IMPACT OF BLOCKCHAIN TECHNOLOGY ON FINANCIAL SERVICES INDUSTRY: STOCK RETURN REACTION AND STRATEGIC ALLIANCE IMPLICATIONS

Vasiliki Mangini
ANR: 342674

Supervisor: Julio A. Crego

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Tilburg School of Economics and Management

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ABSTRACT: The study focuses on the impact of a blockchain implementation announcement on a firm's stock return. The tool used for measuring this effect is event study. Putting as the center of attention the financial services industry, I investigate 76 major banks, insurance companies and financial institutions. Abnormal returns are defined by using the widely known market model. As expected, the results show that financial services firms experience significant positive abnormal returns. In order to find to what extent a participation in a strategic alliance can affect the magnitude of this blockchain impact, a linear regression is specified. Its result show that the companies that participate in a blockchain strategic alliance experience more positive abnormal returns than otherwise. For a more complete understanding, I investigate the impact of the rating, region and sub-industry. I find that only rating and region matter to investors and thus bring positive abnormal returns to companies with higher rating and located in US.

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1 Introduction

1.1 Background

The world has seen a powerful change in the day to day life due to the technological evolutions. The most certain thing is that every one of us has been affected or influenced with the latest technology in a variety of ways. The financial services industry is no different from that and over the past decade has witnessed various reforms in regulation and the way in which traditional financial services interact with consumers. A big part of this reform has come from the developments in blockchain technology.

Blockchain has risen to become one of the most pioneering technologies of our times and plenty of analysts predict that it will cause as great disruption and change as the Internet (Morabito, 2017; Tapscott & Tapscott, 2016). This particular technology has already been developed a lot since its launch by Nakamoto in 2008, but nevertheless it's development is still in a very early stage (Tapscott & Tapscott, 2016). The effects of the disruption will impact a lot of industries, with the financial services industry being one of the first. Banks, insurances and financial institutions have already shown interest in the technology and the millions of its applications, which are able to decentralize the current financial system and change its core functions and services (Tapscott & Tapscott, 2016; Cocco, et al., 2017).

Blockchain is already revolutionizing the financial services industry as hundreds of new start-ups design new innovative financial products and services for customers. These newcomers are challenging the traditional financial services' model and framework. The technology now spreads across the segments of the financial market and along its value chain. Blockchain can undoubtedly be a positive development for the financial sector if handled correctly. This technology is able to lead to greater efficiency, better products and lower prices for consumers. It serves an opportunity for new start-ups to compete with the already established financial institutions, but without the costs of long administration processes and heavy infrastructure. However, this threatens to take business away from banks, insurance companies and investment institutions. Hence, incumbent financial services firms are trying to survive, enter new markets and have access to specific knowledge. Strategic alliances were always a strategic move when there is increased competition. Blockchain era is no different than that, thus we observe multiple firms and institutions to choose to participate in forms of alliances in order to collaborate on exploring this new technology and build a shared pool of technical standards, processes and information.

1.2 Problem Formulation

As previously mentioned, blockchain technology can impact and has already impacted the services and processes of financial firms. Yet, previous literature on blockchain has only focused on the technical processes of the technology and mainly on the changes to core business functions and services. Some studies are analyzing the challenges that plenty of organizations are facing when adapting this revolutionizing technology. Nevertheless, there are no evidences about the financial impact on an organization when the latter decides to adapt to the new era. Is this technology able to add value to the business? Does it have impact to shareholder's wealth? And if yes, to what extend? These are the questions I am answering in this study. More specifically, I study the impact of an implementation of a blockchain technology application on firms' stock returns.

Along with the above, I research whether the participation in a strategic alliance and the sharing of information and knowledge are making the shareholders to trust the firm's decision on blockchain or whether it is still intimidating to be transparent. In order for the technology to be successful, collaboration is needed in development and implementation. In fact, this is a perquisite for the technology of blockchain in order to be as effective, sustainable and functional as possible.

1.3 Research Question

Main research question: ***Does Blockchain adoption have an impact on stock returns?***

Secondary question: ***Do Blockchain strategic alliances help to achieve higher stock returns?***

1.4 Purpose

This study aims to identify whether the stock market reacts to the announcement of a blockchain adoption by a firm in the financial services industry. Additionally, it aims to determine the impact of creating a united infrastructure. The above mentioned effects are investigated from several perspectives that distinguish this study from previous. First of all, a recent database is used (2010-2017). Secondly, this study is focusing on a new specific technology and not in a technology implementation as the majority of the literature does. Additionally, it takes into account the current trend of the business community to collaborate in scope of new technology knowledge and implementation. Lastly, the study examines possible differences on the effects due to basic company characteristics and makes it possible to re-examine other studies who focus on IT investments in general, like the study from Oh et al. (2006).

1.5 Outline

This study is organized as follows. Section 2 presents the theoretical framework and literature review. Section 3 contains the data collection methodology and the methodology used in order to answer the research questions. Section 4 displays the results and lastly section 5 presents the conclusions and limitations of this research along with some propositions for future research.

2 Theoretical Framework

2.1 Blockchain Announcement

2.1.1 Literature Overview-Rationales For Blockchain Implementation

Blockchain is a fairly new technology and it has risen to become one of the most pioneering and disruptive technologies after the Internet (HBR, 2017). This is especially valid for the financial services industry, corrupting the perception of being the most conservative and robust industry (Hitt, et al., 1999). Technological developments of the past have provided high-cost efficiencies to businesses, as well as to consumers due to better management of information systems and automation of data processing (Kaisler, et al., 2013). However, multiple empirical studies have previously suggested that information technology (IT) investments and implementations do not benefit companies as much as a person would expect (Loveman, 1994; Bresnahan, 1986). The only thing to be sure of is that blockchain, like all prior disruptive technologies, can have beneficial but also detrimental aspects that are needed to be considered carefully.

Blockchain and FinTech innovation in general have several advantages and the potential to change the world of financial services.

