Does the hype surrounding FinTechs lead to an overvaluation of their stock prices ?

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Does the hype surrounding FinTechs lead to an overvaluation of their stock prices?

Focus on the Payment sub-sector

Jury

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Executive Summary

This thesis aims to bring its contribution to the academic literature about the financial technology sector, recently referred as "FinTech". More precisely it attempts to detect whether the recent hype surrounding FinTechs has an influence on their stock prices. Firstly, a valuation through a DCF model of FinTechs operating in the payment industry allows to highlight an overvaluation of the Payment FinTech sub-sector. Secondly, various hypothesis tests demonstrate that the overvaluation is significant. Thirdly, the regression of a stock index built from the firms' sample on the hype surrounding the whole sector proves that a greater level of hype leads to a rise in the Payment FinTechs' stock prices. These results are considered as evidence of a possible formation of a bubble in the FinTech sector. These findings are supported by the substantial rise in FinTechs' investments and by the unusual attention from the public towards the sector. This phenomenon is somewhat reminiscent of the high-tech bubble that emerged during the last years of the 20th century.

Ce mémoire aspire à contribuer à la littérature académique portant sur le secteur de la technologie financière récemment renommé « FinTech ». Il essaye plus précisément de détecter un potentiel impact de la récente frénésie entourant les FinTechs sur le prix de leurs actions. Premièrement, une évaluation de plusieurs entreprises opérant dans l'industrie du paiement via un modèle d'actualisation des flux de trésorerie permet de mettre en lumière une surévaluation du sous-secteur des FinTechs de paiement. Deuxièmement, plusieurs tests d'hypothèse démontrent que la surévaluation est substantielle. Troisièmement, la régression d'un indice boursier basé sur les entreprises composant l'échantillon sur l'engouement entourant le secteur prouve qu'un plus haut niveau de ce dernier mène à une hausse des prix des actions des FinTechs de paiement. Ces résultats sont considérés comme des preuves d'une possible formation d'une bulle dans le secteur en question. Ces constats sont également supportés par une augmentation substantielle des investissements dans les FinTechs et d'une attention inhabituelle de la part du public vers ce secteur. Ce phénomène n'est pas sans rappeler la bulle high-tech ayant émergée à la fin du vingtième siècle.

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Finally, I wish to thank my parents that always have been a significant support during my studies. I could not have achieved anything without them.

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List of Abbreviations

ASE: Australian Stock Exchange

AUD: Australian Dollar

CAGR: Compounded Annual Growth Rate

DCF: Discounted Cash Flow

DDM: Dividend Discount Model

EPA: Euronext Paris

ESO: Employee Stock Optionsµ

EUR: Euro

FCFF: Free Cash Flow to Firm

GBP: British Pound

ICT: Information and Communication Technology

IPO: Initial Public Offering

LSE: London Stock Exchange

NASDAQ: National Association of Securities Dealers Automated Quotations

NYSE: New York Stock Exchange

PSD2: Second Payment Service Directive

R&D: Research & Development

US: United States

USD (US$): United States Dollar

1. Introduction[1]

1.1. Context

For a few years, one of the main topics in the financial industry is the "FinTech" phenomenon. Although the word is nowadays broadly used, no unanimous academic definition has been established yet. The Oxford Dictionary[2] defines FinTech as "*computer programs and other technology used to support or enable banking and financial services*", the Cambridge Dictionary[3] defines it as the abbreviation for "financial technology" while the Merriam-Webster Dictionary does not provide any definition. In his book, The Future of Fintech, Bernardo Nicoletti (2017) states that *"[...], it is possible to define FinTech as initiatives, with an innovative and disruptive business model, which leverage on ICT in the area of financial services*" (p.12). Nicoletti (2017) also proposes Schueffel[4]'s definition: "*fintech is an industry made up of organisations using novel financial technology to support or enable financial services*" (p.12). According to Gomber, Koch & Siering (2017), FinTechs are companies that disrupt the financial sector by making use of the Internet and automated information processing to provide innovative, secure and flexible financial services. One common dimension in all the definitions is that "FinTech" is a neologism created from the fusion of the words finance and technology.

