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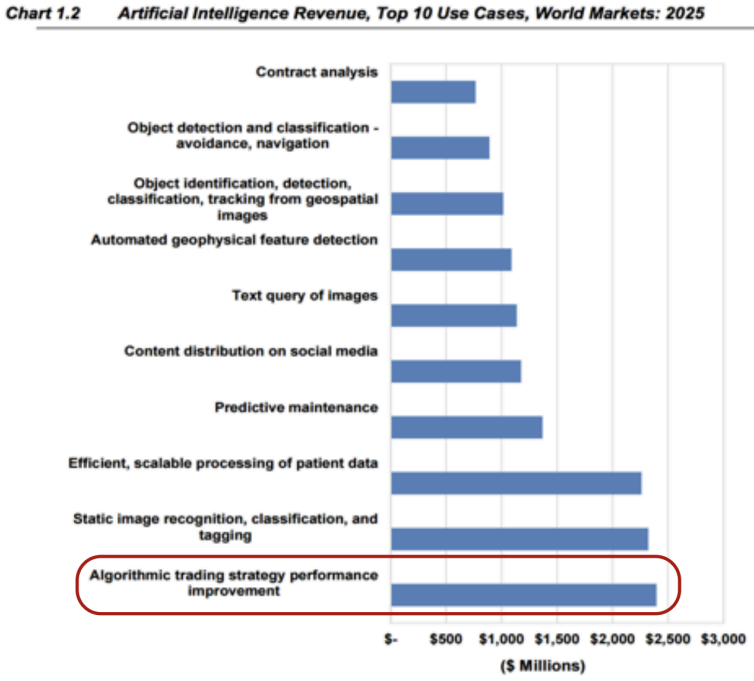
4 Application of AI, InsurTech, and Real Estate Technology

1. **insurtech**
    a. Gross Written Premium 总保费 $4.8 trillion in 2017
    b. redefine the insurance industry
        i. product design: customer experience
        ii. front office: marketing, distribution, channel management
        iii. underwriting new policies: risk analytics, automatic workflow
        iv. policy administration: servicing, market segmentation
        v. claim management: real-time monitoring, fraud detection
        vi. demand modeling
    c. classifications
        i. Milken, traditional
            1. full-stack insurers: mange from beginning to end
            2. agents: extension/partner of incumbent carrier, customer facing
            3. brokers: provide policies by multiple carriers/platforms
        ii. Capgemini, nuanced
            1. full carriers: digital carriers, insurers
            2. distributors: marketplace, brokers, intermediaries
            3. enablers: specialists in any department, 40% of insur companies
    d. market size (from 2018 perspective)
        i. expected $532m in 2018, $5.45 b in 2022
        ii. highest CAGR in Asia Pacific and healthcare
        iii. 45% financing in series A, B, C in 2018 (The State of Global Insurtech 2023)
        iv. investment and aggregate deal size in InsurTech during 2017: $3.2 billion in investments, $2.2 billion worth of deals
    e. key tech: blockchain, smart contracts, SaaS
    f. microinsurance
        i. Omidyar Network (eBay), BIMA (Swedish)
        ii. for low-income, low-networth population
        iii. mobile subscription, pay-as-you-go
        iv. financial protection through risk pooling
2. **RealTech** Real Estate FinTech
    a. real estate: “alternative investment”

b. Capitalization Rate: expected higher return than US government bonds
c. brings improved efficiency instead of disruption
d. residential sector
    i. Multiple Listing Services MLS, important database
    ii. transactions require inspections
    iii. 6% rule, commission fee from both buyer and seller brokerage
    iv. tech disintermediate or force price competition
    v. trends
        1. affordability: millennials spend more and stay with family, Divvy, Bungalow
        2. search for community: network
        3. flexibility: gig economy, furniture rentals,
e. commercial sector
    i. $9.6b investment in CRE Tech in 2018; global sales of commercial properties $873b in FY2017, 57% in US; institutional investment capital to CRE $800b in 2017, doubled 2009
    ii. more data driven han residential for complex property management and hard-to-obtain transaction details
f. VC are a key part, recently heavyweight industry companies such as CBRE have become major investors

3. AI
    a. $70 billion AI market value by 2025 (Bank of America Merrill Lynch), $36.8 billion AI market size by 2025 (Tractica Research), $1.2 trillion invested in cognitive computing technologies by 2020 (Forrester Research), $8.3 trillion in overall AI market value by 2035 (Accenture)



