



Fintech: Ecosystem, business models, investment decisions, and challenges

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Abstract Fintech brings about a new paradigm in which information technology is driving innovation in the financial industry. Fintech is touted as a game changing, disruptive innovation capable of shaking up traditional financial markets. This article introduces a historical view of fintech and discusses the ecosystem of the fintech sector. We then discuss various fintech business models and investment types. This article illustrates the use of real options for fintech investment decisions. Finally, technical and managerial challenges for both fintech startups and traditional financial institutions are discussed.

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1. Fintech: An introduction

Financial technology (fintech) is recognized as one of the most important innovations in the financial industry and is evolving at a rapid speed, driven in part by the sharing economy, favorable regulation, and information technology. Fintech promises to reshape the financial industry by cutting costs, improving the quality of financial services, and creating a more diverse and stable financial landscape ('The FinTech Revolution,' 2015). The technological developments in infrastructure, big data, data analytics, and mobile devices allow fintech

startups to disintermediate traditional financial firms with unique, niche, and personalized services. According to PwC (2016), 83% of financial institutions believe that various aspects of their business are at risk to fintech startups. Due to fintech companies already having a significant impact on the financial industry, every financial firm needs to build capabilities to leverage and/or invest in fintech in order to stay competitive.

The growth of investment in fintech has been phenomenal. According to Accenture (2016a), global investment in fintech ventures in the first quarter of 2016 reached \$5.3 billion, a 67% increase over the same period the previous year, and the percentage of investments going to fintech companies in Europe and the Asia-Pacific nearly doubled to 62%. Much of this increase in investment has come from traditional financial institutions. Traditional financial

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institutions invest in external fintech startups in the form of collaborative fintech ventures, as well as their internal fintech projects in hopes of leapfrogging fintech innovation and gaining a competitive advantage.

According to the annual fintech 100 report published by [KPMG \(2015\)](#), China and the U.S. are leading countries in fintech startups and companies. The fintech 100 companies in 2015 include 25 payments and transactions companies, 22 lending companies, 14 wealth management companies, and 7 insurance companies. [Holland FinTech \(2015\)](#) forecasts that approximately \$660 billion in revenue may migrate from traditional financial services to fintech services in the areas of payments, crowd-funding, wealth management, and lending.

It is clear from the evidence that fintech is now well beyond the stage of hype and has become a major player in the financial world. In light of the urgent need to inform financial professionals of the significance of this disruptive innovation, in this article we will discuss the following topics. First, we introduce a historical view of fintech and presents the fintech ecosystem. We then discuss various business models and investment types. We illustrate the use of real options for fintech investment decisions. Finally, we identify and discuss six technical and managerial challenges for fintech startups and traditional financial institutions: investment management, customer management, regulation, technology integration, security and privacy, and risk management.

2. Emergence of fintech

Financial markets worldwide were profoundly affected by the internet revolution in the early 1990s, with one of the major effects being that it lowered costs for financial transactions. Technological advances driven by the internet revolution changed the face of the financial services industry and led to the development of electronic finance (e-finance). E-finance refers to all forms of financial services such as banking, insurance, and stock trading performed through electronic means, including the internet and World Wide Web. E-finance allows individuals or businesses to access accounts, transact business, and obtain information on financial products and services without being in physical contact with financial firms. Many e-finance business models emerged in the 1990s, including online banking, online brokerage services, mobile payment, and mobile banking. As with e-commerce, many of these changes have led to the downsizing and reduction of number in physical locations for banks.

The impact of internet technology has been especially obvious in the banking industry. Information-intensive and time-sensitive in nature, virtually every component of the banking business' value chain benefitted from an innovative utilization of web technologies. From the bank's point of view, potential benefits of online banking include lower operational costs, shorter turnaround time, real-time managerial information, smoother communication within the organization, more convenient interaction with existing as well as prospective customers, and the provision of value-added services such as access to professional knowledge in financial management ([Nielsen, 2002](#); [Sathye, 1999](#)). Online stock trading is another example of e-finance. It minimizes its operating costs by processing every stock transaction online. It achieves competitive advantage by providing differentiated services at the lowest feasible transaction fees. Some online stock brokers provide their clients free access to high quality research reports developed by reputed financial research firms.

The growth of the smartphone user base in the mid-2000s facilitated the growth of mobile finance, such as mobile payment and mobile banking, which is an extension of e-finance. Financial institutions have allowed their customers not only to access bank account information, but also to make transactions, such as paying bills and remitting money, via their mobile device.