Even though the excitement around FinTech is quite recent, the financial technology sector is much older than thought. In their paper "The Evolution of FinTech: a New-Post Crisis Paradigm?" Arner, Barberis & Buckley (2016) assert that this financial technology sector has existed since the second half of the 19th century. According to them, finance and technology have been closely linked since their beginning. They present three distinct periods in the FinTech evolution, "FinTech 1.0" from 1866 to 1967, "FinTech 2.0" which started in 1967 and ended in 2008 and the current "FinTech 3.0" which began after the 2008-financial and economic crisis. The first period was characterised by the emergence of technologies such as the telegraph, which improved the speed of transmission of financial information. The second period started in 1967 with the introduction of computers (International Business Machines), financial calculators and the firsts ATM[5]. Over time, many financial tasks have been automatized and financial institutions increasingly leveraged on the Information Technology (IT), which made the financial industry one of the most digitalised. Financial companies also largely used the major innovation of the past century, the Internet, to improve their customer experiences. This "FinTech 2.0" period ended more or less in 2008, after the financial crisis,

[1] 14,735 words
[2] Retrieved on July 31, 2017 from https://en.oxforddictionaries.com/definition/fintech
[3] Retrieved on July 31, 2017 from http://dictionary.cambridge.org/fr/dictionnaire/anglais/fintech
[4] Patrick Schueffel is Professor at the Institute of Finance at the School of Management Fribourg
[5] ATM stands for Automated Teller Machine

which deeply affected customers and their consumption behaviours. This crisis had two major impacts on the FinTech sector. Firstly, the population started to challenge the legitimacy of traditional financial institutions that played a major role in the crisis and turned to untraditional providers for their financial services. Secondly, the implosion of the financial system implied a tightening of the regulation (e.g. stronger capital requirement). This regulation turned out to be a financial burden for regulated entities that consequently lost flexibility and put aside inventiveness.

In the framework of this thesis, FinTech is considered as a sector gathering companies that use innovative technologies in order to provide financial services. “FinTech” will be used to mention the sector while “FinTechs” will stand for companies operating in it. Furthermore, since firms gathering finance and technology are not a new phenomenon, FinTechs are not considered as start-up companies as it might be the case in some papers. Some of the FinTechs analysed in the following sections are even mature companies. The maturity of companies, unlike their business activities, is hence not a criterion to be classified in the FinTech sector. What fundamentally characterised a FinTech is the innovative technology it leverages on to provide its financial services.

1.2. FinTech Sector

FinTech is a wide sector gathering many heterogeneous firms operating in different markets. The heterogeneity partially stems from the differences in their ecosystems (stakeholders), in the adopted technologies, in the services offered and in their risk profiles. This implies that the sector can be divided into various categories. This thesis retain seven main sub-sectors: Payment (e.g. digital payments, digital wallets), Alternative Lending (e.g. peer-to-peer lending, crowdfunding), RegTech (e.g. Know Your Customer, Anti Money Laundering), InsurTech (e.g. peer-to-peer insurance platforms), Data & Analytics (e.g. credit scoring, financial database/platforms), Wealth Management (e.g. automated investment services, trading platforms) and BlockChain/Digital Currency (e.g. Bitcoin). Note that this list has been mainly inspired by the “2016 FinTech100 Reports” from KPMG and H2Ventures. Nevertheless, this list is not exhaustive, as many other categories can be established.