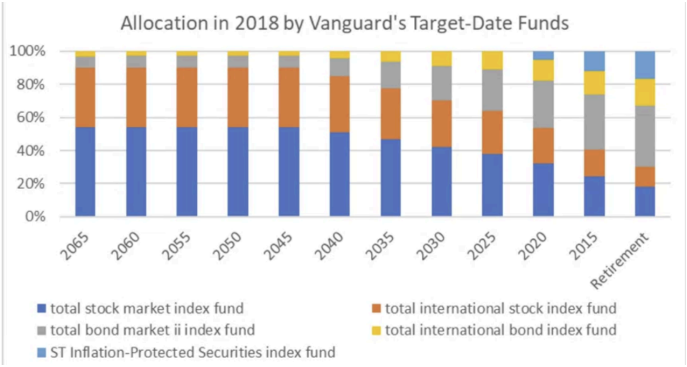
    b.
    c. robo-advisory: unclear role for AI
4. Vanguard FinTech solutions
    a. personal advice service: digitizing advice, Innovation Studio

3 Lending, Crowdfunding, and Modern Investing

1. Which is a true statement about defined-benefit plans?
    a. ❌Defined benefit plans define your retirement income in terms of what you paid in
    b. ✅The pension plan administrators, not the employees, are responsible for investing the fund assets

   c. ❌Employees will definitely get the payments due from a defined-benefit plan, even if the plan's assets aren't sufficient to cover these payments
   d. ❌Defined benefit plans are a growing part of retirement savings
2. 401(k) plans: new retirement plan encourages DIY retirement savings to reduce pressure on the employers' responsibility on pension fund
3. fundamental axioms of economics - key assumptions in investing study
   a. prefer more money to less
   b. decreasing marginal utility: get less out of the next dollar when you already have more
4. Certainty Equivalent indicates risk aversion for robo-advising: $970 vs. gamble between $0 and $2000
5. Which of the following implies that a consumer is risk averse?
   a. ❌She gains more utility from an $x increase in wealth than she loses in utility from an $x decrease in wealth
   b. ❌ She gains more utility from an $x increase in wealth now than she gains from an $x increase in wealth later
   c. ✅She **gains** less utility from an $x increase in wealth than she **loses** in utility from an $x decrease in wealth
   d. ❌She gains less utility from an $x increase in wealth now than she gains from an $x increase in wealth later
6. **Portfolio Therory** contd.
   a. Efficient portfolio: minimum risk for its expected return
   b. easy way for mean variance optimization: take value-weighted market index (all assets based on size) e.g. S&P 500
   c. According to Professor Musto, which of the following is NOT an element of the Hybrid Approach to an efficient portfolio?
      i. ✅Take the value-weighted market index
      ii. ❌Find the efficient portfolio of indices
      iii. ❌Keep transaction costs down
      iv. ❌Get some diversification benefit
7. assets
   a. Mutual Funds
      i. investment program funded by shareholders that trades in diversified holdings and is professionally managed
      ii. active management: pay ~1% for manager to pick stocks
      iii. index funds: simply invest in a defined index, only pay for logistics of getting the index return
         1. one trading time/day
         2. only accessible from some platforms, minimum investment limit
   b. Exchange Traded Funds ETFs
      i. buy shares on the open market, money goes to seller
      ii. youre trade doesn't directly affect the fund
      iii. pay market transaction cost, even lower than index funds
      iv. trade any time the market is open, minimum 1 share
      v. access from any brokerage account
      vi. robo-advisor can optimize ETFs with low fees
      vii. Which is a difference between an open-end fund and an ETF?
         1. ✅An ETF trades on an exchange but an open-end fund does not
         2. ❌Retail investors trade open-end fund shares with each other, and trade ETF shares directly with the fund
         3. ❌An ETF has a pre-determined lifespan but an open-end fund does not
         4. ❌An ETF holds individual securities but an open-end fund does not
8. robo-advising

a. key customization factor: lifecycle, how many years until retirement
b. target date funds: hottest in retirement investing, guess retirement time and choose target date fund for that year
    i. rebalance investment by starting out risky, tilting toward lower risk



    ii. target date not amount
    iii. Vanguard's easy approach: 60% domestic. 40% international, just tilt from equity to bond
c. dynamic readjustment: e.g. property ownership, mortgage, loan, ethical guideline screens

