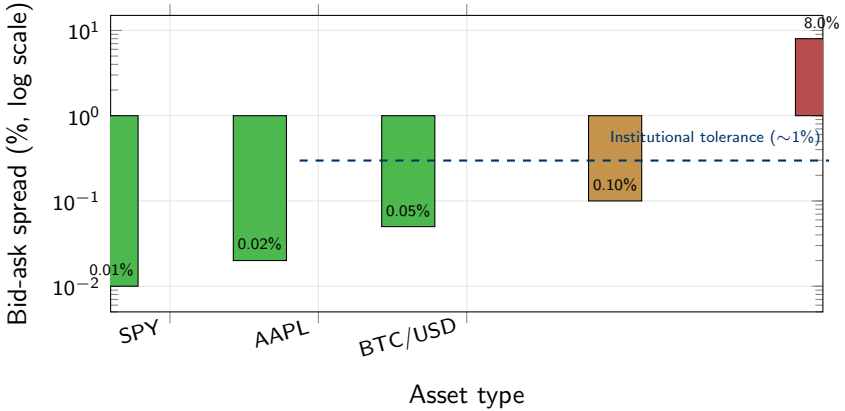
Solution

$r = 3\% + 0\% + 0.80\% = 3.80\%$

$$V = \sum_{t=1}^{4} \frac{40}{1.038^t} + \frac{1{,}040}{1.038^5} = 38.54 + 37.12 + 35.76 + 34.45 + 865.42 = \$1{,}011.29$$

Wait—this is above par because coupon (4%) $>$ discount rate (3.8%). Traditional price (at 3%): \$1,045.80. Discount: $\$1{,}045.80 - \$1{,}011.29 = \$34.51$ (3.3%).

“Tokenize Everything, But Can You Sell It?”



Four orders of magnitude between SPY (0.01%) and tokenized real estate (8%). Tokenization makes assets *tradable* but not automatically *liquid*.

Case Study: Tokenized Berlin Apartment

Asset: \$500,000 apartment, 1,000 tokens at \$500 each. Launched 6 months ago.

Liquidity snapshot:

- Daily volume: 3–5 tokens (\$1,500–\$2,500)
- Best bid: \$480 (50 tokens)
- Best ask: \$520 (30 tokens)
- Spread: \$40 / \$500 = 8%

Urgent sale of 100 tokens (\$50K):

- First 30 tokens fill at \$480
- Next 70 must go lower: $\sim$\$460
- Average execution: $\sim$\$470
- Total: \$47,000 (vs. \$50,000 fair)
- Slippage: 6% discount

This illiquidity discount IS λ_{liq} in the pricing model. The chicken-and-egg problem: investors want liquidity before they buy, but liquidity only exists after many have bought.

Addressing the Liquidity Gap

Solution	Mechanism	Status
AMM pools for RWA	Uniswap-style pools for token/USDC	Early
Professional market makers	Dedicated firms quoting bids/asks	Growing
Cross-platform aggregation	Aggregate liquidity across venues	Nascent
Redemption guarantees	Issuer provides NAV-based redemption	Available
Standardized contracts	Uniform terms enable comparison	In progress

The BUIDL model: BlackRock offers T+0 redemption at NAV. This creates a *floor* on liquidity—you can always sell back to the issuer, even if the secondary market is thin.

For most tokenized RWAs, issuer-provided redemption is currently the primary liquidity mechanism. True secondary market liquidity remains the biggest unsolved challenge.

Measuring Illiquidity: The Amihud Ratio

Definition 2 (Amihud Illiquidity Ratio (2002))

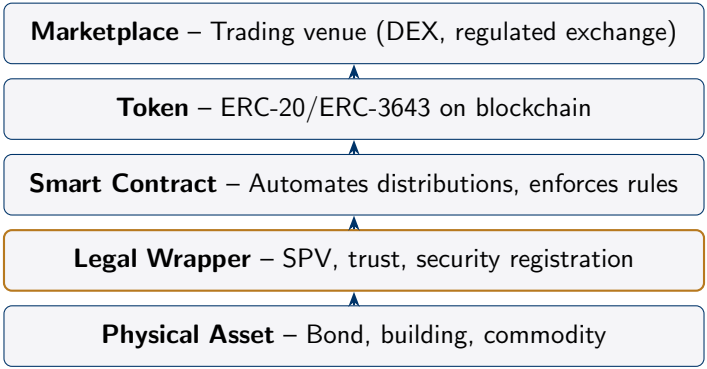
$$\text{ILLIQ} = \frac{1}{D}\sum_{d=1}^{D}\frac{|R_d|}{V_d}$$

where R_d is the daily return and V_d is daily dollar volume. Higher ILLIQ = more illiquid (prices move more per dollar traded).