The financial technology sector is only in the spotlight for a few years while the sector, as explained in the previous section, has existed for a long time. Before the 2008-financial crisis, financial technology companies mainly provided their services to financial institutions. They were mainly involved in business-to-business transactions but much less in business-to-consumers. Consequently, they used to be almost unknown from the public. This changes after the crisis in 2008, which caused distrust and suspicion from the public toward financial institutions. In response, some nonfinancial institutions started to provide financial services directly to consumers. These new market participants took advantages of technological developments in order to provide customised, more efficient and cheaper financial services. The main innovations driving the digital revolution in the industry have been the Internet (e.g. e-commerce) and the mobile phones (i.e. smartphones). It was the beginning of a process of financial services' disintermediation, which will fundamentally reshape the financial industry (Gomber et al., 2017). This disintermediation occurs because FinTechs permit financial services to be supplied without the involvement of a bank or a financial institution. FinTechs provide their services directly to the public or they set up platforms to connect economic agents with common interests (Chiu, 2016). Indeed, the involvement of FinTech in the concept of collaborative economy also had a major impact on the public's perception of this novel financial actor. All these factors gathered gave rise to an increasing interest from the public and the media for FinTechs.

As with the novelty of the sector, some other misconceptions about FinTechs are spreading around the public's opinion. Indeed, it is of public opinion that FinTechs are highly flexible because they are non-regulated entities. This reasoning is false. Indeed the majority of FinTechs are regulated, since they are financial service providers. Their regulations are just less burdensome than the ones enforces to financial institutions such as banks. Moreover, regulators around the world start to work for a more efficient financial industry by supporting innovations and FinTechs. For instance, the British regulator, the Financial Control Authority (FCA), set up a "regulatory sandbox" that offers the possibility to FinTechs to test their products and services in the real market by providing them authorisations and guidance (FCA, 2015). In November 2016, the European Banking Federation (EBF) released a paper entitled "Innovate, Collaborate, Deploy." in which it recommends the EU Commission to settle a European sandbox in order to "*make significant contribution to innovation in the financial services to the benefit of consumers*". Indeed, according to Philippon (2016), FinTechs could improve the financial stability and help to expand the access to financial services to rural areas' population (Brooks & Gabor, 2017).

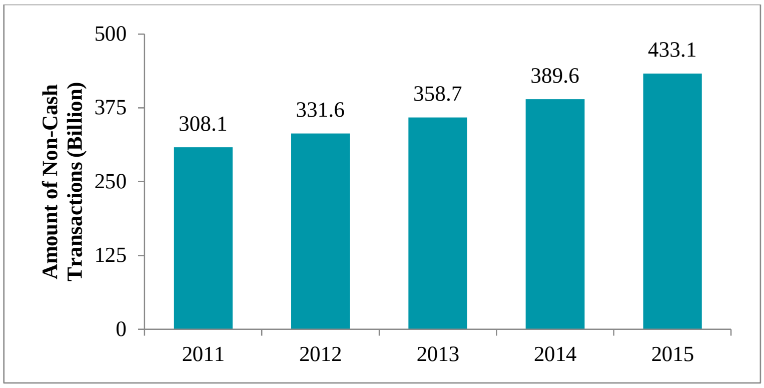
1.3. FinTech in the Payment Industry

As mentioned in the previous section, companies in the FinTech sector operate in various industries. One of these is the payment industry, which is composed of multiple companies that have different precise roles in the complex payment process. Heggestuen (2016) depicts the payment processing ecosystem in dividing the industry into five main categories; the acquirers/processors, the issuers, the gateways, the card networks and finally the Independent Sales Organizations (ISOs)/Merchant Service Providers (MSPs). The acquirers (e.g. Barclays) are the financial institutions that process the payments on behalf of the merchants while the processors (e.g. Fiserv) make the link between the Issuers and the acquirers for the merchants. It should be highlighted that the acquirers and the processors are often the same entity. The issuers (e.g. Citibank) are the financial entities that provide the credit or debit card to the customers. The acquirers are the merchants' banks while the issuers are the customers' banks. The gateways (e.g. PayPal) provide online payments to merchants by managing payments information. A payment gateway collects transaction data to transmit to the merchant's processor and to provide to the issuers the response, through the merchant's interface, whether the payment is accepted or denied. The card network, which is made of various card associations (e.g. MasterCard), is the electronic network that enables communications and transactions within all institutions operating in the payment ecosystem. Finally, the ISOs and MSPs (e.g. VersaPay) are third parties that provide program services to processors, issuing and acquiring banks without being a member of the card network. Some companies can fit in multiple categories as they might fulfil several of these functions.