Firstly, blockchain technology is able to reduce transactions costs. According to Hatzakis et al. (2010), the key activities of financial services involve large volumes, extensive customer heterogeneity, and repeated service transactions. The new FinTech products are changing all of the above. They create a new basis for coordinating trading across businesses and competitors and the new availability of services and products, with which the human involvement is decreased to the minimum on the purely transactional aspects, the cross-border breaks are reduced and new approaches for customer management and operational risks are created. Hence, these technologies can release financial institutions from relying on financial market infrastructures (FMIs) and improve their market efficiency.

Secondly, blockchain and particularly smart contracts aim at reducing the costs of monitoring and enforcement as for example "costs of trust" (Panisi, 2017). Blockchain currently exists as a peer-to-peer network in which all transactions are visible to all of the participants and the history of events cannot be changed by anyone without the consensus of the majority in the network. Hence, through that, there is provided an increased auditability and trust. Additionally, they provide a solid and secure system with no moment of failure. If there is a failure in any of the network members, the other members will continue to work perfectly, maintaining the efficiency of the system (EY, 2017).

In addition, blockchain technology can have a unique impact on the financial industry by increasing the efficiency through the simplification of global money remittance, smart contracts, automated ledgers and digital assets, as Peters and Panayi (2016) state. They, also, add that blockchain technology may find applications in a variety of areas like transaction processing, ledger administration, government cash management and clearing or settlement of financial assets. Agreeing with these, Underwood (2016) argues that blockchain is able to improve prior applications and deploy new that were up to this time uneconomical or impractical.

Regarding the value that is added by the blockchain investment or IT investment in general to the business, not too many studies have tried to link IT investments with the performance of the business. And those that have, a small number managed to find a relationship. Most commonly, the value of these investments comes from system quality, user satisfaction, information accuracy and the direct impact of the IT application on the performance of the activities that are affected (Datar, et al., 1993; Banker, et al., 1990). Apart from this direct impact, there might exist an indirect impact, as the investment may generate new investment opportunities for the firm. For example, investing in a new IT project can raise the ability of the firm to use this technology in future projects, hence it is affecting the firm's prospects in the future (Dos Santos, 1991). However, the value of potential investments in the future is usually ignored in research as well as in practice, as it is difficult to determine and measure it (Mason & Merton, 1985; Myers & Majluf, 1984), resulting in undervaluation of these projects.

Financial services is a unique and "sensitive" industry as it has its own rules and requirements. A lot of studies suggest that while technological innovation like blockchain implementation may be beneficial to a company or a young firm, yet most banking, insurance, and investment institutions are far from that. Hobijn and Jovanovic (2001) suggest that such an incumbent firm resists major innovative changes as the firm is more likely to have old physical capital on hand and thus, it faces an additional economic cost. It also may have old human capital, meaning that its managers may lack the awareness and its workers may lack the skills to implement the new technology. Their results show that US firms in the financial services industry face a huge fall in their market value when a technological innovation appears. Moreover, Hannan and McDowell (1984) support this view by stating that banks are less likely to adopt new technologies fast because of the stricter regulatory environment.

Specifically for blockchain, multiple financial researchers state that this new technology hides a lot of risks and drawbacks as well.

Firstly, the most debatable characteristic of blockchain technology is that it is not private. Ironically, as mentioned earlier, this is its advantage as well. While being a large network can bring a lot of benefits to a firm, it also can bring risks. Within blockchain, participants are anonymous, but transactions are still visible. This can make the customers not trust the system, meaning not trust the firm, as their private information can be visible to all participants. This arises the problem of information privacy and bear risks that require sufficient government regulation and controlling systems like the recently adopted General Data Protection Regulation (GDPR).

A second major flaw of blockchain is the infamous "51% attack". This term describes the security characteristic of this technology that lets the information to be credible if this information is provided by more than half of the network members, even if it is wrong. Consequently, these technologies must be monitored closely ensuring that no one gets such network power. This issue comes closely with the issue of human error. The information used by any blockchain system is, of course, going into the system from a human. This means that if a blockchain is utilized as a database, the input information must be of high-level accuracy and quality, as it may be used by all different parties of the network.

Moreover, despite the wide activity of blockchain, some specialists are not convinced that the implementation of this technology will be very smooth. They state that the challenge for firms is to successfully integrate the new systems with the already owned, making it especially difficult for large organizations (Deloitte, 2018). Along with these lines, financial institutions have heavy and old infrastructures for financial processing and lot of global regulations that need to keep up with, thus it will be really difficult to maintain a smooth transition into the blockchain age. That is why these project innovations are more likely to benefit FinTech firms more than traditional financial institutions (Laven & Bruggink, 2016). In order for such a revolutionizing technology to work, the businesses and their application work flow must be well-designed and well-tempered.

The last but definitely not least challenge that financial institutions have to deal with, regarding blockchain, is competition. Financial services' firms make extremely high profits from financial transactions. If these transactions suddenly become automated, instant and available from web-based applications or providers, then who would pay a bank or insurance to carry them out? In this concept, incumbent financial firms will lose value and their returns will decrease. However, research has shown that although the large volume of investment in FinTech and P2P start-ups make them more and more popular, the funding of those digitalized start-ups is more likely to have a positive effect on the returns of the traditional incumbent financial firms than a negative (Li, et al., 2017).

2.1.2 Literature Overview-Empirical Results

As earlier mentioned, blockchain technology is a recent development thus, little research has been conducted yet and there is no extensive literature on the exact impact of a blockchain announcement and implementation on the share price of a firm. Nevertheless, through the years, a number of studies have been made regarding the information technology announcements in general and their impact on the share prices of a firm. New IT implementations seem to be a very beneficial and value-generating strategy and one may expect that their effects on the company value are always positive. The literature however provides slightly mixed results.

Dos Santos et al. (1993) address the question: Do IT investments really influence the market value of the firm? In order to answer this question, they analyze the effect of 97 IT investment announcements on the common stock prices of finance and manufacturing publicly traded firms. They find that over the announcement period, there are no excess returns neither for the full sample nor for any of the industry subsamples, rejecting the perception that financial firms would experience greater positive impact due to the fact that an IT investment decision may be a major event for a financial firm, while it may not be for a manufacturing firm. However, their cross-sectional analysis reveals that investments which are classified as innovative bear a statistically significant average excess return equal to 1.03%, meaning that investors value more the innovative IT investments than catch-up (or imitative) investments, which have at best zero NPV.