With the advances in e-finance and mobile technologies for financial firms, fintech innovation emerged after the worldwide financial crisis in 2008 by combining the e-finance, internet technologies, social networking services, social media, artificial intelligence, and big data analytics. Fintech startups differentiated themselves from traditional financial firms with personalized niche services, data-driven solutions, an innovative culture, and a nimble organization. While fintech is generally considered a threat to traditional financial firms, it also provides ample opportunities for these firms to gain a competitive advantage over competitors. Most major financial firms have begun taking fintech seriously and are developing strategies to compete, coexist, and collaborate with fintech startups.

3. Fintech ecosystem

To understand the competitive and collaborative dynamics in fintech innovation, we must first analyze the ecosystem. A stable symbiotic fintech ecosystem is instrumental in the growth of the fintech industry. [Diemers, Lamaa, Salamat, and](#)

Steffens (2015) suggested that entrepreneurs, government, and financial institutions are the participants in a fintech ecosystem. We have identified five elements of the fintech ecosystem:

1. Fintech startups (e.g., payment, wealth management, lending, crowdfunding, capital market, and insurance fintech companies);
2. Technology developers (e.g., big data analytics, cloud computing, cryptocurrency, and social media developers);
3. Government (e.g., financial regulators and legislature);
4. Financial customers (e.g., individuals and organizations); and
5. Traditional financial institutions (e.g., traditional banks, insurance companies, stock brokerage firms, and venture capitalists).

These elements symbiotically contribute to the innovation, stimulate economy, facilitate collaboration and competition in the financial industry, and ultimately benefit consumers in the financial industry. Figure 1 shows the five elements of the fintech ecosystem.

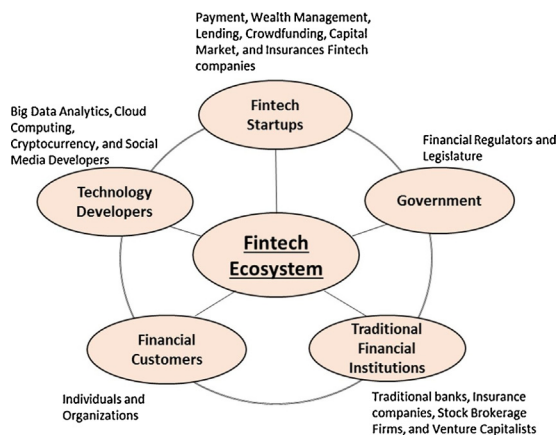
At the center of the ecosystem are fintech startups. These companies are mostly entrepreneurial and have driven major innovations in the areas of payment, wealth management, lending, crowdfunding, capital market, and insurances by incurring lower operating costs, targeting more niche markets, and providing more personalized services than traditional financial firms. They are driving the phenomenon of unbundling financial services, which has been highly disruptive for banks (Walchek, 2015). The ability to unbundle services is one of the

major drivers of growth in the fintech sector, as traditional financial institutions are disadvantaged in this situation. Consumers, rather than relying on a single financial institution for their needs, are beginning to pick and choose services they would like from a variety of fintech companies. A consumer may manage his/her loan via SoFi, while using PayPal to manage payments, Rocket Mortgage for his/her mortgage, and Robinhood for stock management. Venture capitalists and private equities are conducive to the creation of fintech startups and the level of investments increased significantly over time as well.

Technology developers provide digital platforms for social media, big data analytics, cloud computing, artificial intelligence, smart phones, and mobile services. Technology developers create a favorable environment for fintech startups to launch innovative services in rapidly. Big data analytics can be used to provide unique personalized services to customers and cloud computing may be used for cash-strapped fintech startups to deploy web-based services at a fraction of the cost of in-house infrastructure development. Algorithmic trading strategies can be used as the basis for robo-advisor wealth management services at much lower fees than traditional wealth management services. Social media facilitates the growth of communities in the crowdfunding and person-to-person lending services. The ubiquity of mobile devices supplants the advantages of physical distribution. Mobile network operators are also providing low cost infrastructure for fintech companies' service development, such as mobile payment and mobile banking. In turn, the fintech industry is generating revenue for these technology developers.

Governments have been providing a favorable regulatory environment for fintech since the 2008 financial crisis (Holland FinTech, 2015). Depending on the national economic development plans and economic policies, different governments provide different levels of regulation (e.g., licensing of financial services, relaxation of capital requirements, tax incentives) for fintech startups to stimulate fintech innovation and facilitate global financial competitiveness. For example, Singapore is changing online payment regulations to make the regulation friendlier to payment service providers and spur payment technology growth (Reuters, 2016). On the other hand, since 2008, traditional financial institutions have been subject to more rigorous regulation, capital requirements, and reporting requirements from government regulators. The looser regulatory requirements imposed on fintech startups allow them to provide more customized, inexpensive, and easy-to-access financial

Figure 1. The five elements of the fintech ecosystem



services to consumers than traditional institutions. However, while certain regulations are favorable to fintech startups, they still need to understand how regulations may affect their service provisions. LendUp, a payday loan fintech company, was fined \$3.63 million for violations of consumer financial protection laws, including the Truth in Lending Act and the Dodd-Frank Wall Street Reform and Consumer Protection Act ([Consumer Financial Protection Bureau, 2016](#)).