9. **crowdfunding**: started in 2016
10. raising capital: Initial Public Offering **IPO**
    a. engage an underwriter - big investment bank
    b. submit draft registration statement to the Securities and Exchange Commision SEC
    c. submit finished registration statement S1 with price range and number of shares
    d. road show, pitch institutional investors
    e. set price and place the shares
        i. for retail investor: on average IPO goes up 18% on first trading day, but a price down is not a bargain; usually cannot get share at offer price before aftermarket
11. Jumpstart Our Business Startups JOBS Act: bipartisan legislation that developed in 2011
    a. titles
        i. emerging growth companies: encourage companies with revenue < $1b to go public, keep S1 confidential before settled
        ii. allow fundraising in private from accredited investors after public advertisement
        iii. crowdfunding: limited investment amount and holding time, through intermediary
        iv. Regulation A+: mini IPO and lower requirement, sell directly to retail investor (“best effort”)
12. cost (max $1m allowed to raise)
    a. entrepreneur
        i. professional cost (lawyer, accountant) $500 100h = $50k = 5% of $1m
        ii. intermediary fee 5%
        iii. marketing
    b. investor
        i. opportunity cost: annual budget $10k to split for 5 -> $50/h, 8h research = $400, 50% chance to decide on investing -> E[R] = $800, 40% of $2k!
        ii. already picked over: not the first choice for entrepreneurs; yes when used as proof of concept before meeting VC/attract shareholders as customers
13. Impact investing for high CSR
    a. B Corp: recognized by a private outfit B Lab
    b. Benefit Corporation: register by state law
14. consumer credit landscape
    a. assets: physical assets, financial assets, human capital
    b. liabilities: debt incurred in acquiring physical assets (mortgage), debt incurred in developing HC, credit card debt (non collateral)

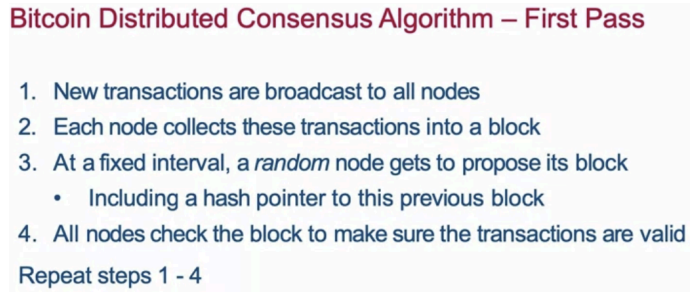
    c. Data and Statistics - FEDERAL RESERVE BANK of NEW YORK
    d. I
15. from Peer to Peer P2P lending to **Marketplace Lending**, alternative to HELOC
    a. platforms more involve in decision, make credit granting, credit risk evaluation, and set interest rate
    b. 95% of lending does not come from the public but institutions, hedge funds etc.
    c. 80% for credit card bill
    d. borrowers allow lenders to access their bank accounts, utility bills etc. for risk score
    e. default 违约 probability is not necessarily strictly related to FICO score
16. Student Loan Debt, social finance SoFi
    a. flat 5.05%/6.6% interest rate for federal undergrad-/grad-school loan 2018-19 for easy profit opportunity to refinance focused lenders, calculated off 10-year treasury rate
    b. trend of transition away from refinancing that depends largely on interest rate (treasury rate) to be the original lender
    c. income-driven repayment of student loans
        i. ❌Any loan taken out for education is eligible for this program
        ii. ✅Any unpaid interest is added to the principal balance
        iii. ✅After 20 years of repayment, the remaining balance is discharged
        iv. ✅Monthly payments are limited to 10% of discretionary income
    d. Which is a downside of refinancing out of federal student loans?
        i. ❌The principal amount will be higher
        ii. ✅The new loan will not be eligible for income-driven repayment
        iii. ❌The lender will need collateral
        iv. ❌The interest rate will be higher
17. lending to small businesses, retailers by payment aggregators e.g. Square
    a. know every transactions, can forecast future cash flow
    b. merchant cash advance: get repaid by taking from it e.g. 10% of all receipts
    c. some money by outside investors
18. fintech dynamics by Square
    a. disaggregation between back end data and customer experience
    b. simple UI
    c. design first products
    d. blockchain infrastructure
    e. challenge: privacy, compliance to regulations in different states

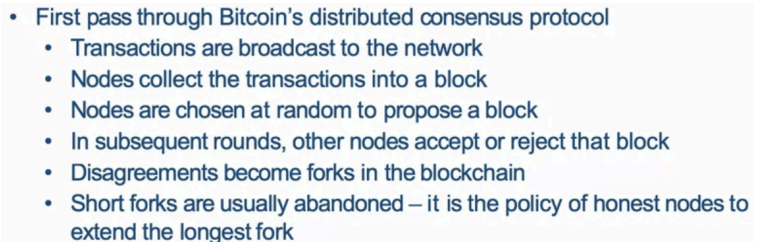
2 Cryptocurrency and Blockchain: An Introduction to Digital Currencies