Im et al. (2001) research the stock price and trading volume reaction with regard to an IT investment announcement and in the context of firm size, industry and time. The results of their 141-sample analysis indicate that there is no statistically significant impact on stock prices of larger firms. Contrariwise, there is a positive reaction of 0.25% for stock prices of smaller firms and consistent with Dos Santos et al. (1993), financial firms did not have a greater reaction to their market value from IT investment announcements than non-financial firms. Moreover, they identify that price reaction gets stronger over time and more specifically that smaller financial firms have more positive excess returns as the announcement gets more recent.

Chatterjee et al. (2002) conduct a study to find the possible differences in share price reactions between firms that implement IT infrastructure and the firms that implement IT applications. The study is conducted for 114 events and the results show that announcements for both investment projects cause positive abnormal returns (0.59%) and higher trading volume for the firms, with IT infrastructure to generate stronger results.

Oh et al. (2006) research the effects of 158 IT investment announcements depending on firm and IT characteristics and find significant changes in firm value and overall positive average abnormal returns equal to 0.14%. Consistent with these results, Dehning et al. (2003) study the value added from 355 announcements of transformational, like blockchain, IT investments and as previously, find positive abnormal returns (1.51%) for firms investing in IT with a transformational strategic role.

Finally, Chen et al. (2018), study the impact of FinTech innovation to the value of the firm by analyzing 7,139 patent fillings announcements. Their results show different share price reactions depending on the industry and the type of innovation. Specifically for the financial sector, FinTech innovation is considered value-generating, with the category of blockchain technology bringing the highest value with median value effect of $ 6,053 million.

Given the above theoretical and empirical literature, I expect a positive share price reaction for all firms, as blockchain technology has outstanding advantages for a business and is currently a trend.

2.2 Strategic Alliances

2.2.1 Literature Overview-Rationales For Strategic Alliance Formation

Firms form joint ventures or strategic alliances in order to work together, gain more value and increase their performance. To start with, the two concepts must be distinguished as there is a fundamental difference between them. A joint venture is a new company which is formed by the investment funds of other two or more companies. The new company is a stand-alone entity and has a business for itself, but profits are owned by the parents. On the other hand, a strategic alliance is a "partnership" or cooperation of a company (or more) with another company that usually has an expertise in the area that the former wants to expand to. Strategic alliances are formed usually when a firm wants to quickly gain expertise in a new area or technology. In the blockchain era, we observe mainly strategic alliances between a financial services' entity and a blockchain specialized company, but nevertheless, this study will focus on both forms of alliances, strategic and joint ventures.

Alliances or consortia are a very popular way for companies to work on blockchain technology and any technology in general. Companies choose to form and participate in alliances because of the multiple advantages they offer.

To start with, alliances are an easy way to remain current on technological trends and be ready to face new potential threats and entrants to the market. Through these, firms are able to gain new or enhance their already existent competitive advantage and obtain access to strategic resources in technology, operational efficiency or manufacturing techniques (Eisenhardt & Schoonhoven, 1996). Noteworthy is the fact that, according to Oliver (1997) these resources are the most infrequent to gain and usually they cannot be replaced. Additionally, alliances are able to offer their members access to other resources beyond the main ones. For example and accordingly with Gulati (1998), alliances are a great strategy for international expansion, as firms in international consortia may broaden their global social network, learn about local circumstances and gain a significant advantage.

Through alliances, firms can also learn about the practices of their competitors. They are given the opportunity to collaborate with other firms in the market, observe how they work and conquer rare skills, methods, and procedures.

Further, implementing blockchain technology requires a great amount of investment and funding and several years of project dedication and that is why firms and especially banks try to keep away from using their own sources on such risky innovations (Pucihar, et al., 2018). Thus, participating in a consortium eliminates the effort, the costs and the uncertainty for a single enterprise. This strategy allows companies to receive all the advantages without setting aside their own activities and operations (Bank for International Settlements, 2001)

However, despite the above-mentioned advantages, when firms enter alliances usually face notable coordination challenges that are able to eliminate all the benefits. Primarily, alliances are frequently linked with interest conflicts between their members. This is especially the case when referring to alliances with many members, as it is quite likely to be a misunderstanding of the agreement or a contention for the techniques, domain and goals that should be followed (Vaidya, 2011). Additionally, in every alliance, disclosure of important and sensitive information is required in order for the project to succeed. This can cause problems in collaboration if there is no trust between the members (Lee & Johnsson, 2010). In the same line, alliances may carry uneven power. When the partnering members have different levels of decision control and the power is distributed unevenly, the weaker member may be forced to act in line with the desire of the members that are more powerful, resulting to a domination of the alliance. Chatterjee et al. (1992) suggest that these inefficiencies in cooperation come from differences in culture, management strategies or other incompatibilities. Yet, strategic alliances may help companies to identify such incompatibilities and avoid inefficient collaboration (Arend, 2004).

According to some analysts of the industry, many companies are joining alliances due to the Fear of Missing out (FOMO), but ultimately, blockchain alliances are formed because of the technology's nature (Acharya, 2018). As previously mentioned, blockchain is currently used as a peer-to-peer network. Consequently, this means that its utility is increasing as its number of users is increasing. The larger the number of users, the more valuable blockchain is for all of them.

2.2.2 Literature Overview-Empirical Results

The current literature regarding the strategic alliances and joint ventures mainly focuses on non-financial industries. Contrariwise, there is only a small amount of papers and researches providing empirical evidence for the impact of this kind of synergies in the financial services industry. This can be explained by the lack of information that is available to the public for the specific industry's cooperative efforts.