Financial customers are the source of revenue generation for fintech companies. While large organizations are important sources of revenue, the predominant revenue source for fintech companies are individual customers and small and medium-sized enterprises (SMEs). A survey found that the use of fintech services is greatest among younger, wealthier customers ([Holland FinTech, 2015](#)). Early fintech adopters tend to be tech-savvy, younger, urban, and higher-income individuals. Currently, millennials (people between the age of 18 and 34) constitute a significant portion of fintech consumption in most countries. The future demographic is favorable to fintech companies in that in the next few decades, the tech-savvy millennials will account for the largest part of the population and drive the growth of fintech services.

Traditional financial institutions are also a major driving force in the fintech ecosystem. After realizing the disruptive power of fintech and dwindling window of opportunities to blunt fintech's impact on the market, traditional financial institutions have been reevaluating their existing business models and developing strategies to embrace fintech innovation. Traditional financial institutions have competitive advantages in economies of scale and financial resources over fintech startups. However, traditional financial institutions tend to focus on bundled services, providing one-stop comprehensive financial products and services to consumers rather than unbundled specialized products and services. While traditional financial institutions initially treated these fast-growing fintech companies as threats, they have shifted their focus to collaborating with fintech startups with various funding provisions. In exchange for providing funding, they are able to draw on the insights of these startup companies in order to stay on the forefront of the technology ([Yang, 2015](#)).

4. Fintech business models

According to a recent report by [Accenture \(2016a\)](#), more than \$50 billion has been invested in almost 2,500 companies since 2010, as these fintechs

redefine the ways in which people store, save, borrow, invest, move, spend, and protect money. We identify six fintech business models implemented by the ever growing number of fintech startups: payment, wealth management, crowdfunding, lending, capital market, and insurance services. Their value propositions, operating mechanisms, and major fintech companies in each business model are discussed below.

4.1. Payment business model

Payments are relatively simple compared to other financial products and services. Fintech companies focusing on payments are able to acquire customers rapidly at lower costs, and are one of the fastest moving in terms of innovation and adoption of new payment capabilities. The two markets of payment fintechs are (1) consumer and retail payment and (2) wholesale and corporate payment. Payments are one of the most used retail financial services on a day-to-day basis, as well as one of the least regulated financial services. According to [BNY Mellon \(2015\)](#), consumer and retail payment fintechs include mobile wallets, peer-to-peer (P2P) mobile payments, foreign exchange and remittances, real-time payments, and digital currency solutions. These services improve the experience for customers who look for a streamlined payments experience in terms of speed, convenience, and multi-channel accessibility.

Mobile payment services that can be conveniently and securely used on mobile devices are a popular business model. Approaches to mobile payments include but are not limited to: charging to a phone bill, near field communication (NFC), barcode or QR code, a credit card on mobile websites, a mobile phone card reader, and direct mobile payment without using credit card companies ([Li, 2016](#)). The most widely known NFC-based mobile payment applications are Google Wallet, Apple Pay, and Samsung Pay. Another popular payment business model is P2P payment services. Users are now able to reimburse each other with apps such as PayPal and Venmo for free.

4.2. Wealth management business model

One of the more popular wealth management fintech business models is automated wealth managers (robo-advisors) that provide financial advice for a fraction of the price of a real-life adviser. These robo-advisors use algorithms to suggest a mix of assets to invest in based on a customer's investment preferences and characteristics ('[Ask the Algorithm,](#)' 2015). This business model benefits

from changing demographics and consumer behavior that favor automated and passive investment strategies, a simple and transparent fee structure, and attractive unit economics that allow low or no investment minimums (Holland FinTech, 2015). A survey by the CFA Institute in April 2016 found the majority of survey participants to be most concerned about the disruptive characteristics these fintech companies would have in the wealth management sector (Sanicola, 2016). Wealth management fintechs include Betterment, Wealthfront, Motif, and Folio.

4.3. Crowdfunding business model

Crowdfunding fintechs empower networks of people to control the creation of new products, media, and ideas and are raising funds for charity or venture capital (International Trade Administration, n.d.). Crowdfunding involves three parties: the project initiator or entrepreneur who needs funding, the contributors who may be interested in supporting the cause or project, and the moderating organization that facilitates the engagement between the contributors and the initiator. The moderating organization enables the contributors to access information about the different initiatives and funding opportunities for the development of products/services.