1. **cryptocurrency summary**
    a. relies on probabilistic thinking, no 100% certainty of ownership
    b. hedging asset, relative low return, but sometimes brings surprise
    c. blockchain: decentralized, transparent, secure, and immutable
2. **bitcoin**
    a. decentralized system of property rights
        i. transaction is expensive in current system since need to deal with different jurisdictions/sovereigns
    b. key: notion of identity - digital signature, ensure impossible to forge or replicate
    c. private key: 256 bit number in hexadecimal from pseudo random number generator
    d. public key: address, for transaction
    e. only valuable for exchange, but not for tax, stock etc.
    f. prevent tamper on ledger: a memory system, contains all bitcoin transactions
        i. make it recursive - keep all previous transactions in each digest

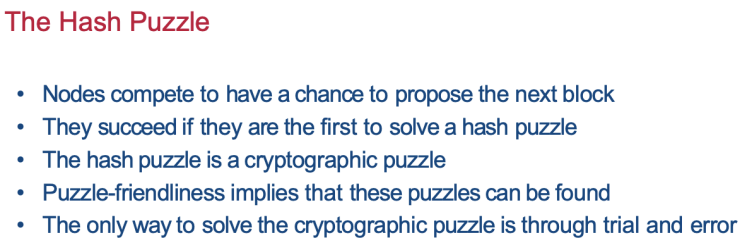
g. equilibria for using bitcoin
    i. major value
        1. not relying on a centralized intermediary
        2. not manipulated by a central bank
    ii. no one uses - worth 0
    iii. used by a narrow group
    iv. dominant medium of exchange
    v. alternative for dollar (even Federal Reserve seems solid now)

3. **blockchain**: cryptographic method of the tamper proof ledger, and store transactions into blocks
    a. implementation: linked list of transactions as blocks, use hash pointer SHA-256 that generates cryptographic digest pointing to the previous transaction
        i. collision-resistance
        ii. hiding: impossible to reverse engineering
        iii. puzzle-friendliness: for mining
    b. issue
        i. *double-spend attack*: require sign-off of a certain address (person) for the transactions - tend to be centralized
        ii. *distributed consensus*: use randomness and avoid honest assumption on any node, only extend on the longest fork - some node may try to include both correct and malicious transactions



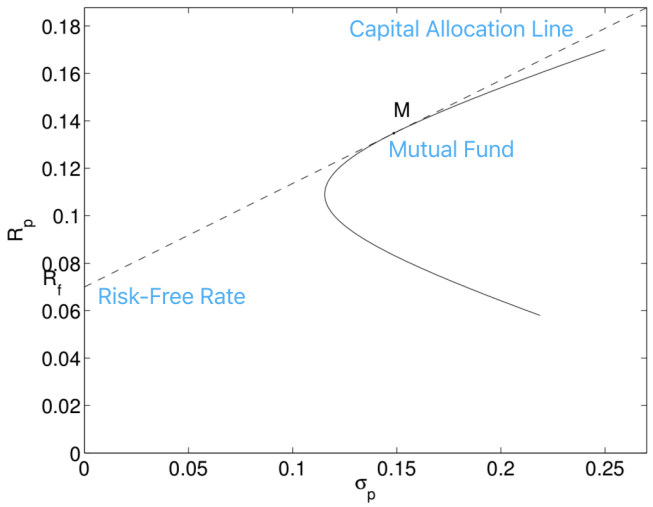


        iii. *Proof of Work PoW*: incentivize honest behavior when a node extends on your block
            1. challenges: concentrating mining power, not likely; high energy use, 6% of banking; low scalability
            2. breakthrough: incentivize so that tampering is unprofitable instead of making tampering impossible
    c. architecture: Base layer, Application protocol, Application layer at the top of the "stack"
    d. decentralization pros: reduces entry barriers, creates potentially much more competitive ecosystem of products and services
    e. investors: Initial Coin Offerings ICO: fundraising for projects
4. **mining**: for rewards due to PoW, a block is mined every 10 minutes



a.

