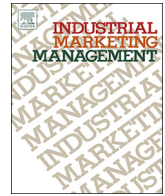




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Research paper

Big data analytics for supply chain relationship in banking

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ABSTRACT

This paper reports how a commercial bank in Asia uses big data analytic as a tool to explore the internal B2B data to improve supply chain finance and the efficiency of marketing tactics and campaigns. A case study was conducted by analyzing two types of supply chain relationships: (1) supply chain relationships in the credit reports; (2) e-wiring transactions among supply chain companies. The results show that big data analytics is very useful in terms of improving the commercial banks' marketing and risk management performances. The case study also set a good example for B2B firms seeking to understand how they could leverage big data analytics to differentiate customer solutions, sustain profitability and generate new business values. Theoretical and practical implications are also discussed.

1. Introduction

Two main purposes of a marketing campaign are to retain existing customers and to acquire new customers. Many businesses are recognizing the significant role that big data analytics could play in growing customer loyalty and in marketing, especially for the banking industry (Hassani, Huang, & Silva, 2018). The major two divisions in the banking industry are personal and corporate banking. The former provides services to individuals, and the latter focuses on corporate customers. Many banks systematically track and store large amounts of customer data (Ghafari & Ansari, 2018). However, regarding the idea applying big data analytics in marketing, this effort has been mainly focused on personal banking (Hassani et al., 2018; He, Wang, & Akula, 2017). Since corporate banking is the major revenue source for most banks, their applications of data analytics have been limited to risk management only (Choi, Chan, & Yue, 2017).

The term “supply chain” has been defined as “the integration of key business processes from end user through original suppliers that provides products, services, and information that add value for customers and other stakeholders” (Lambert, Cooper, & Pagh, 1998). That means that each of corporations is a node in the supply chain network. As the results of internationalization, supply chains might stretch across the globe with multinational buyers and suppliers. Corporations are under pressure to unlock the working capital trapped in their supply chains. Banks' supply chain finance, also known as “supplier finance” or as “reverse

factoring”, is a set of solutions that optimizes cash flow by allowing businesses to lengthen their payment terms to their suppliers while providing the option for their large and Small and Medium-sized Enterprises (SME) suppliers to get paid early (Bogdan & Sava, 2018). Nowadays, all business activities can be tracked in terms of cash and information flows, which are usually completed electronically among different bank accounts, either within the same bank or across different banks. These business activities can be utilized to establish a specific company's supply chain, and then can be extended to a larger supply chain network by including affiliated or upstream/downstream companies along their related supply chains. Such information was mainly limited to risk management like fraud detection (DuHadway, Carnovale, & Hazen, 2017) or like loan early warning (Wang, 2017). Since its supply chain activities reflect a business's operations, banks should explore other potential applications by analyzing the data. Lilien (2016) found that most of the B2B data have not been analyzed in meaningful ways to identify potential corporate customers or to improve business offerings to existing corporate customers along the business's supply chains. That means that banks or financial institutions do not know how to effectively utilize big data analytics to identify potential corporate loan customers via supply chain relationships or how to differentiate their product and service offerings for existing customers. Thus, this study aims to illustrate how a bank can identify potential customers via analyzing supply chain relationships. Our specific research questions are:

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1. How can big data analytics be leveraged to identify potential corporate customers, and how can business offerings to existing corporate customers be improved via supply chain relationships?
2. What additional lessons can be learned from the aspects of analytics and marketing campaign implementation?

We believe that the results of this case study will set a good example for banks or other types of financial institutions seeking to understand how they could leverage big data analytics to differentiate customer solutions and to sustain profitability via supply chain relationships.

This paper is organized as follows. In the next section, the literature review of related studies is presented. Next, there is a case study with background introduction, and the data collection procedure and data analysis are described. This is followed by the discussion section and then by the conclusion of this research.

2. Literature review

2.1. Big data analytics in banking

As business management becomes more and more complex due to internationalization and to new innovations, business administrators need better support for decision making. That is why data-driven decision making is becoming increasingly important (Tiwari, Wee, & Daryanto, 2017; He, Zhang, Tian, Tao, & Akula, 2019). For companies, there are two major trends in big data analytics: (1) current companies rely on big data analytics to identify new opportunities, to improve current products or services, and to optimize internal processes (Kaisler, Armour, Espinosa, & Money, 2013); and (2) new companies rely on big data analytics to develop innovative products and services (Zhang, Ren, Liu, & Si, 2016). The banking industry can be considered an early adopter in data-driven decision making. Big data is a term that “describes large volumes of high velocity, complex and variable data that require advanced techniques and technologies to enable the capture, storage, distribution, management, and analysis of the information.” (TechAmerica Foundation's Federal Big Data Commission, 2012). As a bank stores a large collection of customer's demographics, behavioral, and transactional data, big data analytics have been proven to be very useful in terms of improving the marketing of commercial banks (Sun, Morris, Xu, Zhu, & Xie, 2014), as well as their risk management performance (Rahman & Iverson, 2015). However, regarding the application of data analytics in marketing, most of the efforts have been limited to personal banking (often called retail banking) only (Hassani et al., 2018). The most common marketing models are (1) customer lifetime value prediction, the predicted monetary value that represents the amount of revenue that a customer will provide the business over the lifetime of their relationship (Moro, Cortez, & Rita, 2015); (2) customer clustering, a model, used in customer relationship management, that aims to classify customers based on attribute similarity (Ma, Baer, & Chakraborty, 2015); and (3) product affinity prediction, the model that predicts a customer's preferred products or services by analyzing his/her historical transactions and profiles (Dash, Pattnaik, & Rath, 2016). Since corporate banking is the major revenue source for many banks, applying analytics in the corporate banking marketing realm has not yet attracted much attention. Instead, because corporate banking usually involves larger transactional amounts per customer when compared with personal banking (e.g. corporate loan vs. personal loan), research efforts in corporate banking have been focused on risk management.