Rewards-based crowdfunding, donation-based crowdfunding, and equity-based crowdfunding are the most popular crowdfunding business models. Rewards-based crowdfunding has been an attractive fundraising option for thousands of small businesses and creative projects. In the event that there is any interest to be charged on the amount of the rewards-based crowdfunding, the borrower sets the interest rate that they are comfortable with and can guarantee a refund within the stipulated time period (Mollick, 2014). In return for a fund from supporters of a project, the business typically gives some type of rewards. Donation-based crowdfunding is a way to source money for a charity project by asking donators to contribute money to it. In a donation-based crowdfunding, the funder receives nothing at all other than some form of non-monetary recognitions. Equity-based crowdfunding is an appealing option for small and medium-sized companies (SMEs) as increased capital ratio requirements on traditional banks make lending to SMEs less prioritized by the traditional banks. Equity-based crowdfunding allows entrepreneurs to reach investors interested in acquiring equity in their startup or other privately held small business.

The essential difference between equity-based crowdfunding and other crowdfunding types is that

in equity-based crowdfunding, fund-seeking entrepreneurs give up a portion of the ownership in exchange for the funds. Examples of reward-based crowdfunding companies include Kickstarter, Indiegogo, CrowdFunder, and RocketHub. Donation-based crowdfunding companies aimed at fund-raising for charitable causes include GoFundMe, GiveForward, and FirstGiving. Equity-based crowdfunding companies include AngelList, Early Shares, and Crowdcube.

4.4. Lending business model

P2P consumer lending and P2P business lending is another big trend in fintech. P2P lending fintechs allow individuals and businesses to lend and borrow between each other. With their efficient structure, P2P lending fintechs are able to offer low interest rates and an improved lending process for lenders and borrowers. A subtle but significant distinction from a bank is that these fintechs are technically not involved in the lending themselves, as they are simply matching lenders with borrowers, and collecting fees off of users. Because of this distinction, P2P lending fintechs currently do not need to meet the capital requirements that influence the total amount of lending, while banks have become more and more limited in the lending they are engaged in (Williams-Grut, 2016).

The fintech innovation in lending manifests itself in the use of alternative credit models, online data sources, data analytics to price risks, rapid lending processes, and lower operating costs. However, the success or failure of this business model is largely dependent on how interest rates behave, something that firms do not have any control over. P2P lending and crowdfunding are different in purpose. While the primary purpose of crowdfunding is funding for projects, the primary purpose of P2P lending is debt consolidation and credit card refinancing (Zhu, Dholakia, Chen, & Algesheimer, 2012). Lending fintechs include Lending Club, Prosper, SoFi, Zopa, and RateSetter.

4.5. Capital market business model

New fintech business models take hold across a full spectrum of capital market areas such as investment, foreign exchange, trading, risk management, and research. One area of promising capital market fintech is trading. Trading fintechs allow investors and traders to connect with each other to discuss and share knowledge, place orders to buy and sell commodities and stocks, and monitor risks in real time. Another area of capital market fintech business models is foreign currency transactions. Foreign currency transactions have been a service

dominated by financial institutions. Fintechs lower barriers and costs for individuals and SMEs engaging in foreign currency transactions all around the world. Users are able to see live pricing and send/receive funds in various currencies securely in real time, all via their mobile device. Fintechs offering this service are able to do so at a much lower cost, via payment methods that are much more familiar to individual clients or businesses. Capital market fintechs include Robinhood, eToro, Magna, Estimote, and Xoom.

4.6. Insurance services business model

In insurance fintech business models, fintechs work to enable a more direct relationship between the insurer and the customer. They use data analytics to calculate and match risk, and as the pool of potential customers broadens, customers are offered products to meet their needs (e.g., car, life, healthcare, or causality insurance). They also streamline healthcare billing processes. The insurance fintech business model seems to be the most well-embraced by traditional insurance providers. The technology allows insurers to expand their data collection to non-traditional sources to supplement their traditional models, improving their risk analysis. Insurance services fintechs that are disrupting the insurance industry include Censio, CoverFox, The Zebra, Sureify Labs, and Ladder.