More specifically, from what I am aware of, there are 4 papers which focus on financial services firms. Gleason et al. (2003) analyze the share price reaction of US firms in the financial services industry regarding a joint venture or strategic alliance announcement. Their results of 513-sample event study show that on average companies undergo significant abnormal returns of 0.66% when they publish their participation in such alliance. In the same context, Marciukaityte et al. (2009) examine a 795 sample of strategic alliance announcements made by US financial industry firms and also find significant and positive average abnormal returns of 0.48%.

Amici et al. (2013) study to what extent strategic alliances and joint ventures create shareholder value for banks that are engaged in such partnerships. This paper is the first that studies European market and banking industry. The study includes 219 alliance announcements and results confirm that value is created for both strategic alliance and joint venture members as the average abnormal returns are positive, statistically significant and equal to 0.52%.

Chiou & White (2005) examine the Japanese financial market and the wealth effects that arise from a strategic alliance formation. Their study includes 109 announcements and the findings suggest that a strategic alliance is able to create value for a firm, as the average abnormal returns are significantly positive and equal to 2.93%. Further, these results are consistent with Gleason et al. (2003) and Amici et al. (2013), though they are greater in magnitude, suggesting that alliances play a greater role in the Japanese market than everywhere else.

In a more general perspective, Chan et al (1997) research the effect differences of high-tech versus low-tech alliances on a member firm price. The result of their 345 announcements' study show that alliances that are related to higher technological projects, like blockchain, generate highly significant positive returns equivalent to 1.12%, whilst alliances related to lower technological projects do not generate any significant reaction.

In accordance with these results, Brooke & Oliver (2005) study 123 strategic alliance announcements and find significant average abnormal returns of 1.6%, while stating that the main source of the reaction comes from lower growth firms due to additional information that is released to the market regarding the new growth potential.

Lastly, Chang et al. (2008) study the impact of 178 strategic alliances between US and Japanese firms on shareholders' wealth effects and find that shareholders from both markets receive extra benefits and statistically significant positive abnormal returns equal to 2% and 0.42% respectively. More specifically, the effect is stronger when the partnering companies are rather small in size, less profitable and have exceeding opportunities for growth.

Negative effects of alliance announcements are also experienced, yet these kind of results are extremely rare, as I was able to identify only one paper regarding this. Waheed & Mathur (1995) research the wealth effects of foreign expansion of US banks and find that when the mode of expansion is through a joint venture, the average abnormal returns are significantly negative of -0.11%.

Given the above theoretical and empirical results, I expect a stronger magnitude for the positive share price reaction of firms that implemented blockchain as part of an alliance.

3 Methodology and Data Description

Overall, there are two main methodologies to estimate the economic impact of information technology implementations in accordance with the current literature. The first is the event study methodology, with which we measure the abnormal returns of stocks' prices. The second is measuring the return on assets (ROA) and the return on investments (ROI). In order to assess the effect on these returns, I compare pre-announcement performance and post-announcement performance using the event study methodology.

3.1 Event Study Methodology

I rely on the event study methodology to analyze whether an announcement of a blockchain implementation has an impact on the short-term performance of a company's stock price. This impact is measured by the cumulative abnormal returns of the stocks (CARs). The sign of CARs imply positive and negative impact accordingly.

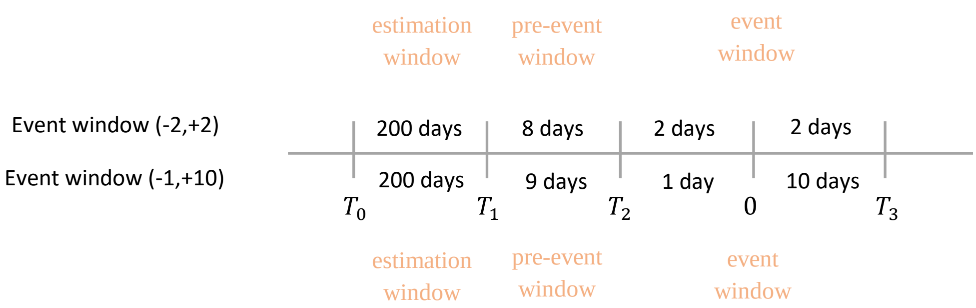
An event study can be conducted in many different ways. In this study, I will follow the structure given by MacKinlay (1997).

3.1.1 Define The Event Of Interest

The first step in the process is to define the event of interest. In this case, the event is the date of the first announcement of the first initial implementation of blockchain technology to a company. The event date differs for the majority of companies. However, it is the same for some, as there are cases of a massive implementation of blockchain technology by a consortium or alliance.

3.1.2 Identify The Period Of Time

The timing of the event is composed of the estimation window, the event window and the event time. The estimation window is the period for which the normal performance is estimated. The event window is the period of time that we examine, concerning the impact of the event on stocks' prices and the event time is the day that the event takes place. The time structure of this event study is visualized in the timeline below:



In the above Figure, the period between T_0 and T_1 is the estimation period and is 200 days long. The prior literature does not suggest a particular number of days as an estimation window. For instance, Dos Santos (1993) uses 200 days, Im et al (2001) use 199 days and Amici et al. (2013)

use 252 days. Nevertheless, it is common to use an estimation window equal to around 200 days, as this is the average trading year. An important note to the above is that the estimation window should not include the event itself, as this will interfere in normal performance estimates. In order to prevent any of this interference, estimation window in this study will stop 10 days (T_1) before the event. Consequently, this creates a pre-event window of 8 and 9 days for the (-2, +2) and (-1, +10), respectively.

Similarly, the period between T_1 and T_2 is the event window. Considering possible lag or prior spill over in announcements and news, this study will test 2 event windows: (-2, +2) and (-1,+10).