Studies have found that the key success factor of the corporate banking lies in the management of customer relationships (Turnbull & Gibbs, 1987). The risk-aversion trend has the following reasons. It is noted that the corporate banking market is considerably more valuable and more complex, since a company usually works with multiple banks at the same time. In addition, the relationships between a bank and its corporate customers are more frequently and more closely examined

than those of personal banking customers (Guo, 2018). For the case study reported in this study, the total number of banks was increased by 5 times due to the financial deregulation in 1990s. Customers can find a bank branch every 3.7 km² and an ATM every 1.32 km² on average (Hung & Luo, 2016). As one corporate customer might have several corporate loan accounts with different banks, banks have the desire to establish long-term relationships with corporate customers in order to gain a moderate or a greater share of the financial market and of the customers' business (Heinonen, Johnson, & Peterson, 2014). In addition, retaining an active existing corporate customer is much cheaper than acquiring a new customer (Ennew, Binks, & Chiplin, 2015). Therefore, most banks have been investing more efforts in maintaining existing corporate customers than acquiring new customers. The other reason is that corporate customers involve larger transaction amounts. One default loan from a corporate customer is much more serious than the default of an individual's personal loan. Therefore, for corporate customers, research efforts have been focused on risk management (Valverde, Solas, & Fernández, 2016), and include additional managerial or monitoring mechanisms to decrease information asymmetry (Cycon, 2018) as well as better credit evaluation to exclude high-risk corporations (Beccalli & Poli, 2015). In the era of big data analytics, advanced analysis methods and the inclusion of non-traditional data (such as non-financial data) have also been adopted, in order to further improve credit evaluation or dynamic monitoring (Zhang & Pang, 2019). Due to the rapid development of technology, some of the existing banks are adopting big data analytics to enhance their competitive strength in order to better deal with challenges from FinTech companies (Trelewicz, 2017). One competitive advantage, for existing banks, is that they own a large amount of historical customer data. However, it is questionable whether a bank can convert these data into actual benefits (Liu, Liu, Xiao, & Eltabakh, 2018). According to resource-based theory (Barney, Ketchen, & Wright, 2011; Slotegraaf, Moorman, & Inman, 2003; Vorhies & Morgan, 2005), understanding collectable or collected business/consumer related data resources, and finding out an appropriate way to utilize them, are key ways to attain a competitive advantage (Gupta & George, 2016; Marr, 2015). For example, airlines such as Southwest are using insights from big data to facilitate its dynamic capability to deliver excellent customer service and meet unrecognized customer needs (van Rijmenam, 2013). Southwest has used speech analytics to analyze live-recorded interactions between customers and southwest personnel to identify customers' needs/issues and staff's corresponding responses. The extracted knowledge was used for training to better understand various customer demands/issues and improve customer relationship management. Another example is American Express (Amex). Amex understood that mobile geotargeted advertising requires accurate geolocation data. Therefore, Amex partnered with Foursquare which is a technology company to collect users' real-time locations via their sharing and checking-in behaviors on the social networking site. Amex can achieve the goal of geotargeted advertising by combining Amex's customer purchase history, other preferences revealed by analysis, and customer's geolocations (Deutsche Bank, 2014).

To enhance a competitive advantage in marketing, a bank can explore the following three steps: first, it can understand what has been collected in its data warehouse; second, it can extract insights from stored data; and finally, it can utilize these insights to enhance dynamic/adaptive capabilities (Erevelles, Fukawa, & Swayne, 2016). Nowadays, the ratio of electronic payments, which involves information and cash flow transactions within the same bank or between banks, is rising (Asokan, Janson, Steiner, & Waidner, 2000). Commercial banks can identify potential corporate customers by tracking the accumulated cashflow transaction data of existing corporate customers. These transactions reflect a corporation's operations and can be used to support a customer's credibility (Wang & Gao, 2018). It is especially important for new SMEs who have just entered the business and have not yet shown good numbers on their financial statements. These new

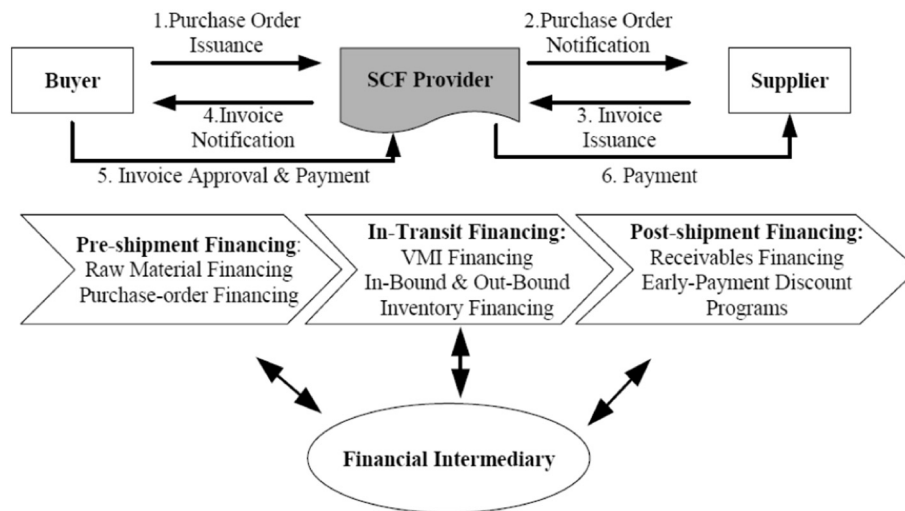


Fig. 1. The Framework of SCF.