Asset	**ILLIQ** ($\times 10^{-9}$)
SPY (S&P 500 ETF)	0.0003
BTC/USD	0.03
Tokenized Treasury	5
Tokenized Real Estate	50,000

Tokenized real estate is $\sim$10,000$\times$ more illiquid than tokenized Treasuries. This gap must close for institutional adoption.

A Token Without a Legal Wrapper Is Worthless



The legal wrapper is what gives the token its "teeth": the right to dividends, the right to vote, the right to a share of liquidation proceeds. Without it, a token is just a number on a blockchain with no legal meaning.

The SPV: How Tokens Get Legal Rights

Special Purpose Vehicle (SPV):

- A standalone legal entity created for one purpose: holding the asset
- Token holders own equity (or debt) in the SPV
- SPV's sole asset: the underlying (bond, property, etc.)
- SPV's sole liabilities: the tokens
- **Bankruptcy remote:** if the *sponsor* fails, the SPV (and thus the token holders' assets) is protected

Example

"Paris Apartment Token SPV S.à r.l." (Luxembourg)

- Owns the apartment (registered deed)
- Issues 1,000 tokens representing shares in the SPV
- Rental income flows: Tenant $\rightarrow$ SPV $\rightarrow$ Smart contract $\rightarrow$ Token holders

Regulatory Frameworks: A Global Comparison

Dimension	EU	US	Switzerland
Framework	DLT Pilot Regime	Reg D/S/A+	DLT Act
Status	Active (2023–2028)	Case-by-case	Active (2021+)
Token recognition	Via MiFID II + pilot	Securities law	**Direct in law**
Max issuance	EUR 6B per DLT-TSS	No cap (if exempt)	No cap
T-bill tokenization	Permitted	Permitted	Permitted
Retail access	Capped (EUR 600K)	Accredited only (Reg D)	Open
Settlement	T+0 on-chain	Varies	T+0 on-chain

Switzerland is the most advanced: the DLT Act directly recognizes "uncertificated register securities" on blockchain, giving tokens the same legal status as traditional securities.

EU DLT Pilot Regime: The European Approach [ ]

Regulation 2022/858: Launched 2023, extended to 2028.

- **Scope:** Allows licensed entities to operate DLT-based trading and settlement systems for tokenized securities
- **Bond cap:** EUR 1B per issuer on DLT-TSS
- **Token standard:** ERC-3643 (permissioned, KYC-gated)
- **Settlement:** T+0, no Central Securities Depository needed
- **Cost saving:** 0.05–0.10% per transaction (no SWIFT, no CSD)
- **Status (2026):** 12 DLT-TSS applications approved, EUR 2.5B issued

Compliance features of ERC-3643:

- On-chain identity registry: only whitelisted addresses can hold tokens
- Automated reporting: all transfers and coupons logged immutably
- Forced transfers: issuer can comply with court orders

Legal Risks in Tokenization

Risk	Scenario
Jurisdictional mismatch	EU token held by US investor: which law applies?
SPV default	Manager misuses funds; how do token holders enforce?
Oracle failure	Wrong NAV feeds to smart contract; incorrect redemptions
Regulatory change	New law bans token class; stranded assets
Smart contract bug	Exploit drains the redemption reserve
Cross-chain risk	Bridge hack destroys tokens on one chain

The key question in any tokenization:

"If everything goes wrong, can the token holder enforce their rights in court?"

If the answer is "no" or "unclear," the token carries legal risk that must be priced into λ_{reg}.

Hands-On Session

RWA Valuation Exercise and Tokenization Debate

Spreadsheet exercise + structured debate

Exercise 1: RWA Valuation with Risk Premia

Tokenized real estate project:

- Commercial building in Frankfurt, appraised at EUR 5M
- Annual net rental income: EUR 250,000 (5% gross yield)
- 10,000 tokens at EUR 500 face value
- Expected holding period: 10 years, terminal value = EUR 5.5M

Tasks:

1. **Traditional DCF:** $r_f = 2.5\%$, $\lambda_{\text{RE}} = 3\%$, $\lambda_{\text{credit}} = 1\%$. Calculate the traditional value per token.
2. **Tokenized DCF:** Add $\lambda_{\text{sc}} = 0.5\%$, $\lambda_{\text{liq}} = 1.5\%$, $\lambda_{\text{reg}} = 0.5\%$. Calculate the tokenized value per token.
3. **Sensitivity:** How much does the token price change if λ_{liq} drops from 1.5% to 0.5%?
4. **Break-even:** At what total blockchain premium does the tokenized price equal the traditional price?

Exercise 2: Liquidity Comparison Across Asset Classes

Using the data below, calculate the Amihud ILLIQ ratio:

Asset	Avg Daily Vol	Avg $\lvert R \rvert$	ILLIQ
SPY	\$30B	0.8%	?
BTC/USD	\$15B	3.5%	?
Tokenized Treasury	\$50M	0.1%	?
Tokenized RE Fund	\$2K	0.5%	?