This payment industry has been, for a long time, dominated by a few firms such as American Express, MasterCard, and Visa. Nevertheless, more and more FinTechs are entering the payment market by leveraging on innovative technologies. They mainly fulfil functions of processors, gateways, ISOs, and MSPs. Indeed, they provide different type of services such as e-commerce payments (e.g. Klarna, Shopify), mobile payments (e.g. Nubank, Square, iZettle, PayRange), multichannel payments (e.g. Adyen), payment processing (Stripe), cross-border payments/transfers (e.g. Payoneer, Azimo), e-wallets (e.g. Leetchi), and so forth.

The payment industry is thought to be a promising sector since the amount of non-cash transactions is continuously increasing and is expected to keep growing in the future. Between 2011 and 2015, the non-cash transactions grew by a compounded annual growth rate (CAGR) of 7.05%. Figure 1.1 illustrates this growth.

Figure 1.1 – Evolution of Non-Cash Transactions



Source: World Payment Report 2017 (Capgemini and BNP Paribas)

In the "Global Mobile Payments Market 2016-2020 Report", NOVONOUS[6] (2016) predicts that the global mobile payment market will grow at a CAGR of 36.26% by 2020. Furthermore, the Visa's 2016 Digital Payments Study established that the amount of people regularly using mobile devices to make payments has tripled in one year, rising from 18% to 54% of the European consumers surveyed (36,000).

Payments activity is one of the most represented in the FinTech sector along with the alternative lending. In the above-mentioned "2016 Fintech100 Report", 18 of 100 firms are active in the payment industry. A study from Haddad & Hornuf (2016), demonstrates that payment is the second sub-sector in which the more FinTech start-up are created. The study from Lee & Lee (2016) reveals that the electronic payment area is the most utilised in the FinTech sector. According to them, the mobile payment market surged from $ 52.9 to $235.4 billion between 2010 and 2013. They expect the growth to continue to reach a level of $720 billion in 2017.

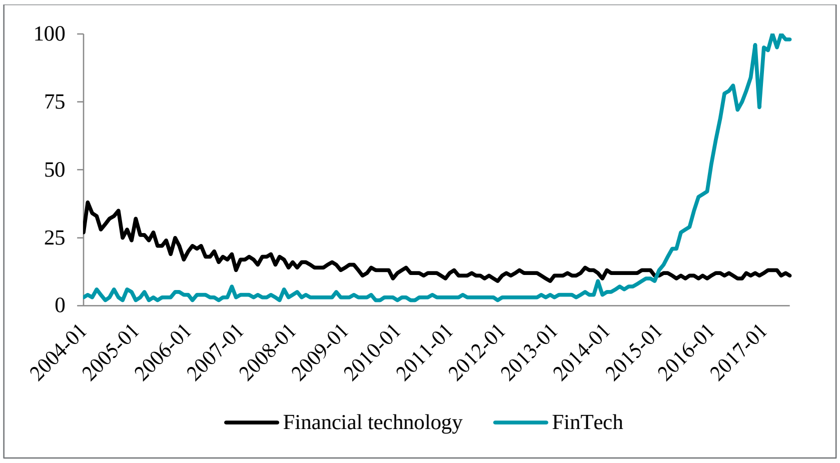
In this thesis framework, only one sub-sector of FinTech will be studied. Considering its high growth potential and its level of representation in the sector, the Payment sub-sector seems to be relevant to study in order to draw conclusions about FinTechs. This decision has been made considering the fact that the FinTech sector is made of a wide range of heterogeneous firms' categories and that a sole valuation methodology might not be suitable for all of them. For instance, alternative lending firms have very different business models considering the granting of loans and credits.

[6] NOVONOUS is a market research company.