SMEs might not be able to pass a bank's credit evaluation, in order to obtain a corporate loan. However, since supply chain finance's credit evaluation focuses on buyers in the supply chain, it is an alternative financing source for new SMEs, if they are vendors of one of the bank's trustworthy corporate customers (Song, Yu, & Lu, 2018). The next section will provide more detailed information on supply chain finance.

2.2. Supply chain finance

Supply chain finance (SCF, hereafter) is an emerging topic at the intersection of logistics, supply chain management and financing (Hofmann & Johnson, 2016). Hofmann (2005) defines SCF as “an approach for two or more organizations in a supply chain, including external service providers, to jointly create value through means of planning, steering, and controlling the flow of financial resources on an inter-organizational level”. In the past decades, many companies have implemented SCF as a solution for optimizing cash flow and improving supply chain-wide financial health and stability. SCF represent a combination of financial services and technology tools that provide short-term credit to optimize working capital for businesses (Lamoureaux & Evans, 2011, 2011; Carlo & Menno, 2014). Fig. 1 shows a framework which lists possible SCF services in the business activities (More & Basu, 2013). It involves three parties in each transaction: the buyer, the supplier, and the financing institution (i.e. SCF provider). The SCF provider in the Figure can be transitional financial institutions or FinTech companies which provide SCF services via traditional application documents or online platforms. The basic types of SCF can be classified into pre-shipment financing, in-transit financing, and post-shipment financing. The post-shipment financing is also known as “supplier finance” or as “reverse factoring.” The suppliers (or sellers) sell their invoices or receivables at a discount to SCF providers. In return, these sellers gain faster access to the money that they are owed, which can be used as working capital. At the same time, the buyers usually retain a lengthened payment term. The banks also get the benefit of collecting the money directly from buyers, rather than counting on the creditworthiness of the supplier. When the buyer has a better credit rating than the supplier, the SCF allows the supplier access to a larger financial capacity at a lower cost, by leveraging the buyer's stronger credit rating (Schofer & Fowler, 2017). To optimize the financing efficiency of SCF, financial institutions need to gain knowledge about a corporate buyer's creditability by analyzing its accumulated cash flows. Therefore, bank prefers to provide post-shipment financing to a large manufacturer (e.g. Apple), so they can count on the manufacturer's creditworthiness, rather than its hundreds of individual suppliers, especially when these suppliers are relatively smaller with lower credit ratings.

In-transit financing aims to turn in-transit inventory into cash. For example, an importer can turn imported overseas goods into working capital. Once the inventory is loaded on the ship, the exporter sends the bill of lading, commercial invoice and proof of insurance (if exporter paid) to the importer, the importer can forward these documents to SCF providers for monitoring and can draw on his/her available credit under his/her inventory-in-transit facility at any time.

Pre-shipment financing is another common type of SCF aiming to convert supplier's non-liquid assets (such as raw materials, inventory, account receivable, etc.) into cash (Vousinas, 2019). With the development of the online B2B platform, electronic invoicing, and e-wiring services, most of the payment processes can be made electronically and can be tracked by banks or by B2B platforms (Bogdan & Sava, 2018; Vousinas, 2019). That means that SCF providers can better track and monitor business operations and can open opportunities to smaller companies, even to those which cannot provide complete, well-prepared financial statements (Tsai & Peng, 2017).

2.3. The SCF market

In the past decade, the market of the SCF sector has maintained strong demands, and this trend has resulted in many successful business applications. PrimeRevenue, a supply chain finance platform, has an operations processing volume of \$7 billion worth of invoices each month (Elms, Hassani, & Low, 2017). In addition, leading banks have also partnered with Fintech companies to set up their SCF services. For instance, HSBC and Santander have formed an alliance with Tradeshift, an invoicing, finance, and procurement network, to connect with over 1.5 million buyers and suppliers worldwide (The Economist, 2017). Further, multinational corporations are seizing many new business opportunities in emerging markets through the SCF platform. Apple, Colgate, Dell, P&G, Kellogg's, and Siemens are working with FinTech companies to increase capital available to their whole supplier ecosystems (Rogers, Leuschner, & Choi, 2016). A business case study conducted by the Aite Group (Camerinelli & Schizas, 2014) reported that 80% of business-to-business transactions were carried out on credit terms, and that trade credit constituted 37% of the total business assets in the United Kingdom. The use of receivables as assets through an SCF platform is an effective way to optimize the management of the working capital and the liquidity tied up in supply chain processes for collaborating business partners.

2.4. Research in SCF

The supply chain processes contain three important flows: the

material, the information, and the cash flows (Tang & Musa, 2011). With the development of the online B2B platform, electronic invoicing, and e-wiring services, the ratio of trackable cash flow is rising, as well (Schoenherr & Pero, 2015). Therefore, there is an increasing amount of effort spent on applying analytics in supply chain research (Waller & Fawcett, 2013), especially in the risk management. For banks, risk management has been aimed at addressing various issues in B2B transactions. Those issues could be identified and classified as the potential risks associated with material, cash, and information flows (Tang & Musa, 2011). Material flow risks arise either from the problems of coordinating supply and demand or from the disruptions to normal activities (Kleindorfer & Saad, 2005). Cash flow risks vary with the fluctuations of the cash inflows, outflows, and netflows in each period of a planning horizon (Tsai, 2008). Information flow risks cover various issues, including information accuracy, information system security and disruption, intellectual property, and information outsourcing (Faisal, Banwet, & Shankar, 2007; Tang & Musa, 2011).