3.1.3 Define Normal Performance

The next step of the process is to define the normal returns. Generally, normal return is the return that one would expect if the event would not happen (MacKinlay, 1997). According to current literature, there are multiple ways of calculating the normal performance, meaning the normal returns, such as the Mean Adjusted Model, the Market Model or the Capital Asset Pricing Model (CAPM). In this study, the Market Model method is adopted as it is the most common method to measure the normal performance of a company. The market model method assumes a stable and linear relationship between the market index returns and individual companies' stock returns. Hence, for each company, the following applies:

$$\mathrm{NR}_{it} = a_i + \beta_i R_{m,t} + \varepsilon_{i,t}$$

Where:

NR_{it} is the normal return for the company i at time t

$\mathrm{R}_{m,t}$ is the return for the market at time t

a_i and β_i are the estimated parameters

$\varepsilon_{i,t}$ is the error term for company i at time t

3.1.4 Measuring AR, AAR, CAR and CAAR

After defining the normal expected returns, the calculation of the abnormal returns should follow. Since a_i *and* β_i are now computed, I estimate the abnormal returns by subtracting the expected returns from the actual return $R_{i,t}$. The formula used is the following:

$$AR_{i,t} = R_{i,t} - \mathrm{NR}_{i,t}$$

The results are the abnormal returns of each company stock and the sum of those over the event window gives the cumulative abnormal return (CAR_i) for each company. Moreover, by computing the average of AR across companies in a day during the event window, I obtain the average abnormal return at day t (AAR_t).

$$AAR_t = \overline{AR} = \frac{1}{N}\sum_{i}^{N} AR_{i,t}$$

Further, I calculate the cumulative abnormal returns (CAR), which is the sum of abnormal returns.

$$CAR = \sum_{t=t_1}^{t_2} AR_{i,t}$$

where:

t_1: the starting date of the event window

t_2: the ending date of the event window.

By cumulating the AAR's over the event window, I obtain the cumulative average abnormal return for that event window ($CAAR_t$).

$$CAAR = \frac{1}{N}\sum_{i}^{N} CAR_i$$

3.1.5 Significance Of Abnormal Returns

After computing the CAAR for the event window of the study, a statistical test for significance of the abnormal returns can be performed. The literature concerning event study statistics and its significance is very broad. Generally, significance tests are split in two groups, parametric and non-parametric. The first group assumes a normal distribution, whereas the second group does not. Previous studies have used parametric tests such as t-test or z-test (Oh, et al., 2006; Dos Santos, 1993; Im, et al., 2001) depending on the number of observations. Most studies combine non-parametric tests along with parametric, in order to verify that their results are not biased because of outliers. Hence and accordingly, this study uses the classic t-test, along with complementary rank and sign tests as well.

The t-test is performed over the entire event window, meaning it is performed for CARs, in order to take into account possible lag in the spread of news. The null hypothesis (H_0) tested is that the CAR of the sample for the given event window equals to zero: $H_0: E(CAR_i) = 0$. This practically means that there is no significant effect in the returns of the companies. To calculate the t-test, I use the following procedure. First, calculate the standard deviation based on the computed CARs and CAAR:

$$s = \sqrt{\frac{1}{N-1}\sum_{i=1}^{N}(CAR_i - CAAR)^2}$$

Then, the t-test simply is:

$$ttest = \sqrt{N}\frac{CAAR}{s} \approx N(0,1)$$

Complying with the previous literature, I also use a set of non-parametric tests, the sign and the rank test. In case the cross-sections of events used are very small, the assumption of normality is not valid. Hence, the approximation of t-test distribution is too small and the null hypothesis is rejected too often. Therefore, these tests are used in order to avoid frequent rejection of the null hypothesis and to verify that my results are not biased due to outliers.

The sign test examines if the positive abnormal returns are as many as the negative abnormal returns on event dates. Under the null hypothesis, and considering that the return distribution is symmetric, the expectation of the fraction of positive abnormal returns (p) in the event period is 0.5. The formula is as follows:

$$signtest = 2\sqrt{N}(p - 0.5) \approx N(0,1)$$

The rank test takes into account the magnitude of an abnormal return, but without any distributional assumptions. In order to perform the test, I firstly denote the rank of the abnormal return $AR_{i,t}$ by $K_{i,t}$. This rank transforms into the following statistic formula:

$$U_{i,t} = \frac{K_{i,t}}{T}$$

Under the null hypothesis and considering that the return distribution is symmetric, the expectation of $U_{i,t}$ is 0.5. To test this hypothesis, I then use the following formula:

$$ranktest = \sqrt{N}\sum_{i=1}^{N}\frac{U_{i,t} - 0.5}{s_{ut}} \approx N(0,1)$$

with:

$$s_{ut} = \sqrt{\frac{1}{N-1}\sum_{i=1}^{N}(U_{i,t} - 0.5)^2}$$

3.2 Cross-Sectional Regression Analysis

The second part of this study is focusing on different sub-samples in order to receive further insight on the impact of blockchain technology implementation regarding specific company characteristics. During this study, I mainly focus on the company's participation in a strategic alliance or joint venture, and this composes the second part of the study. As a complementary research, I study the difference in abnormal returns considering difference in region, industry and rating.

Firstly, in order to identify the impact that a participation in a strategic alliance has on the change of the firm's stock price due to a blockchain announcement, I use a regression analysis. Hence, I construct a regression model with CAR as the dependent variable and Str_Alliance as independent variable. The model is as follows:

$$CAR_i = a_1 + \beta_1 \text{Str\_Alliance}_i + \varepsilon_i$$

Where Str_Alliance_i is a dummy variable that takes the value of 1 if the company i participates in a strategic alliance or joint venture and the value of 0 if not.

Then, I introduce the additional independent variables Region, Industry and Rating (as they are defined in the next chapter) in order to estimate any further determinants of the impact of blockchain announcement on stock prices.

$$CAR_i = a_1 + \beta_1 \text{Str\_Alliance}_i + \beta_2 \text{Region}_i + \beta_3 \text{Ind}_i + \beta_4 \text{S\&P}_i + \varepsilon_i$$

In order to control the difference between the several sub-samples during the research, a two-sample t-test is used. With this method, it is possible to test whether the mean of the two-paired samples is different from each other at a significant level.

3.3 Data Collection And Selection Criteria

In order to induce the research, I collect data from three main sources. The first source is the web, which is used to determine the company selection and the event dates as described in the next sub-section. The second source is the Datastream database. I used this database to acquire all necessary information and financial data required for the methodology used, as for instance, the stocks' prices of the companies or the market index prices. The last main source of data is the OECD database to find the risk-free returns.