5. Investment decisions for fintech projects and real options

On June 30, 2016, J.P. Morgan's Corporate & Investment Bank announced the launch of the In-Residence Program for fintech startups to work side-by-side with its employees in order to develop innovations that enable banks to operate faster, safer, and at a lower cost. This type of incubator program is one of many approaches to fintech developments by financial institutions. Our brief survey reveals that traditional financial institutions are investing in fintech in a variety of ways, including (1) partnering with fintechs or technology companies, (2) outsourcing fintech services from fintechs, (3) providing venture capital to fintechs, (4) incubating/accelerating fintech startups, (5) acquiring/buying fintechs, and (6) developing internal fintechs. In general, financial institutions are going to take an immediate investment or a wait-and-see approach to the above-mentioned investment options based on the volatility and project duration of the specific fintechs.

In order to grow businesses and secure venture capital, fintech startups can choose to compete with the traditional financial institutions or to collaborate with them. According to [Accenture \(2016b\)](#), overall U.S. fintech investment favors collaborative ventures, with the volume of collaborative investment increasing from 21% in 2010 to 35% in 2015. On the other hand, in Europe, investment in collaborative fintech declined from 38% of deals in 2010 to 14% of deals in 2015. These opposite trends may be attributable to the different banking regulations in these regions. When the regulation is favorable for new startups to establish their business, they tend to be less collaborative with established institutions.

6. A real options approach

To value the technology projects more appropriately, a real option approach has been suggested. In this section, we discuss how real option valuation can be used to develop traditional financial institutions' fintech projects. A real option approach with an option to wait for technology project investment was explained by [Lee and Lee \(2015\)](#). While traditional net present value (NPV) without real options thinking has been widely used, it ignores flexibility in investment such as deferment and expansion in the investment horizon. Therefore, NPV tends to undervalue a project's worth with a higher discount rate, and is not suitable for highly uncertain, risky technology projects. Since many fintech projects are experimental and being developed in highly fluid economic and regulatory environments, real options may be an appropriate evaluation method.

Similar to financial options, real options are the right, but not the obligation, to take an action such as 'wait,' 'expand,' and 'abandon' during a period of time or by an expiration date. There are characteristics that make real options an appropriate application for fintech projects. Fintech projects inherently carry technical as well as economic and regulatory uncertainties. The potential regulatory intervention is a big factor in the growth rate of the fintechs. Real options applicable to fintech projects include: (1) option to defer, which gives management the option to wait/learn more to see if a project will be profitable; (2) option to expand, which gives management the option to invest more in a project that is profitable; (3) option to abandon, which gives management the option to abandon a project that is operating at a loss and sell or redeploy the assets; (4) option to contract, which gives management the option to scale back a

project that is operating at a loss. For example, if a fintech market test suggests that customers are far more receptive to a new fintech service than expected, the firm can use the pilot fintech service as a basis for expanding the scale of the service.

Values of real options for projects can be calculated using the Black-Scholes model (Black & Scholes, 1973) and the binomial option pricing model (Cox, Ross, & Rubinstein, 1979) if the estimates of the underlying asset's value and variance are obtained. However, the use of these financial option pricing models is usually not possible for fintech projects due to the lack of reliable market data and possibly one-of-a-kind project nature that is not traded. Furthermore, for financial options, the buyer and the seller of the option are different entities. For example, a European call option is traded in the options market between a seller and a buyer of the option. A buyer pays the value of the option as an option price (or as an option premium) in exchange for the right to exercise the call option on the expiration date. The price of the option is for risk protection and it is difficult for an option buyer to make any extra return (e.g., profit) over the expected market return. While some type of real options such as patent and license to drill oil wells may involve sellers and buyers, for real options for internal development—such as R&D and technology development projects—the option buyer and seller are the same entity. When the same entity plays the role of both the seller and buyer of the real option, any returns accrued from the investment belong to the investor.

For real options, using decision trees is recommended, as it allows the ability to set up the possibilities of the project according to what management believes it to be or data obtained from simulations. Furthermore, decision trees are more intuitive to decision makers, and solutions can be framed flexibly and realistically without confined assumptions of other real option pricing models. Smith and Nau (1995) studied decision tree analysis and standard binomial lattice-based option pricing methods and showed that the two methods yield the same results, as long as the risk level is correctly specified throughout the decision tree.

Using decision trees to calculate the value of projects, one can stage the possible values a project can take, exercise the option at the optimal time/value of the project, and discount backwards in order to find the value of the option. In the following, we give an example of using the decision tree with a 2-period expansion options. In a decision tree, we begin with the starting value today, S_0 , and move forward 1 period. The value can either

increase to S_u , or decrease to S_d . We can use the risk-free rate, r , and determine the probability of success/move-up (p) and failure/move-down ($1-p$). An early example of this type of binomial decision tree approach was a binomial lattice model developed by Cox et al. (1979), which depicts two possible changes in value for a stock in each time period, a move up by a factor u or a move down by a factor d . These factors, u and d , and move up probability and move down probability are derived in closed-form solutions.