The other risk management trend is the inclusion of non-traditional data sources and advanced analytic methods in SCF's credit evaluations (Fu & Zhu, 2016), especially in SCF services offered by FinTech companies (Li, 2018). Traditionally, banks have long-term relationships with buyers in the SCF, and these corporations have been evaluated and monitored periodically before they offer SCF services to their sellers. However, as FinTech companies which offer SCF services, their target customers are SMEs (including sellers and buyers) (Chen, 2016). These companies, usually, do not complete detailed financial statements. Therefore, these platforms need to rely on additional data and on robust analytic methods to improve the quality of credit evaluation (Zoran, Tatjana, & Aleksandra, 2018) by building a robust fraud detection and prevention mechanism to tackle possible risks. According to a Deloitte poll, the use of analytics to mitigate third-party fraud, waste, and abuse risks in supply chains jumped to 35% in 2017, compared to its level of 25.2% in 2014 (Deloitte, 2017). Zainal, Som, and Mohamed (2017) reviewed existing computer platforms such as spreadsheets, big data, forensic analytics, text analytics, and expert systems to detect and prevent digital fraud. They suggested that, to curb fraud, expert systems are the best option among the alternative tools available. Researchers have also recommended that the application of a Benford analysis (Clearly & Thibodeau, 2015) could support forensic analytics, to detect supply chain fraud (Kraus & Valverde, 2014; Varma & Khan, 2012). The Benford analysis approach identifies abnormally mismatched data in an excel sheet, and helps to locate fraudulent transactions on a dataset of a supply chain network. This could help the commercial banks to detect and to prevent financial fraud within a short time span. More research efforts are needed to develop robust fraud detection and prevention systems, in order to reduce the risk of fraud in supply chain finance.

Some FinTech companies collect front-end data, which includes transactional data from SMEs' customers and competitors, actual sales, and customers' reviews, for credit evaluation (Kharif, 2016). For example, Alibaba utilized transactional, behavioral, rating, and profile data for credit evaluation (Li, 2018). JD Logistics combines a corporation's financial data and material flows tracked by IoT technology, as well as payment information, for its credit evaluations (Tsai & Peng, 2017). The Ping An Bank chose to collaborate with third-party companies to obtain additional data like invoices, tax records, and receipts from water and electricity spending, in order to better understand a corporation's operations (Zhou, S, & Yang, 2016).

The literature review shows that banks should look for innovative ways to better utilize their B2B customer data, especially in the realm of marketing. However, due to the unique characteristics of corporate banking, there are some special considerations in corporate banking marketing, as compared with the retail industry.

3. Case study

As precision marketing and risk management are two major

applications of big data analytics in personal banking (Jagtiani, Vermilyea, & Wall, 2018; Sun et al., 2014). The literature review shows intensive studies have been focused on the discussion of innovative SCF services offered by FinTech companies (e.g. Kharif, 2016; Li, 2018; Tsai & Peng, 2017; Zhou et al., 2016). In addition, studies have been focused on the risk management in SCF, rather than marketing. Therefore, the purpose of this study aims to describe how a large commercial bank in Asia combined multiple data sources to establish and to expand its customers' supply chain network and how it actively used those analytic results for corporate banking marketing. Case study was adopted as the research method for this study because it can provide in-depth and contextual understanding about the phenomenon of the target case. Yin (2017) defined a case study is "an empirical method that investigates a contemporary phenomenon in depth and within its real-life context, especially when the boundaries between phenomenon and context may not be clearly evident". The case study research method allows researchers to focus in-depth on a case or cases. It is commonly used in many social science disciplines and the practicing professions such as business, social work and education (Yin, 2017). Many researchers in the business domain successfully use the case study research method to study real business situated issues (Eriksson & Kovalainen, 2015).

To answer the two research questions proposed in the introduction section, the case study starts with the descriptions of the case background, data sources, and processes of the supply chain network construction. A campaign was implemented, based on the supply chain network, to acquire new customers of corporate loan. The details about the campaign design, the implementation, and outcomes were reported in the case study as well. Lessons learned from the case study and implications were discussed in the discussion section.

3.1. Case background

The target bank (ABC Bank, hereafter) is under a financial holding company and is ranked as one of the top 250 banks worldwide. Its headquarters is in Asia, and it has 190 branches, 34 overseas branches/representative offices, and over 7000 domestic employees. Overall, ABC Bank's strength is in corporate banking, especially in SME loans. Until the end of 2018, the bank's active corporate customers numbered about fourteen thousand companies. Here, "active" means that the corporate customer had completed at least one active transaction in the past six months. Among the fourteen thousand companies, about 35,000 companies (25%) applied the e-wiring service, which allows corporates to schedule online payments to corporate accounts. Table 1 shows the statistics of e-wiring transactions in 2016.

3.2. Analysis

The purpose of the analysis aims to establish and expand the supply chain network relationships of the ABC's corporate customers. The supply chain relationships come from the following sources: (1) affiliated or upstream/downstream companies on a corporation's credit report; or (2) e-wiring transactions to upstream or downstream companies tracked by ABC Bank. A corporation has the obligation to reveal important affiliated companies, major downstream/upstream companies, and the list of the members of its board of directors, when it files a loan application. Fig. 2 lists the data collection and the data analysis

Table 1
Statistics of e-wiring in 2016.