This research focuses on the industry of Financial Services, thus the companies used in the sample have as their main activity of work the provision of insurance, banking, investment and other financial services. To construct a sample base for the study, I use Reuter's SDC Platinum Securities database to firstly obtain all major companies of the industry with headquarters located in Europe and U.S and categorize each company into its according industry.

The collection of data about blockchain implementation is very demanding. The short-life of this technology, as well as the restricted company announcements when implementing a system technology, are the main reasons of the limited data availability. Consequently, the massive collection of information about blockchain implementation is practically impossible. It demands extensive research of the market news. Hence, I use the above source combined with google search, newspapers, websites with emphasis on economic news such as Bloomberg and dedicated blockchain blogs such as Coindesk, in order to determine the companies with a blockchain implementation, pilot or successful test, as well as to define the exact dates of the first announcement and their possible participation in a strategic alliance. This type of research occurs for each company individually and the main keywords used can be found in the table below:

Keywords	
blockchain	transaction
application	batavia
use	r3
first	b3i
implement	alliance
launch	joint venture
bitcoin	project
application	trial
pilot	hyperledger
smart contract	corda

TABLE 1: THIS TABLE SHOWS THE MAIN KEYWORDS USED FOR THE DATA COLLECTION PROCESS THROUGH INTERNET SEARCH. THESE KEYWORDS WERE TYPED IN SEARCH ENGINES/FUNCTIONS ALONG WITH COMPANY'S NAME AND UP TO 10 PAGES OF RESULTS WERE SCANNED AND CONSIDERED.

3.3.1 Sample Overview

The final data sample consists of 76 financial services' firms (31 U.S. and 45 European) and 76 announcements from 2014 until 2017. Some key statistics and numbers are presented below.

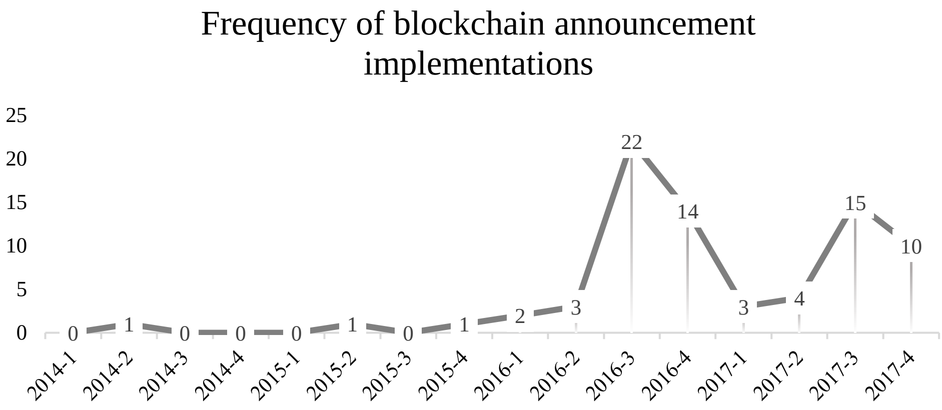


FIGURE 1: FREQUENCY OF BLOCKCHAIN ANNOUNCEMNTS PER QUARTER OVER TIME

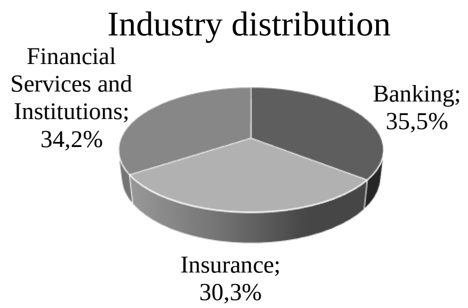


FIGURE 2: DISTRIBUTION OF ANNOUNCEMENTS OVER TIME PER ACTIVITY

Announcements per region, activity		
U.S.		31
	Banking	6
	Insurance	8
	Financial Services and Institutions	17
Europe		45
	Banking	21
	Insurance	15
	Financial Services and Institutions	9

TABLE 2: DISTRIBUTION OF ANNOUNCEMENTS OVER TIME PER ACTIVITY AND REGION

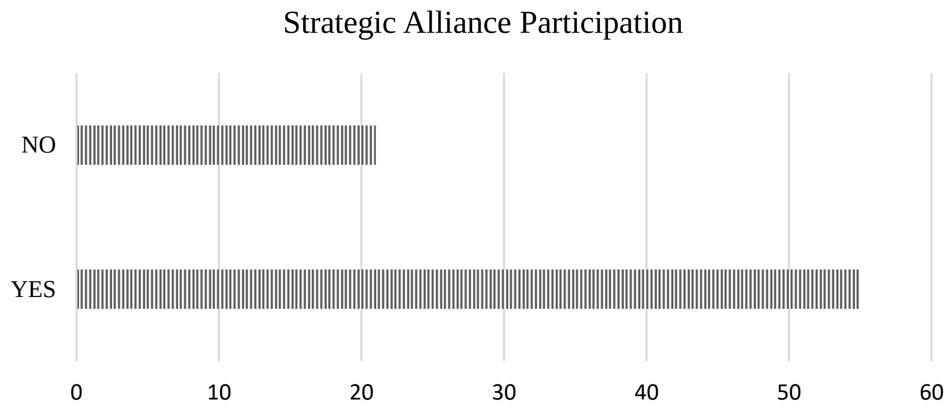


FIGURE 3: FIRMS PARTICIPATING IN A STRATEGIC ALLIANCE

4 Empirical Results

In this section of the study, the main results regarding the impact of blockchain technology implementation on firm performance are discussed per approach. Firstly, the results of the event study are presented, followed by the results of the regression analysis regarding strategic alliances and firm characteristics.