   b. a block contains: a timestamp, a nonce/hash referring to previous block, and list of all previous transactions
   c. after a block is mined and puzzle solved, the transaction is confirmed
   d. a process can be both deterministic (given initial conditions) and random (unpredictable)
5. **Staking**: address low speed of mining with Proof of Stake PoS
   a. amount of crypto held determines the amount one can mine
   b. encourages honesty to each node's interest in holding value for their own value
6. interoperability: ensure blockchain implementations can work with each other
   a. cross chain messaging: relays messages about blockchain state
   b. cross chain atomic swaps: exchange tokens w/o third party
7. other extensions/parties
   a. Smart Contracts: algo performs contract terms
   b. Oracles: submit real-world occurrences (e.g. data) to a blockchain for smart contracts
   c. legal audit
   d. security and audit
   e. distributed data privacy platforms
8. crypto finance
   a. Crypto payment: effectuate real-time payments
   b. Crypto Privacy: use ring signature by anyone from a group to obscure identity
   c. Crypto wallet: work for multiple currencies, interact with blockchains
   d. Crypto exchange: for fiat currency based on current market price
   e. Stable coins: linked to currencies or indices, avoid price volatility
   f. Hardware wallet: reduce large scale vulnerabilities
   g. Blockchain merchant: accep cryptos as payment
   h. Crypto FinTech: trading, insurance (but lack data), lending (high interest), investment funds
9. cryptocurrency **return** measurement: price determined by exchange rate to dollar
   a. median return usually < mean return
   b. if return is normally distributed, volatility measures risk
   c. subject to survivor bias (top 3 cryptocurrencies have positive mean return)
10. **Portfolio Theory** 投资组合理论 (more in 3.4)
   a. key: there are gains from diversification, transcends the normal distribution assumption
   b. assumptions
      i. investor prefer more to less
      ii. investors are risk averse
      iii. returns are *normally distributed*
   c. all risky assets lie inside of the risky asset frontier
   d. efficient frontier is part of the minimum variance frontier that gives high expectation
   e. Tangency Portfolio

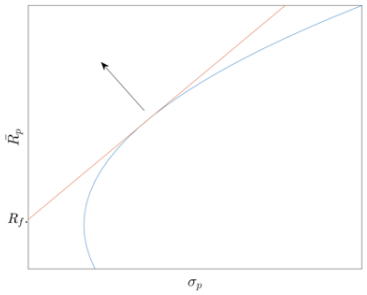


i. M has the attainable highest tangent slope so optimal and efficient
ii. Sharpe ratio: (E[R] − RFR)/σ, describes extra return you receive per unit of standard deviation or risk return trade off, reach highest at Capital Allocation Line
iii. Mutual Fund Theorem: solve portfolio allocation problem
    1. determine M
    2. determine where you want to be on the Capital Allocation Line based on risk tolerance
iv. consequence: Capital Asset Pricing Model CAPM
    1. market portfolio, the portfolio that holds assets each one's market weights, is an efficient portfolio
    2. the market portfolio has the highest Sharpe ratio possible
    3. security market line/ security characteristic line: can take RFR = Treasury Bill return 国库券收益

$$E[R_i] = RFR + \beta(E[R_M] - RFR)$$

$$\beta = Cov(R_i, R_M)/Var(R_M)$$

11. asset allocation with cryptocurrency
    a. CAPM: Sharpe ratio of top 3 cryptos do no yield better result than S&P 500, unfavorable
    b. Alpha: abnormal return that CAPM does not explain, α = E[R] - E[R_i] = 0 if CAPM holds
        i. cryptos has positive α higher than many other investments
        ii. actually you can push the Sharpe ratio higher by including an asset with positive α



    c. Gordon Growth Model: price of an asset is determined by next year's dividends, expected return and annual dividend growth rate $P = \frac{D}{r-g}$ -
        i. cryptos value is 0 all the time since D = 0
        ii. consider D as convenience of exchange (convenience yield) - cryptos serves as a hedging security in bad economic times
12. business use cases of blockchain
    a. value exchange
        i. content monitezation
        ii. marketplaces of goods, services, jobs etc.
        iii. energy: relevant data services, smart grid management etc.
    b. shared data
        i. IoT
        ii. Supply chain/logistics: increase transparency, security, efficiency and scalability
        iii. attribution for collaboration: for artistic content production, verify and authorize
        iv. reputation system: reward accurate info, create reputation score
        v. healthcare info: access control of personal info
    c. authenticity: ownership transfer
        i. data and title (real estate)
        ii. ticketing
    d. diversified financial