Category	Statistics
Transaction frequencies	175,290
Average number of wiring receivers	9.6
Average number of wiring per receivers	5.9
Average wiring amount per transaction	\$33,000
Average registered capital amount per receiver	\$9,110,700

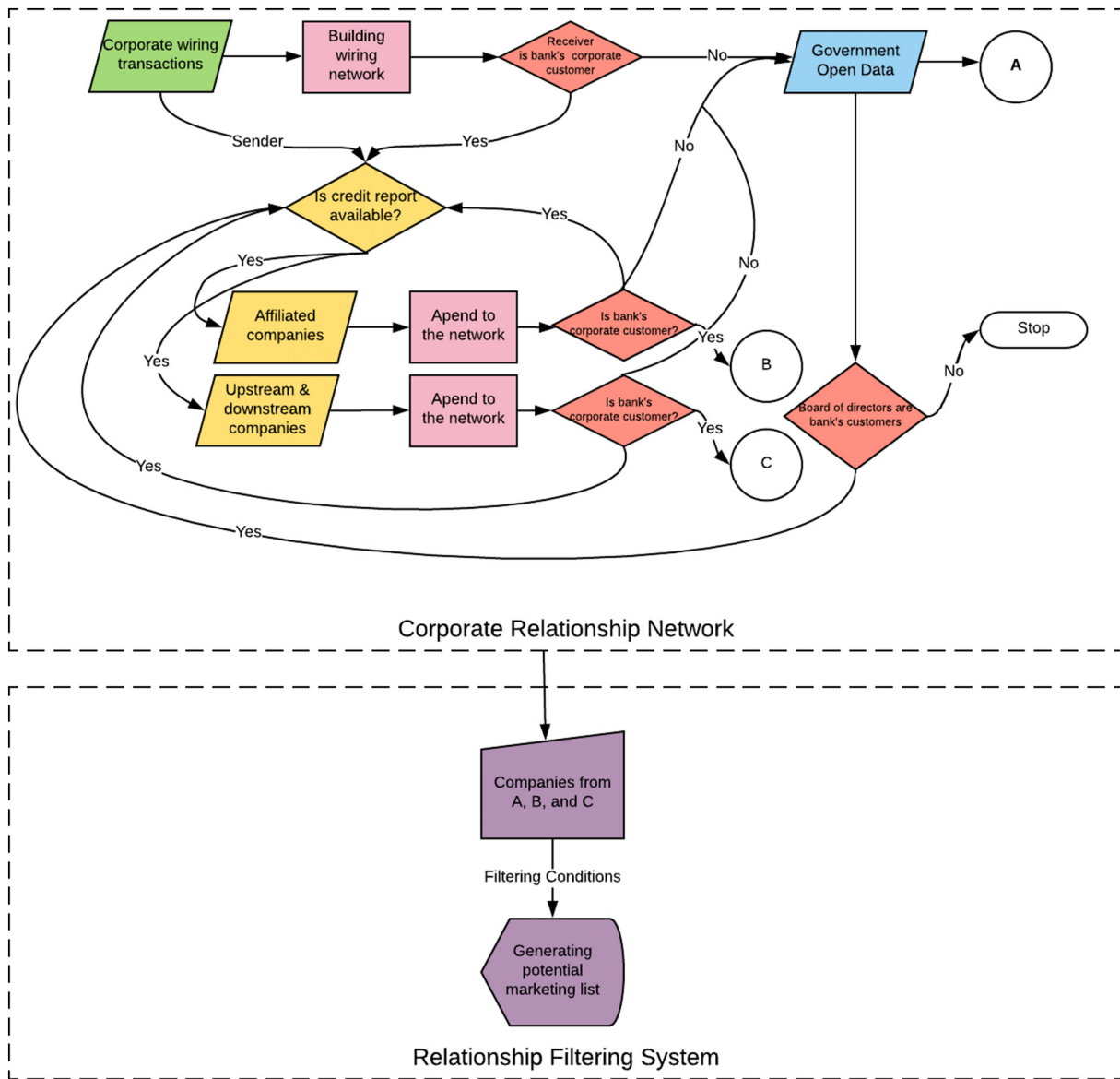


Fig. 2. The Analytic Flow of the Supply Chain Network.

flows. First, an e-wiring network is developed, using all online wiring transactions among companies. The senders of these wiring transactions are ABC Bank's corporate customers. The analytic flow examines whether the receivers are ABC Bank's corporate customers, as well. If the answer is No, then the list will become a partial list of A. If the answer is Yes, then the analytic flow checks whether sender's or receiver's credit report is available. If the sender/receiver is ABC Bank's corporate customer, and the credit report is available, then affiliated and downstream/upstream companies can be retrieved from the report. These affiliated and downstream/upstream companies will be appended to the wiring network. At the same time, if affiliated and upstream/downstream companies are also ABC Bank's corporate customers, the analytic flow will loop back to search for corresponding credit reports. If not, these companies will be merged into List A. The loop will continue until all potential customers have been identified via the credit reports (Lists B and C).

List A includes companies identified via various relationships, but they are not ABC Bank's corporate customers. E-wiring transactions or credit reports are required to include a company's Tax ID, which allows a search of the government's open data for company's contact information. The contact information contains the name of the company's

president, a list of the members of its board of directors, the company's phone number, the company's address, and its registered capital amount. The next step checks whether the members of the board of directors are ABC Bank's personal banking customers or if they own other companies. If the answer is Yes, then it continues to search whether the credit report is available, and the loop will continue until all potential customers have been identified. If the answer is No, then the analytic flow stops. Fig. 3 shows the results of the initial network (i.e. the list of potential customers), which contains 225,733 companies. Compared with the original 35,000 customers upon opening the e-wiring service, the analytic flow expands the network 5.4 times larger.

Fig. 3 can be further used to generate potential customers by applying filtering conditions. For example, Fig. 4 shows the network of corporations with at least eight annual wiring transactions and over 13,500 USD total wiring amounts. The network contains 1621 current corporate customers (green nodes). The other 2563 companies were non-ABC Bank customers (purple nodes). Both types of companies can be potential customers for marketing campaigns. Fig. 4 shows that more than half of the companies were not ABC bank customers. How to select potential customers with higher responses and higher credit approval rates are the major goals of the follow-up analysis.