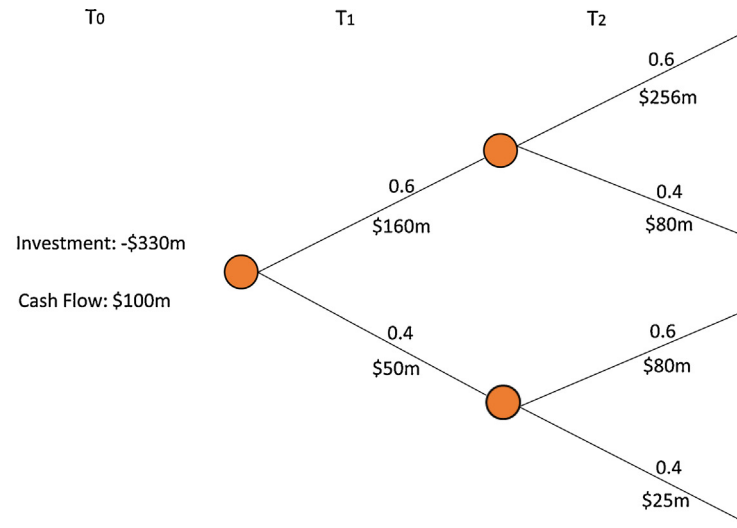
6.1. A real options decision tree example

For example, one bank is looking to invest in a new P2P lending fintech project that will add additional revenue and increase profits. To value the expansion options, as suggested by Copeland and Antikarov (2003), we use the present value of the project without options as the underlying asset for the options. Management assumes the following for the investment evaluation without real options:

1. The fintech project will generate a cash flow of \$100 million at T_0 .
2. The initial investment for the fintech project is \$330 million at T_0 . The initial investment will be sufficient for the maximum market growth potential of the project.
3. The expected annual growth rate is 16%. At each period, the cash flow will go up by 60% with a probability of 0.6 and the cash flow will go down by 50% with a probability of 0.4.
4. The annual discount rate is 3%. For simplicity and comparison purposes, we assume discount rates with real options and without real options are same. In reality, the risk-free discount rate for real options should be much lower than the discount rate for a project without real options.
5. There are two periods (T_1 and T_2) in the decision horizon for this project. After the project expires at the end of T_2 , the project does not have any value and a new fintech project will take over.

Figure 2 shows a decision tree without real options and Table 1 shows the summary of the present values generated from the investment evaluation. From a simple NPV calculation, the value of the project is \$7.95 million, which the standard NPV would accept. However, for the bank, many projects compete for a limited budget and therefore a

Figure 2. A decision tree without real options



PV of Cash Flow in T₀: -\$230m PV of Cash Flow in T₁: \$112.62m PV of Cash Flow in T₂: \$125.33m

positive NPV does not guarantee the acceptance of the investment plan. Next, we explore a real option approach to evaluate this investment as an expansion option. The option to expand is set up as follows:

1. At the beginning, there is a \$110 million investment for the initial cash flow of \$100 million.
2. If the first period has up to \$200 million in cash flow, \$110 million is invested to expand. If the cash flow is below \$100 million, no option to expand is exercised.
3. If the second period has up to \$300 million in cash flow, \$110 million is invested to expand. If the cash flow is below \$200 million, no option to expand is exercised.

Figure 3 shows a decision tree with real options. Table 2 shows that the net present value of the investment with real options is \$126.54 million. However, note that value of option is \$118.59 million, since the bank needs to take into consideration the

NPV of the investment without real options (i.e., \$126.54 million—\$7.95 million). In this example, we did not consider extra cost which might occur to incorporate flexibility for expansion. As long as the extra cost for flexibility for incremental expansion is less than \$118.59 million, the real option investment approach would be beneficial for the bank.