4.1 Event Study

The results of the event study for the entire sample period are presented in the following table (Table 3):

	Cumulative Abnormal Returns
Total Sample	
Number of observations	76
CAR (-1,+10)	1.5870***
t-test	3.7358
% positive	62.82
CAR (-2,+2)	0.7532***
t-test	3.1105
% positive	57.36

TABLE 3: CAR (-1, +10) DENOTES THE 12-DAY CUMULATIVE AVERAGE ABNORMAL RETURN BASED ON MARKET MODEL (IN PERCENT). CAR (-2, +2) DENOTES THE 5-DAY CUMULATIVE AVERAGE ABNORMAL RETURN BASED ON MARKET MODEL (IN PERCENT). % POSITIVE IS THE PERCENTAGE OF POSITIVE CARS DURING THE EVENT WINDOW. T-TEST IS THE PROBABILITY THAT THE OBSERVED CAR IS SIGNIFICANTLY DIFFERENT FROM ZERO. *, **, AND *** DENOTE STATISTICAL SIGNIFICANCE AT 10%, 5%, AND 1%, RESPECTIVELY.

The above table shows the reaction of the market to blockchain technology implementation announcements, measured by the cumulative abnormal return (CAR). Table 3 presents the CARs for the two event windows taken into account in the study: (1) 1 day before the announcement to 10 days after the announcement, (2) 2 days before the announcement to 2 days after the announcement. I find significant changes in the value of the firms around the announcement, with CAR=1.59% with t-test=3.73 and CAR=0.75% with t-test=3.11 respectively. The results for both of the event windows are statistically significant at 1% level, fact that confirms that investors react in a positive manner to the blockchain implementation announcement. These findings are consistent with previous literature like the study from Chen et al. (2018) and the study from Oh et al. (2006). However, in scope of the magnitude of CARs around the announcement day, the result of this study is significantly higher. Additionally, the percentages of positive returns present that over the total sample, more than 57% of the CARs are positives. On a more economical perspective, the above results show that a firm which announces a blockchain implementation will increase its share price by 0.7532% on 5-day window and 1.5870% on 12-day window.

Figure 4 displays the AARs over the 2 event windows. This figure is also verifying the positive effect of the blockchain announcement on the stock prices, as all AARs are positive, with exception event time=-1 and event time=+7. I can also observe that AARs mostly move between 0.0005 and 0.0025.

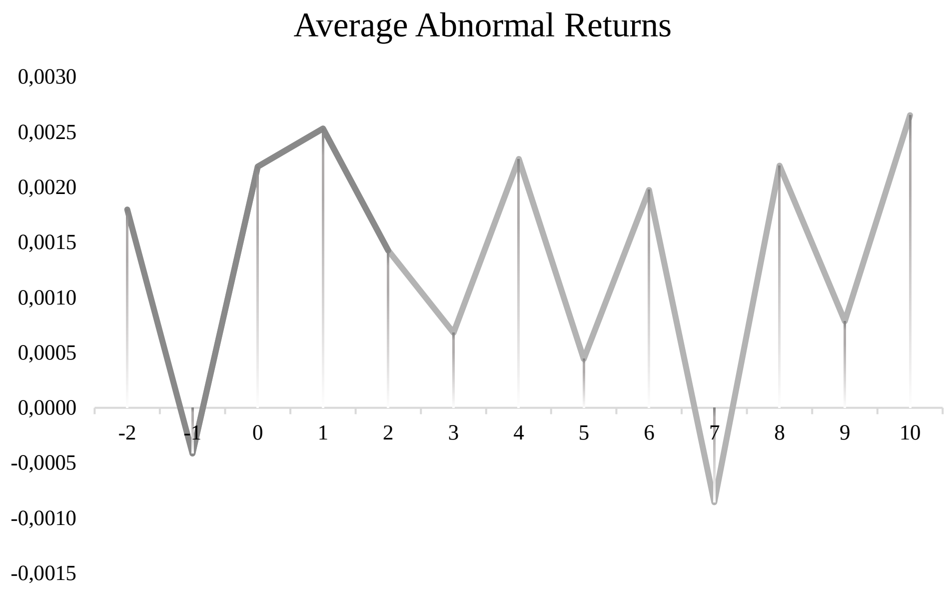


FIGURE 4: AVERAGE ABNORMAL RETURNS OVER THE EVENT WINDOWS

Table 4 summarizes the results of the two additional statistical tests performed in the study, in comparison with the already mentioned classical t-test. It is important to note that as already mentioned t-test is performed on CARs and sign and rank tests are performed on AARs.

Event Window	t-test	rank test	sign test
-1	-0.3395	-0.9582	-1.1470
0	1.0311	1.4046	0.9177
1	2.1412	1.8933	1.6059
2	2.6467	1.6535	0
3	2.8044	-0.1812	0.4588
4	3.1566	2.1799	1.8353
5	2.9706	0.7675	0.9176
6	3.4901	1.8166	0.4588
7	3.0086	1.4813	0.4588
8	3.7321	1.9616	1.3765
9	3.6107	0.5089	-0.4559
10	3.7358	2.7101	1.8353
-2	1.5537	3.9863	1.8353
-1	0.8493	1.0382	-1.1471
0	1.5805	3.3225	0.9177
1	0.1950	3.9515	1.6059
2	3.1105	3.3081	0

TABLE 4: THIS TABLE REPORTS THE RESULTS FROM THE SIGNIFICANCE TESTS PERFORMED REGARDING THE EVENT STUDY RESULTS. T-TEST IS PERFORMED ON CAARS. RANK AND SIGN TESTS ARE PERFORMED ON AARS

4.2 Cross-Sectional Regression Analysis

Further, I want to test the hypothesis of the higher magnitude of CARs when the firm is part of a strategic alliance, as well as the impact of different firm characteristics on this effect. For this reason, I construct regression models based on an ordinary least squared method (OLS). The models are presented below:

$$CAR_i = a_1 + \beta_1 \text{Str\_Alliance}_i + \varepsilon_i$$

$$CAR_i = a_1 + \beta_1 \text{Str\_Alliance}_i + \beta_2 \text{Region}_i + \beta_3 \text{Ind}_{1i} + \beta_4 \text{Ind2}_i + \beta_5 \text{S\&P}_i + \varepsilon_i$$