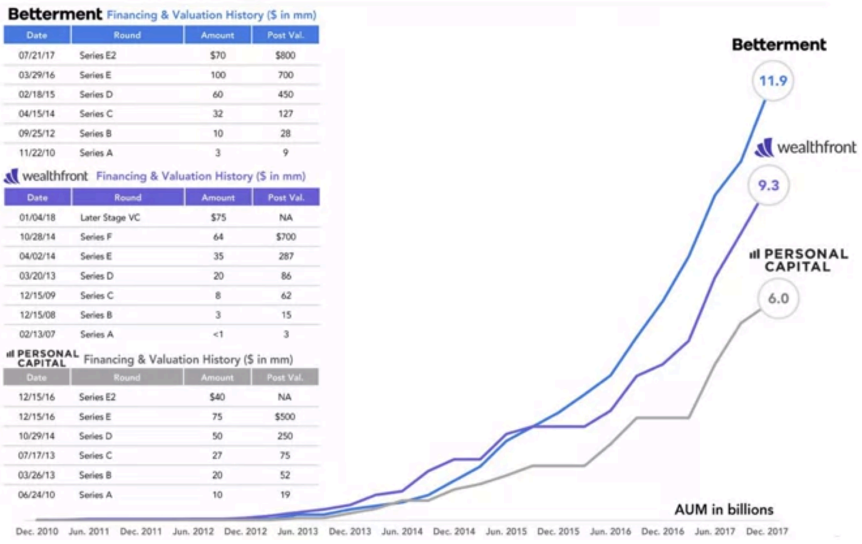
i. legal
ii. accounting
iii. middle and back office functions
iv. payroll, lending and trading, market analytics etc

e. gaming: artistic personalization, gambling, VR

13. 'Securitize' takeaway
    a. public blockchain is the trend
    b. digitization trend
    c. marketing is highly needed in FinTech
    d. FinTech industry will be more decentralized

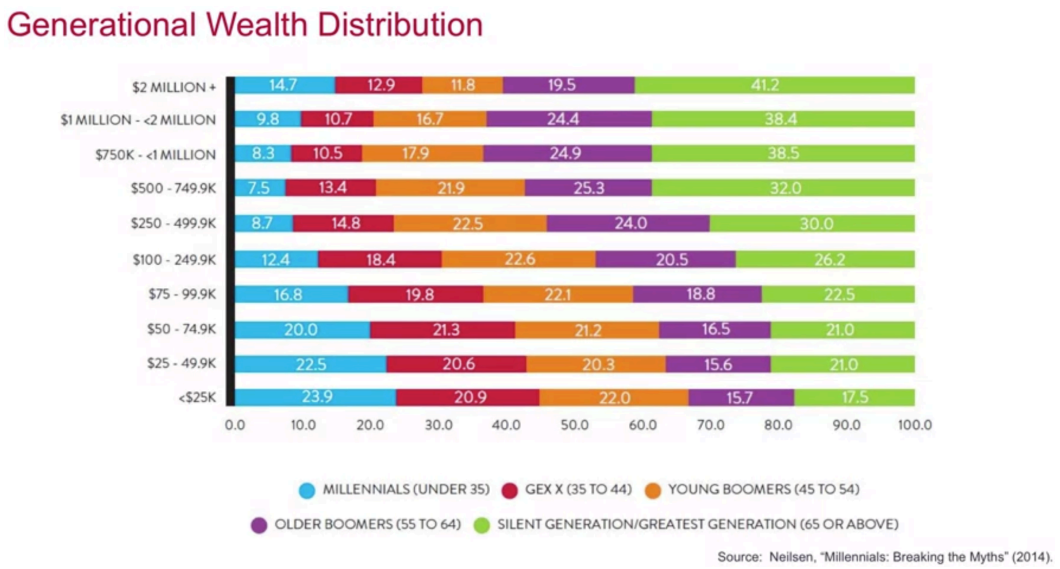
1 FinTech: Foundations, Payments, and Regulations

1. robo-advisory: a financial advisory firm, a practice that uses an algorithm to build a customer allocation, based on automated inputs (to build an investment strategy approach)
    a. deprecated definition: Business models that reduce costs of client service by disintermediating humans
    b. largest: Vanguard ($150-200 b AUM), Schwab, Wealthfront, Betterment etc
    c. reported valuations