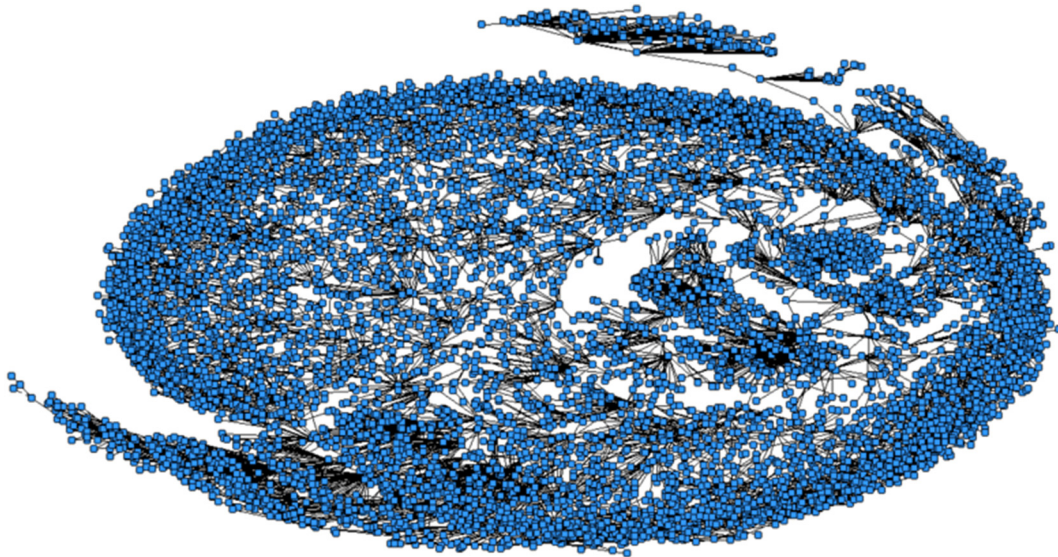


Fig. 3. Results of initial network.

3.3. Campaign implementation

Because the corporate loan is the most profitable product in corporate finance, the first campaign aimed to identify potential corporate loan customers. However, if the potential customer does not need a corporate loan, the account official will introduce other corporate financial services. The campaign list was generated with the following filtering conditions:

- Identify companies with at least 50 million in USD loan amounts as the core companies. Limit the search scope to the companies which had supply chain relationships with these core companies. (Most of these core companies are exchange-listed companies, and this condition promotes target potential companies' credits and enhances the credit approval rate.)
- Possible supply chain relationships include: (1) affiliated companies with or without wiring transactions; (2) upstream/downstream

companies with or without wiring transactions; (3) inbound or outbound wiring transactions with the core companies only.

- Exclude companies whose tax IDs or contact information cannot be located.

The first round of implementation selected 4800 companies. Table 3 lists the distributions of these 4800 companies, which were assigned to account officers at all domestic branches. Because corporate finance usually requires a longer time to interact with customers, to prepare application materials, and to review and approve applications, the implementation period lasted nine months, during 2017. Table 2 lists the numbers of potential companies and their relationships with the core companies. Based on Table 2, it is clear that most of the potential companies had only one relationship with the core companies: (1) companies with an affiliate relationship only (34.4%), (2) companies with an upstream/downstream relationship only (12.7%), or (3) companies with an e-wiring transaction relationship only (50.3%).

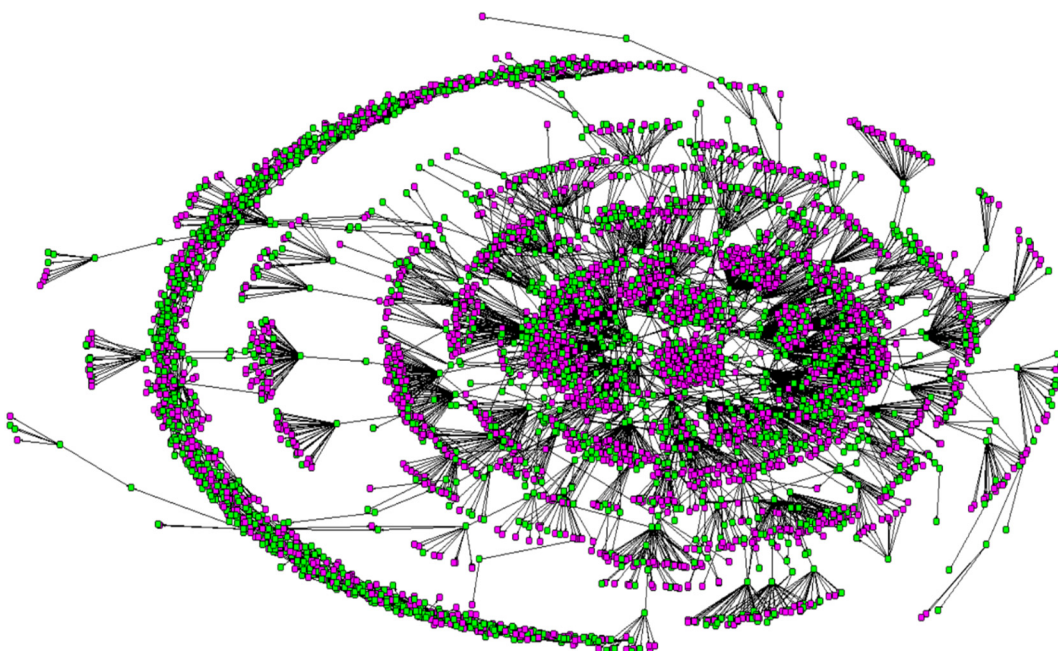


Fig. 4. Network after applying filtering conditions.

Table 2
The distribution of potential companies.