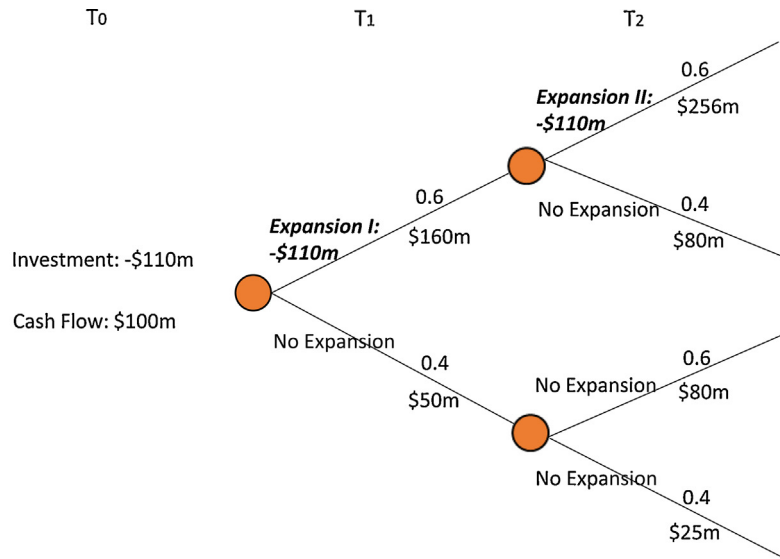
In the fintech industry, some external variables, such as government regulations and technology development, are quite uncertain and their changes will have significant impact on the growth and profitability of fintechs. Currently, national regulations are very favorable for fintech startups, in part because governments do not want their fintech sector to get behind in the global financial market. However, if fintechs threaten the health of domestic and global financial markets, strong regulations will be introduced and the profits of fintechs will decline significantly.

The decision tree-based real option model requires estimates for the parameters. These estimates can be obtained from experts and various Delphi methods can be used to obtain the estimates. While this example was simplified for

Table 1. Net present value without real options

	Expected Cash Inflow in Present Value	Investment without Real Options (Cash Outflow)	Net Present Value
Period 0	\$100m	\$330m	
Period 1	\$112.62m [i.e., $(\$160m * 0.6 + \$50m * 0.4) / 1.03$]		
Period 2	\$125.33m [i.e., $(\$256m * 0.36 + \$80m * 0.24 + \$80m * 0.24 + \$25m * 0.16) / (1.03 * 1.03)$]		
Total Period	\$337.95m	\$330m	\$7.95m

Figure 3. A decision tree with real options



PV of Cash Flow in T0: -\$10m PV of Cash Flow in T1: \$48.54m PV of Cash Flow in T2: \$88m

Table 2. Net present value with real options

	Expected Cash Inflow in Present Value	Investment with Real Options (Cash Outflow)	Net Present Value
Period 0	\$100m	\$110m	
Period 1	\$112.62m [i.e., $(\$160m \cdot 0.6 + \$50m \cdot 0.4)/1.03$]	\$64.08m [i.e., $(\$110m \cdot 0.6)/1.03$]	
Period 2	\$125.33m [i.e., $(\$256m \cdot 0.36 + \$80m \cdot 0.24 + \$80m \cdot 0.24 + \$25m \cdot 0.16)/(1.03 \cdot 1.03)$]	\$37.33m [i.e., $(\$110m \cdot 0.36)/(1.03 \cdot 1.03)$]	
Total Period	\$337.95m	\$211.41m	\$126.54m

readers who are not in finance area, more complicated scenarios can be analyzed with the same principles. Our example highlights the value of the real option approach to fintech projects.

7. Challenges facing the fintech sector

Currently, the financial industry is experiencing unprecedented change. A wide range of traditional banking products from payments to investment advice are being challenged by innovative fintech products. Blockchain technology is revolutionizing many traditional banking services with better transaction security and faster exchanges of money at lower costs domestically and globally. Fintech innovation has the ability to shake up the entire financial landscape in the coming years. As with any disruptive innovation, the disruptive power of fintech innovations will manifest themselves clearly as the market evolves. This section discusses six challenges facing both fintech startups and traditional

financial institutions in this time of disruptive innovation: investment management, customer management, regulation, technology integration, security and privacy, and risk management.

7.1. Fintech investment management challenge

The ability to assess the value of projects accurately will be critical in an increasingly competitive business environment. Without a proper portfolio management of fintech projects, financial firms can get easily swamped in the plethora of fintech technologies. The selection of promising fintech projects is challenging. It is still early to predict the best portfolio of fintech projects that will deliver the most competitive and profitable outcomes. Financial institutions may choose to invest in internal fintech projects in competition with fintech startups. Alternatively, financial institutions can use collaborative investments with fintech startups as a means of remaining on the cutting edge of the

technology without requiring internal innovation. For example, a fintech startup may invest in a robo-advisor fintech. The fintech startup can benefit from the financial institution's expertise in modeling and analysis, while the financial institution can gain insight into what kind of fintech services clients are looking for, as well as the cost structure and revenue streams.

7.2. Customer management challenge

As competition is high for customer acquisition and retention, customer management is crucial. Many customers use multiple services from different fintech firms for different needs. For example, customers may use PayPal for paying businesses online, while using Venmo for paying friends. Fintechs need to understand the niche they are in and strive to provide the best possible service in that niche. High responsiveness and care to customer concerns is paramount, as word of mouth recommendations can be crucial for the success of a fintech startup in this fast-paced environment.