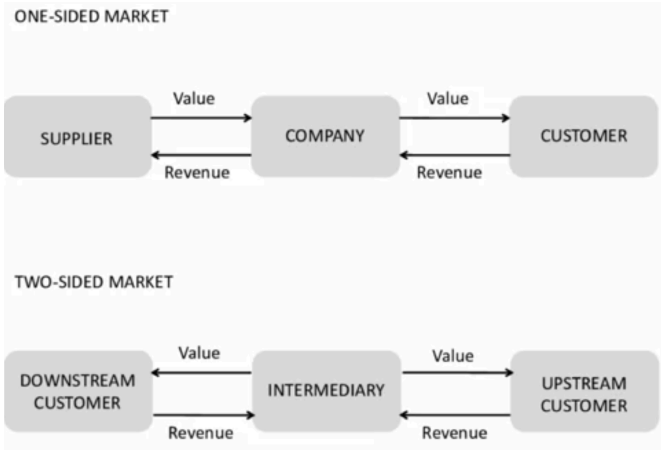
2. market sizing
    a. factors
        i. Assets under management AUM
        ii. flows of funds
        iii. valuations of businesses in a sector of sub sector
        iv. number of competitors
    b. global fintech funding ~ $111.8 billion in 2018
        i. $20.7 b in UK, 2018
        ii. $18.2 b in China, 2018
        iii. $34.2 b in Europe, 2018
    c. digital payments is the largest component of fintech by transaction volume, ~$3.6 trillion in 2018
3. Insurtech: property, casualty, life and health, financial product insurances like variable annuities etc.
4. Millennials/Gen Y 1977-1995 are critical fintech target group
    a. 25% of US population, 83 m, in 2015
    b. 40% of global adult population in 2015

c. median income $25k for 18-27, $47k for older
d. more double millionaires



e. less confident in managing family money
f. lower trust in others
g. interested in entrepreneurship, heavily attached to social network
h. optimistic about financial future
i. highly affected by previous experience, low risk tolerance if experienced financial crisis

5. discrepancy of important aspects of advisors between financial advisors and clients (see slides 1-2): trustworthiness, knowledge, friendliness etc
6. People trust humans more than algorithms - practical implication for the digital human application?
7. challenge: choice architecture
    a. as choices increase, decision-making paralysis happens, and people tend to be less happy at the result
8. **card** dominates modern payment
    a. card networks are more than a two-sided market



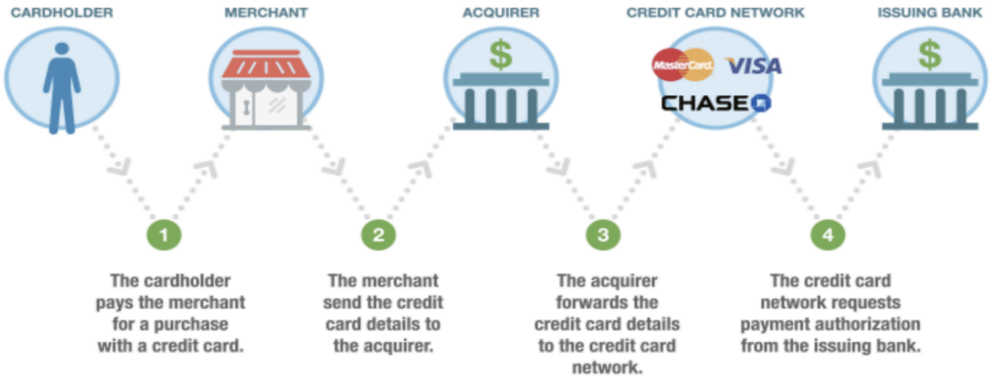
b. transaction fee is usually the second highest cost for merchants after labor

	Merchants	Cardholder
Benefits	Customers that don't carry cash can buy products/services Cash-based theft reduced	Credit care rewards (points, airline miles, etc.) Ease-of-payment A credit line
Costs	Pay 1-3% of transaction value in fees	Possibility of fraud Interest if late on a statement payment