Affiliated relationship	Upstream/downstream relationship	Wiring relationship	Percentage
Y	Y	Y	0.1%
		N	0.6%
	N	Y	1.1%
N	Y	N	34.4%
		Y	0.9%
	N	N	12.7%
		Y	50.3%

4. Results

Table 3 shows the campaign results by checking the response and the approval rates. Traditionally, account officers were used to check into the yellow pages or the list of companies within their branch's region to identify potential customers. They were also required to input their contact histories with these potential customers into the salesforce system. The baseline response rate is the number of applied companies divided by the total number of contacted companies. The baseline approval rate is the number of approved applications divided by the number of submitted applications. Both are the indicators to evaluate the effectiveness of this campaign. Based on Table 3's results, it is clear that both the response and the approval rate were significantly higher than the baseline rates. ABC Bank approved almost all of the applications in the campaign.

Fig. 5 shows the results of a decision tree analysis which analyzed what kind of companies responded to the campaign and applied for a corporate loan (since it was the major target product of this campaign). The results show the average rate of response to the corporate loan was 2.17% (104 companies). The response rates were higher if these potential customers already had a corporate account at ABC Bank. If their experience with ABC was longer than 4.5 years, then the response rate was 1.96%. However, if their experience with ABC was shorter than 4.5 years, the response rate increased to 15.35%. The condition, plus at least one wiring transaction, increased the response rate to 20.66%. It decreased to 9.35% for companies without any wiring transactions.

For companies with a longer experience with ABC Bank (longer than 4.5 years), the average response rate was 1.96%. The response rate increased to 9.52% for companies with at least 3.5 of ABC Bank's corporate product holdings. The response rate decreased to 1.71% if the product holding was less than 3.5. For companies that were only listed on the core companies' credit reports (i.e., with zero corporate product holdings), the response rate was zero. Finally, for companies with wiring transactions, but which had not been ABC Bank's customers before the campaign began, the response rate was 1.25% (still higher than the baseline).

5. Discussion

Traditional banks and Fintech companies might choose to collaborate or compete with each other (Hung & Luo, 2016). Traditional banks look for new technologies to maintain their competitive strength, when they are facing challenges from FinTech companies (Hung & Luo, 2016). FinTech companies might have creative ideas to design and develop innovative products and services. However, the challenge is how to attract customers to use their innovative services. However, for

Table 3
Results of campaign response and approval rates.

Financial Services	Baseline response rate	Baseline approval rate	Campaign response rate	Campaign approval rate
Corporate loan	0.98%	48.1%	2.17%	89.4%
Other financial services	2.67%	73.6%	3.75%	100%

existing banks, one advantage is the large number of existing customers and the generated historical data. The case study reported here demonstrates how a bank utilizes the stored data resources for customer acquisition (Gupta & George, 2016). The discussion will focus on two research questions: (1) How can big data analytics be leveraged to identify potential corporate customers and to improve business offerings to existing corporate customers via supply chain relationships? (2) What additional lessons can be learned from the aspects of analytics and marketing campaign implementation?

5.1. The unique characteristics of corporate customer marketing

Compared with personal banking, customer relationship management in the corporate banking is more complex and time-consuming. In this case study, we can observe the following unique characteristics of corporate banking:

- A longer implementation period and a lower response rate: Compared with personal banking marketing, corporate banking marketing requires a longer implementation period, because each customer needs multiple visits, longer discussions, and more application materials. Because the process involves more complex considerations at both ends (bank and corporate), the response rate is usually lower than that for personal banking marketing.
- Precise marketing with risk-aversion consideration: Risk management is the core of the banking industry. The case study shows that potential customers increased by 4.4 times (compared with the number of existing customers) via assorted relationship connections. In the corporate marketing, risk is an indispensable factor which should be considered when generating the list of customers for marketing. Otherwise, even a corporation which might be interested in a corporate loan might not be approved after the bank's credit evaluation.
- Supplementary information to boost the response rate: The summarized relationship information regarding the target company and its relationships with the core and with other corporate customers was provided to the corporate banking officer. That allowed the officer to design a strategic plan and to customize services before visiting the target company. Based on the results, this action also boosted the response rate.
- A growing supply chain network: When new customers are converted, they also bring new relationships with new potential customers. That means that the supply chain network keeps growing, as more marketing efforts are spent in this approach.

5.2. The type of customers with a higher response rate

The relationship network was generated by analyzing the following three supply chain relationships: (1) affiliated companies, (2) upstream and downstream companies, and (3) e-wiring transactions. When the scope is limited to companies with any one of above relationships with the core companies, the results show that both the response and the approval rates are significantly higher than those in the past. The core companies had long-term relationships with ABC Bank, so when account officers contacted these potential customers, both ABC Bank and potential customers had at least a common connection (i.e., the core companies). Therefore, the success rate was significantly higher. In addition, because these potential customers showed stable relationships