1.4. FinTech's Hype

What fundamentally differentiates the "FinTech 3.0" period from previous periods is the awareness of the sector by the public and its interest in it. The evolution of the interest in the FinTech sector can hardly be measured. However, the Google Search Trend is a consistent indicator of the hype surrounding FinTechs. Figure 1.2 depicts the evolution of the number of searches conducted for the keyword "FinTech" in Google since 2004. The indicator represents the amount of searches in proportion of the maximum reached during the period. In the period studied in Figure 1.2, the maximum amount of searches carried out for "FinTech" was reached in March 2017. Consequently, the indicator is equal to 100 for this month. The other numbers of searches are expressed in proportion of this amount. In October 2015, the Google indicator for the keyword "FinTech" was 40, which means that during this month the number of searches for this keyword represented 40% of the number reached during March 2017.

Figure 1.2 – Evolution of the Number of Google Searches for "FinTech"



Source: Google Trends[7]

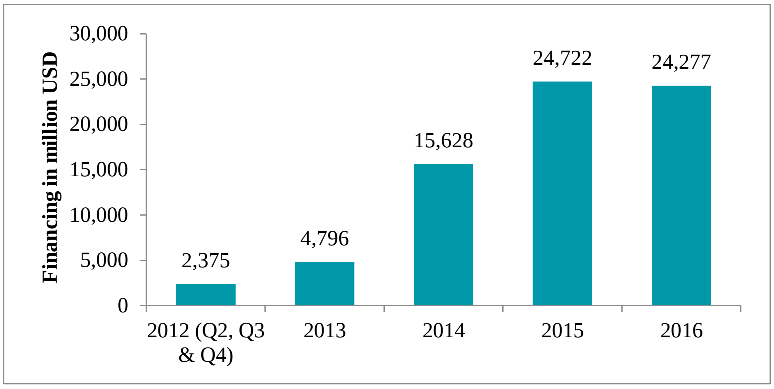
From Figure 1.2, it is clear that since 2014, FinTech has been gathering growing interests. It can also be observed that the term "financial technology" used to have more attention than "FinTech" until 2015. The trend reversed in 2015 for the benefit of FinTechs. Furthermore, in more than thirteen years, "financial technology" never achieved the maximum number of searches reached by "FinTech" in March 2017. It proves that even though the financial technology industry has existed for a long time, it never attracted as much as interests as from it has been publicly renamed "FinTech".

[7] The overall set of data for the keyword "Fintech" research has been retrieved from https://trends.google.fr/trends/explore?q=fintech

According to Dolata, Schwabe & Zavolokina (2016), the FinTech phenomenon has gained substantial visibility over the past few years in the media. They state that in 2015, even though it was hardly present in the scientific literature, the FinTech phenomenon was being hyped by the popular media. They noted that few months after they research, the phenomenon also started to reach the research community.

From this growing public interest, significant investments emerged in FinTech companies. CB Insight has collected global financing data for FinTechs for the past four years. This includes financing from various sources such as Venture Capitalists, Corporates, Private Equities, Business Angels and Initial Public Offerings (IPO). The evolution of the level of financing is available in Figure 1.3.

Figure 1.3 – Evolution of Global FinTechs Financing



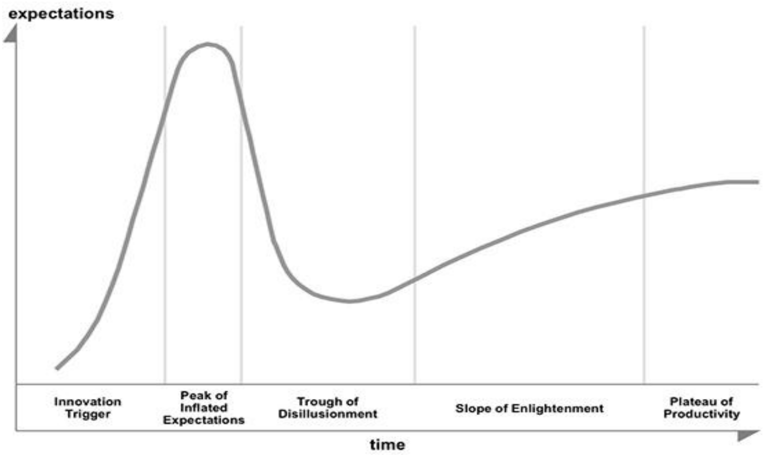
Source: CB Insights Database on FinTechs Financing