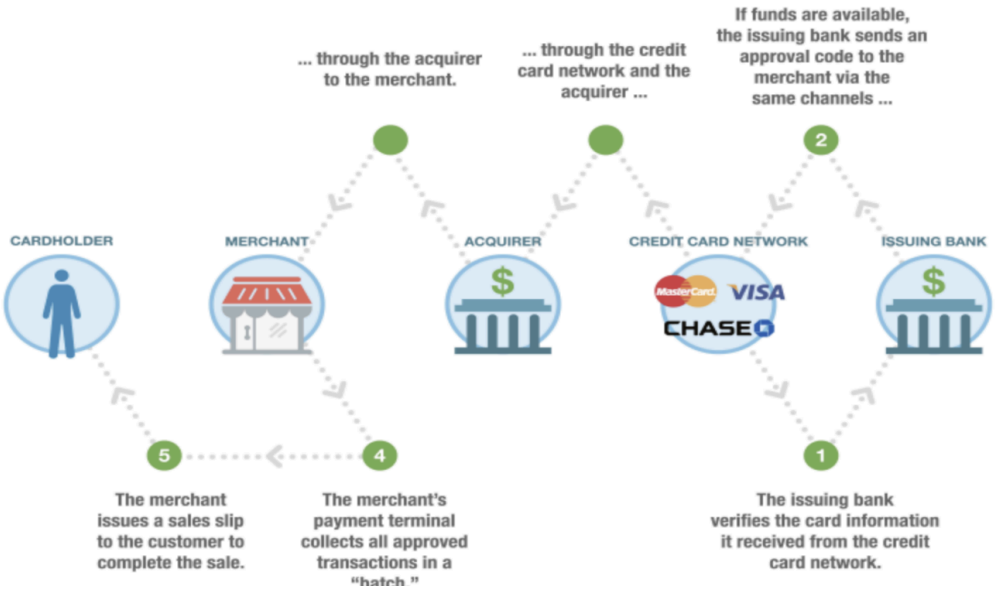
   i. starbucks solution: pay processing fee for gift card purchase instead of every time a coffee is sold
   ii. venmo: initially P2P transaction, now allows C2B without fee
   iii. paystand: reduce fees for B2B transactions

c. complex card payment process - far from real time processing in US

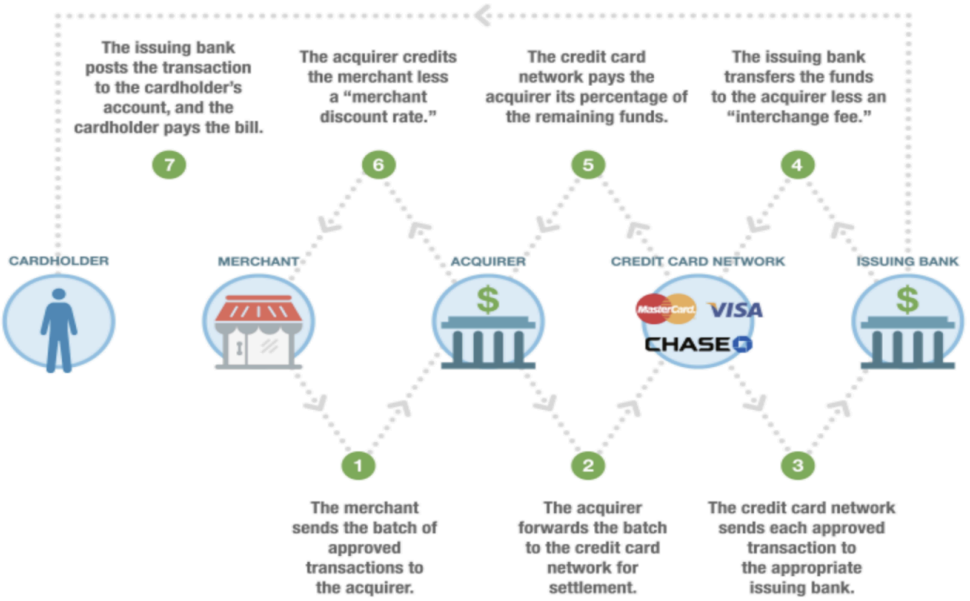
   i. authorization



   ii. authentication



iii. clearing & settlement



d. credit card reward comes by high processing fee e.g. American Express
e. debit card **overdraft fees**: started with case-by-case practice, then spread due to significant revenue potential - protection regulations and opt-in rules - cut or eliminated
f. 2009 USA Credit Card Accountability, Responsibility and Disclosure (CARD) Act: reduce excessive **late fees** charged, limit interest increase rates without fair warning

9. regulatory sandbox: framework to allow small scale live testing of innovations in a controlled environment under the regulator's supervision
10. global fintech regulations
    - Clearly defining internal regulatory authority is a necessary step for coherent FinTech regulation (USA)
    - Regulatory sandboxes have been found to increase value and capabilities of participating firms (UK)
    - While absent regulation can spark a boom, it also gives rise to a market full of scams and high-risk financial models (China)
    - Active and collaborative regulation can be encouraged through innovation hubs that help FinTechs navigate the regulatory landscape (Australia, Singapore)
11. RegTech: tech to address regulatory challenges and facilitate delivery of compliance