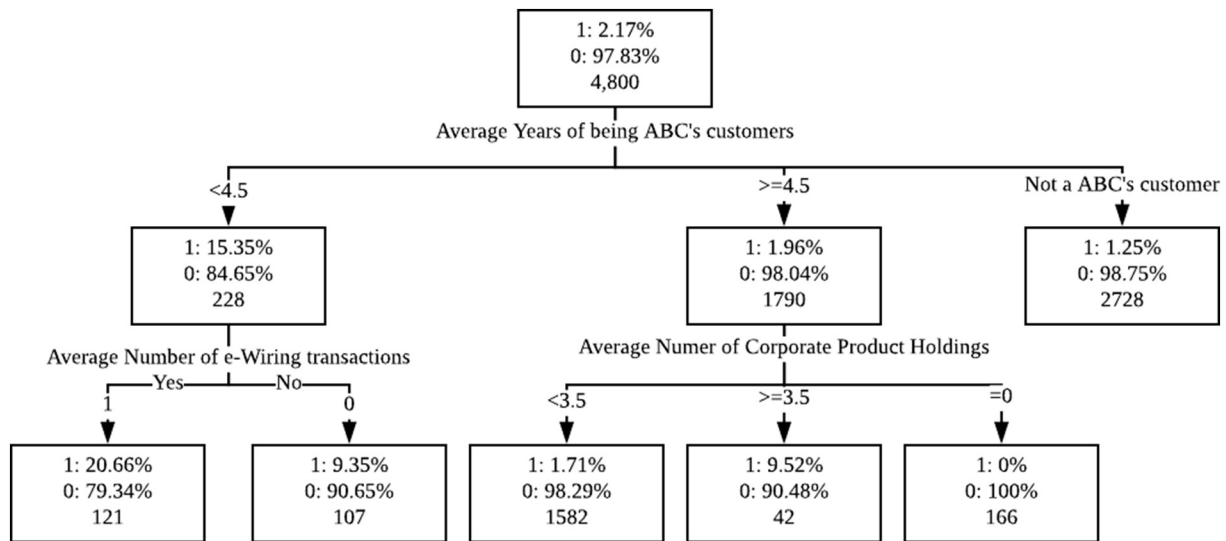


Fig. 5. Companies which responded to the corporate loan in the campaign.

with these core companies, the loan approval rate was also significantly higher than the natural baseline. Unlike banks that have more complete customer profiles, historical wiring records, and account activities, most of the FinTech platforms track transactional data only (Song et al., 2018). That means that banks own more detailed data in the credit evaluation and can develop the Supply Chain Network for other applications (Sawers, 2017).

Based on the results, relatively new existing customers (those with less than 4.5 year) with wiring transaction relationships showed the highest response rate. The second highest group was relatively older existing customers (those with more than 4.5 years) with more than 3.5 product holdings (no corporate loans). The third highest group was relatively new existing customers without a wiring transaction relationship. Therefore, for ABC Bank, attracting companies to open a checking or a saving account as a starting point is crucial, as these companies can start using the e-wiring service. On the other hand, older companies might have been contacted by the account officers, so the success rate is lower unless these companies had already made use of several of ABC's corporate banking services. In summary, the wiring transaction relationship promoted the success rate, especially when they potential loan customers were already existing ABC Bank customers. In addition, an increase in the number of relationships with the core companies, or with the bank, showed a higher response rate, as well.

An intensive literature search has shown successful stories about the Fintech companies in SCF (Fenwick, McCahery, & Vermeulen, 2017; Song et al., 2018). Our study reveals how traditional banks can respond to challenges via analytics. Most banks should have more corporate customers and historical customer data than Fintech companies. The key becomes whether banks can convert data into revenue.

5.3. True and false supply chain relationship

From the aspect of analysis, wiring transactions cannot always be regarded as a supply chain relationship. For example, a shipping company might show many inbound wiring transactions, since it provides shipping services to the core company. Therefore, it cannot be regarded as a potential customer, due to its not having a supply chain relationship. However, if the wiring transactions occur among companies within the shipping industry, then these transactions can be regarded as supply chain relationships. Because the strength of wiring transactions was calculated by the wiring frequencies and the wiring amounts, non-supply chain transactions should be excluded from the computation.

5.4. Other possible applications

The relationship network can have other possible applications. For example, in the constructed network, there were 117 companies which had wiring transactions with more than 100 companies. In addition, 95 out of the 117 companies had at least 10 million USD in registered capital. ABC Bank is contacting these companies for more advanced SCF. Because the process is sophisticated, and involves companies' ERP systems, the campaign (supply chain + sale chain finance) is still ongoing.

5.5. Implications

The discussion presented in this paper provides several insights for both theory and practice. In terms of theoretical implications, the study provides a concrete real-world case to support the resource-based theory in the Big Data Era, which advocates that big data analytics should be considered by banks as key resources in attaining a competitive advantage (Gupta & George, 2016). Since Big Data is a new source of capital in today's marketplace and is also a great source of idea generation for product development, customer service, and so on, organizations that do not develop the resources and capabilities to effectively use Big Data will have a hard time to survive the Big Data revolution (Erevelles et al., 2016). Due to the unique characteristics of corporate banking, marketing considerations are different from personal banking. Because corporate loan must be approved via credit evaluation, the selection of potential customers should take risk into consideration to raise the approval rate. In addition, the campaign response rate indicates the importance of customer relationship management in corporate banking. As marketing research in banking industry has been focused on personal banking, more research efforts are desired to focus on the B2B marketing.

In term of practical implications, banking firms can learn from our findings to improve their finance services by 1) providing convenient B2B e-wiring service and attracting potential customers in the supply chain to open a checking or a saving account. It is a good start point to manage potential corporate customers and these corporates can start to accumulate credits.; by 2) enhancing interactions with existing customers to strengthen relationships, as customers with higher numbers of product holdings also showing higher response rates; and by (3) better utilizing B2B data to generate more corporate banking applications.

5.6. Conclusion

Big data analytics has been widely adopted in personal banking marketing, especially in customer segmentation and profiling, in product affinity prediction, and in customer attrition prediction. This study shows a potential application of big data analytics by analyzing three types of supply chain relationships to identify potential corporate customers. Results indicate that the approach can significantly enhance a customer's response rate to the marketing campaign and can improve the approval rate. The relationship analysis can, then, be extended to more sophisticated applications, such as supply chain financing and supply chain risk detection.

5.7. Limitation and future research

This study shows a potential application of big data analytics in identifying potential corporate customers. The authors compared what types of customers had higher response rates and proposed our interpretation. However, we cannot prove our assumption by interviewing account officers and customers. The relationship network identified many potential customers and applied filtering conditions to generate the campaign list. Future research might focus on other filtering approaches, for better outcomes.

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