Investments in the sector are increasingly important since 2012. The most significant surge occurred between 2013 and 2014, with an annual growth rate of 225.85%. Even though the investments grew less between 2014 and 2015 they remained substantial with a 58.2% increase. In 2016, the investments slightly decreased but remained at around US$24 billion. The investments of the two first quarters of 2017 already total almost US$13 billion, which predict slightly higher annual investments for 2017 compared to 2016. It seems important to note that it is not the amounts of investments that matter but rather the significant growth rates.

This type of substantial interest from the public a sector already occurred in the last years of the 20th century, during the *high-tech bubble*. The Internet firms were expected to experienced high growth and to generate substantial profits. This hope implied important overvaluations a bubble formation. This bubble finally burst and caused the “dotcom crash” in 2000 (Ho et al, 2011). The market prices were, at the end, completely independent from the fundamental value of their firms (Gatti, 2004). The same pattern occurred for various innovations over time; the railroads, the telephone, automobile, radio, and so forth. (Fenn & Raskino, 2008).

Gartner's[8] analysts underline that most innovations go through a "*hype cycle*". This cycle implies that, at the beginning, innovations gain a substantial amount of visibility in a short period of time. After it peaked, the visibility suddenly and aggressively decreases. Then, it tends to increase back but only slowly. This visibility can also be interpreted as the public's expectations in the innovation. This "hype cycle" is illustrated in Figure 1.4.

Figure 1.4 – Gartner's Hype Cycle



Source: Gartner

Since the FinTech sector is made of companies leveraging on technological innovations, the "hype cycle" can be applied to it. In FinTechs' case, the previously mentioned Google Search Trend can measure the visibility of the sector. Therefore, from Figures 1.2 and 1.4 it can be interpreted that the FinTech sector seems to be in the upswing part of the cycle. It is therefore rational to think that FinTech is in a substantial "hyped" period.

[8] Gartner is an IT research and advisory company.

2. Research Question

2.1. Research Question

This thesis first attempts to determine whether the Payment FinTech sub-sector is overvalued or not. In a second phase, it aims at detecting a potential impact of the hype surrounding the whole sector on the valuation of Payment FinTechs. These two objectives can be summarised by the following research question: does the hype surrounding FinTechs lead to an overvaluation of their stock prices?

In this thesis' framework, the hype can be referred as an unusual amount of interests from the public. This interest is spread around the public through several canals such as the news, media, conferences, mouth-to-mouth and so forth. (Fenn & Raskino, 2008). In the academic literature, the Google Trends index tends to be more and more used to measure the hype. Isaksson & Karpe (2016) employed it to quantify the hype surrounding IPOs in Sweden. Heiberger (2015) investigated the Google Trends indicator between 2004 and 2014 to prove that mass media information can help investors to hedge their portfolio in difficult financial times. Balakrishnan & Dixit (2013) also proved that Google Trends can be used to predict the market volatility by selecting relevant financial keywords.

From literature, it can be determined that media information influences the firms' valuation in various ways. Butler & Gurun (2012) demonstrated that hype generated by local newspapers about local firms had a positive impact on the concerned firms' valuation. They asserted that newspapers tend to influence public's perception and consequently, firms' valuation. Wang & Ye (2013) proved that media coverage of firms' controlling shareholders has an impact on stock market values.