Robo-advisors are designed to provide more personalized 24/7 service to a greater number of people with low fees. However, the human element is still important in investment services. Providing a personalized experience without a significant cost increase is challenging, but critical for customer acquisition and retention. As the clients from Generations X and Y are more tech-savvy, fintechs need to better address customer needs by offering enhanced accessibility, convenience, and tailored products. It will be more important to have an integrated client service management due to the addition of fintech-based channels.

7.3. Regulation challenge

Both traditional financial institutions and fintech startups face regulatory challenges in capital requirements, anti-money laundering, and privacy and security. For traditional financial institutions, the cost to meet regulatory requirements and compete against fintech startups can be significant. Traditional financial institutions and fintech startups face different regulatory requirements based on the type of financial services they provide. For example, most banks operate on some form of fractional-reserve banking system. There are strict and complex guidelines for what kind of lending can be done based on the capital held by a traditional financial institution that may not apply to a lending fintech startup that does not technically lend (e.g., a P2P lending firm). As regulatory changes lag behind the innovation of the industry,

fintech firms need to be aware of potential changes that may impact them and find ways to handle those changes.

7.4. Technology integration challenge

Technology integration is essential in providing seamless customers service. Many fintechs are based on new technologies, and it is challenging to integrate the fintech applications with existing legacy systems. In addition to the internal development of fintechs, banks need to create partnerships and joint ventures with fintech startups via corporate venture funds and incubator programs (Drummer, Jerez, Siebelt, & Thaten, 2016). These partnerships and joint ventures will allow traditional financial institutions to have a stake in an external source that will focus on new fintech technology. However, without a sound integration plan and experience, traditional banking processes in many areas may become incompatible with new technology and business models that the financial institutions are interested in utilizing.

7.5. Security and privacy challenge

In March 2016, the Consumer Financial Protection Bureau (CFPB) settled its first data security enforcement action against Dwolla, a Des Moines-based online payment processing company. The CFPB found the company's representations to customers about its cybersecurity misleading. Dwolla agreed to pay a \$100,000 penalty and take certain steps to improve its data security practices for the next 5 years as part of a consent order that the CFPB issued (Hayashi, 2016). Other government regulators that have been involved in privacy and security action include the Securities and Exchange Commission (SEC), the Department of Justice (DOJ), the Financial Industry Regulatory Authority (FINRA), Commodities Futures Trading Commission (CFTC), and state attorney generals.

For fintech applications, critical information may be stored on mobile devices that oftentimes get lost or stolen. Security of mobile devices can also be compromised through payment applications such as Google Wallet and MasterCard PayPass. As consumers can easily file complaints related to data security and privacy breaches to regulatory agencies, fintech and privacy companies need to develop appropriate measures to protect sensitive consumer data from unauthorized access. Furthermore, as trust plays an important role in the adoption of new technologies, it is in the fintech's best interest to maintain security and privacy as one of their top priorities. It is expected that regulatory agencies, consumer

protection organizations, and fintechs keep working together to make fintech services a secure and value-adding experience for consumers.

7.6. Risk management challenge

There are many risks for fintech startups to deal with, including financial risk as well as regulatory risk, as mentioned above. The financial risk can vary based on what exactly the fintech specializes in. For example, a fintech offering financial services for student loans or mortgages may face counterparty risk that can be absorbed by a financial institution with large amounts of capital that a smaller startup would not be able to cover. Deploying robo-advisors for the wealth management of bonds, treasury bills, and stocks may expose customers to financial risk and the fintechs may have to take potentially serious responsibilities for any loss due to the algorithmic failure of the robo-advisors. Recent lawsuits and a number of settlements arising from the faulty sales of derivative products by top-tier banks indicate that fintechs will not be immune to the liability arising from robo-advisors' faulty investment advices.

Overall, it is crucial for fintechs to have a focus on risk management in addition to the technology management of the firm. As many fintechs were created after the 2008 financial crisis, they need to fully understand their exposure to liquidity risk, as well their interest rate risk. The present lending environment is vastly different from before due to the current ultra-low interest rate environment in the financial market, so it is important for fintechs that are involved in lending to recognize how the current lending environment will impact them.

8. Summary

Because fintech is such a recent development, there is still a paucity of studies on the social, regulatory, technological, and managerial aspects of fintech. This makes it very challenging for financial firms to make informed decisions in regard to the investment in fintech projects. This article is one of the first studies to develop a high-level architectural view of the fintech sector. We presented five elements of the Fintech ecosystem and discussed six fintech business models before explaining the real options approach. Finally, six challenges facing the fintech sector were discussed.

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