Where:

CAR_i = cumulative abnormal return of firm i

Str_Alliance_i = a dummy of 1 for firms participating in strategic alliance; 0 otherwise

Region_i = a dummy of 1 for firms headquartered in US; 0 for Europe

$Ind1_i$ = type of industry, 1 for insurance; 0 if otherwise

$Ind2_i$ = type of industry, 1 for banking; 0 if otherwise

$\text{S\&P}_i$ = the rating of firm i provided by S&P

Table 5 reports the results of the regression models explaining the effect on CARs in terms of the underlying firm characteristics. The dependent variable is the CARs measured in the event study from the previous section and more specifically, the 12-day CARs measured from the event window (-1, +10). In total, 4 models are specified. In model 1, I examine strategic alliance participation as the main effect only. In model 2, I examine strategic alliance participation, along with the rating of the company by S&P, if any. In model 3, I add one more firm specific characteristic to the previous, the region where the headquarters of the firm are. Finally, in model 4, I examine all previously mentioned effects along with the sub-industry where the firm belongs to.

	(1)	(2)	(3)	(4)
_cons	0.0004	-0.0054	0.0008***	-0.0128
	(0.0079)	(0.0082)	(0.0001)	(0.0116)
Str_Alliance	0.0213**	0.0157	0.0045***	0.0162
	(0.0093)	(0.0095)	(0.0001)	(0.0010)
S&P		0.0175**	0.0025***	0.0159*
		(0.0085)	(0.0000)	(0.0093)
Region			0.0012***	0.0030
			(0.0000)	(0.0093)
Ind1				0.0086
				(0.0107)
Ind2				0.0090
				(0.0107)
Observations	76	76	76	76
R^2	0.0106	0.0143	0.0153	0.0244

TABLE 5: THIS TABLE REPORTS THE RESULTS OF OLS REGRESSIONS EXPLAINING THE EFFECT ON CARS IN TERMS OF THE UNDERLYING FIRM CHARACTERISTICS. DEPENDENT VARIABLE IS THE CARS MEASURED FROM THE EVENT STUDY. THE EVENT WINDOW USED IS (-1, +10). STR_ALLIANCE IS A DUMMY VARIABLE OF 1 FOR FIRMS PARTICIPATING IN STRATEGIC ALLIANCE; 0 OTHERWISE. REGION IS A DUMMY VARIABLE OF 1 FOR FIRMS HEADQUARTERED IN US; 0 FOR EUROPE. IND1 IS A DUMMY VARIABLE FOR THE TYPE OF INDUSTRY, 1 FOR INSURANCE; 0 IF OTHERWISE. IND2 IS A DUMMY VARIABLE FOR THE TYPE OF INDUSTRY, 1 FOR BANKING; 0 IF OTHERWISE. S&P IS THE RATING OF FIRM I PROVIDED BY S&P. STANDARD ERRORS ARE REPORTED IN PARENTHESES. *, **, AND * DENOTE STATISTICAL SIGNIFICANCE AT 10%, 5%, AND 1%, RESPECTIVELY.**

Overall, I find that a participation in a strategic alliance has a positive effect in CARs and consequently, in firms' share prices, with these results being statistically significant in models 1 and 3, at 5% and 1% respectively. This result aligns with the findings of Gleason et al. (2003) and Marciukaityte et al. (2009) and confirms the perception that investors seem to trust more the companies that are part of an alliance. Moreover, an important impact to the magnitude of the announcement effect has the rating of the company, which is positive and statistically significant to all 3 models, where it is considered. Companies with a higher rating are perceived as more trustworthy and thus they experience higher returns when implementing such a technology, in contrast with the firms with lower or no rating at all. In addition, I can also observe, that region plays a significant role as well, as the firms that are located in US experience higher abnormal returns than the ones located in Europe. Lastly, investors don't seem to have a preference between the sub-industries, as there are no statistically significant results coming from the cross-sectional analysis regarding this.

5 Conclusions

This study finds that the majority of announcements regarding blockchain implementation result in a higher shareholder wealth for the announcing firms. To be able to conclude to this approach, I investigate the change of the share prices around the announcement dates, while further controlling for different firm characteristics in order to find the effect on the magnitude of the change.

With the first step of examining the change of stock prices, I find that investors seem to have a positive view when a firm proceeds to a high technology implementation and more specifically to a blockchain implementation. An explanation for this may be the fact that technology is usually positively correlated with a firm's development and hence growth. One more reason explaining the investors' preference to this implementation is that blockchain is a very new yet powerful technology, which can disrupt the entire industry. Along with this, investors can be risky by investing in a controversial technology yet safe at the same time by investing in an incumbent financial services firm.

With the second step of introducing company characteristics and more specifically the participation in a strategic alliance, I find that investors trust more the firms which proceed to a blockchain implementation and are part of a blockchain strategic alliance than others. An explanation for that is the fact that strategic alliances provide a larger pool of specialized information which may offer higher chances of success to a project or implementation. In addition to that, shared information is basically the nature of blockchain, thus being part of an alliance gives access to centralized databases and ultimately better implementation. Lastly, I find that investors seem to also prefer firms with higher ratings, because they provide increased security and firms which are located in US than firms located in Europe. For the latter fact however, there is no clear explanation found.

As stated above, this thesis studies blockchain implementation from different perspectives. Nevertheless, there are multiple limitations to this study which may influence the results and which could be measured and taken into account in future research. Firstly, collection of the sample data is mainly based on web research, which is prone to inaccuracies. Future studies can base their research in a sample taken from patent filing databases with regards the blockchain implementation. Secondly, future studies can research the impact depending on additional company characteristics, such as the scale of installed IT infrastructure of the company or the number of blockchain applications that are applied already. Lastly, this study focuses on company-specific news. Future studies can take into account general news that could affect public perception about the soundness and viability of blockchain technology. For instance, if a firm announces that it is building an application on Ethereum technology, to what extent is the firm's stock price affected by the moves in the price of Ethereum itself?

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