Questions:

1. Calculate ILLIQ for each asset.
2. What daily volume would tokenized RE need to match tokenized Treasury ILLIQ?
3. At what volume does an institutional investor (\$1M position) face $<1\%$ market impact?

Exercise 3: Design a Tokenization

Choose one of the following assets and design the tokenization:

1. A \$50M portfolio of European corporate bonds
2. A luxury vineyard in Tuscany (valued at EUR 3M)
3. A portfolio of 100 renewable energy patents

Your design must specify:

- **Legal wrapper:** SPV jurisdiction, governance structure
- **Token standard:** ERC-20, ERC-3643, or ERC-1400? Why?
- **Cash flow distribution:** Frequency, mechanism, currency
- **Compliance:** Which investors? Which jurisdictions?
- **Liquidity strategy:** AMM pool? Market maker? Redemption window?
- **Risk premia:** Estimate λ_{sc}, λ_{liq}, λ_{reg} and justify

Debate: Will Tokenization Replace Traditional Finance?

Motion

"Within 20 years, the majority of financial assets will be issued and traded as tokens on distributed ledgers, making traditional securities infrastructure (CSDs, SWIFT, T+1 settlement) obsolete."

For the motion:

- 24/7 settlement is strictly superior
- Programmability enables new products
- Fractional ownership democratizes access
- BlackRock, JPMorgan already building
- Cost savings of 50–90% on settlement

Against the motion:

- Legal frameworks are decades behind
- Liquidity is minuscule vs. TradFi
- Smart contract risk adds new failure modes
- Institutions trust existing infrastructure
- "Tokenize everything" ignores network effects

Debate: Critical Discussion Points

1. **The liquidity threshold:** At what TVL does tokenized finance become self-sustaining? Is \$100B enough? \$1T?
2. **Regulatory arbitrage:** Will jurisdictions compete on tokenization-friendly regulation (race to the top or bottom)?
3. **The interoperability question:** 50+ blockchains, incompatible token standards, fragmented liquidity. Is this a feature or a fatal flaw?
4. **Privacy paradox:** Transparent blockchains expose all positions. Can ZK-proofs (Day 8) solve this for institutional RWAs?
5. **The incumbent advantage:** DTCC processes \$2.4 *quadrillion* per year. Can blockchain realistically compete at this scale?

Final Synthesis: 10 Days in Digital Finance

Week 1: Foundations

- Day 1: Crypto pricing, market microstructure
- Day 2: DeFi mechanics, AMMs, on-chain options
- Day 3: Game theory, consensus, fees, MEV
- Day 4: ML pipeline, features, SHAP, backtesting
- Day 5: Fat tails, portfolios, systemic risk, regulation

Week 2: Advanced Topics

- Day 6: Perpetuals, power perps, option vaults
- Day 7: AI agents, LLMs, autonomous finance
- Day 8: ZK proofs, rollups, privacy, ZK-KYC
- Day 9: Prediction markets, LMSR, info aggregation
- Day 10: RWA tokenization, pricing, legal

The connecting thread: From crypto-native assets (Days 1–4) through risk and regulation (Day 5), to advanced instruments (Days 6–9), and finally to where crypto meets the real economy (Day 10).

Tokenization: Where Crypto Meets the Real Economy

Tokenization is where crypto meets the real economy. DeFi started with native crypto assets—tokens, stablecoins. Now it is incorporating real-world assets: bonds, real estate, commodities.

If this works—if the legal, technical, and liquidity challenges are solved—it is not just digital finance. It is the future of **all finance**. *The $600T global asset market becoming programmable, composable, and accessible 24/7.*

That is the vision. Whether it becomes reality depends on the problems **you** *will solve.*

Thank You!

Course Wrap-Up and Next Steps

What you now have:

1. Crypto pricing, DeFi mechanics, AMMs, options (Days 1–2)
2. Game theory of consensus, fee mechanism design, MEV (Day 3)
3. ML pipeline for crypto: features, models, SHAP, backtesting (Day 4)
4. Fat-tailed risk, portfolio construction, regulation (Day 5)
5. DeFi derivatives, AI agents, ZK proofs, prediction markets (Days 6–9)
6. RWA tokenization, pricing, and legal frameworks (Day 10)

Final assignment: Due in 3 weeks. Details on course platform.

Questions? • Office hours: by appointment • `joerg.osterrieder@usi.ch`

References I

[1] European Commission. *Regulation (EU) 2023/1114 on Markets in Crypto-Assets (MiCA)*. Official Journal of the European Union. 2023.

[2] Gary B. Gorton and Jeffery Y. Zhang. *Taming Wildcat Stablecoins*. Tech. rep. 3. University of Chicago Law Review, 2023, pp. 909–971.