Tetlock (2007) found significant evidence to reject hypotheses according to which the media has no relation with the asset market and that media contents provide new information about fundamental asset values. These rejections imply that media does have an impact on asset market prices and that information contained in the media is not based on assets' intrinsic value. This former statement had been supported by Shiller (2000), Nobel Laureates of the Memorial Prize in Economics Sciences. He stated that "*the media seem often to disseminate and reinforce ideas that are not supported by real evidence*". He even went further and specified that "*the news media are fundamental propagators of speculative price movements […]*". Baker & Wurgler (2007) proved that investors' sentiments engendered by media have a high impact on stock prices. They created two indices of investors' sentiments and both captured the bubbles and crashes that occurred between 1966 and 2015.

Brown (1999) asserts that sentiment is the noisy signal when noise traders affect prices. Noise traders can be defined as irrational investors that do not have the objective to maximize their utility (Campbell & Kyle, 1993). They can imply substantial differences between stock prices and their intrinsic value (De Long, Schleifer, Summers & Waldmann, 1990). Allen et al. (2003) state that individuals' willingness to pay for an asset, such as a stock, tend to be highly impacted by the average opinion expectations. Public information overweighs the private information and in consequence, it is the public opinion that is reflected in market prices.

Even though mass media communicate about FinTechs' potential overvaluation, no academic paper has yet addressed this topic. This thesis aims at filling this gap.

2.2. Hypotheses

Four hypotheses have been set with the purpose to give elements of respond to the underlying research question of section 2.1. The hypotheses that follow are expressed in order to reflect the subsequent idea; "*the null hypothesis plays a role similar to that of a defendant on trial in many judicial systems: just as a defendant is presumed to be innocent until proven guilty, the null hypothesis is presumed to be true until the data strongly suggest otherwise*." (Wooldridge, 2009, p. 770).

Hypothesis 1:

$(H1)_0$: Payment FinTechs are fairly valued

$(H1)_1$: Payment FinTechs are not fairly valued

The null hypothesis 1 will first detect whether the FinTechs operating in the payment industry are fairly valued or not. If this hypothesis is rejected it would mean that FinTechs' stocks prices are deviating from their fundamental values.

Hypothesis 2:

$(H2)_0$: Payment FinTech sub-sector is undervalued

$(H2)_1$: Payment FinTechs sub-sector is overvalued

The second null hypothesis attempts to evaluate if the sub-sector is over or undervalued. If this null hypothesis fails to be rejected it would mean that Payment FinTechs are undervalued. On the other hand, if it is rejected, there is substantial incentive to accept the alternative hypothesis according to which they are overvalued.

Hypothesis 3:

$(H3)_0$: Payment FinTechs sub-sector is not significantly overvalued

$(H3)_1$: Payment FinTechs sub-sector is significantly overvalued

The third null hypothesis helps to determine whether the overvaluation is substantial or not. The hypothesis' rejection would imply a significant overvaluation of the sub-sector. However, if it fails to be rejected, it would mean that there is not enough evidence to assert a substantial overvaluation.

Hypothesis 4:

$(H4)_0$: The hype surrounding FinTechs has a negative or no impact on their market prices.

$(H4)_1$: The hype surrounding FinTechs creates an upward pressure on their market prices.

The fourth hypothesis attempts to detect whether the hype surrounding the FinTech sector has a positive impact on the FinTechs' stock prices or not. If the null hypothesis fails to be rejected, it would suggest that the hype surrounding the sector has no effect on its stock prices or creates a downward pressure. On the other hand, if it is rejected, it would imply that market prices tend to increase when the sector faces a higher level of hype.

It is to be noted that the first hypothesis is bilateral since the alternative hypothesis can be either that FinTechs are overvalued or undervalued. The three other hypotheses are unilateral since their alternatives are unique. More details on hypothesis testing will be brought in Section 3 while the formalisation of the hypotheses and the tests' results will be available in Section 4.

3. Data and Methodology

3.1. FinTechs' Valuation

3.1.1. Methodology

The three first hypotheses will be tested by comparing the intrinsic value of firms' stocks with their market values. The Fundamental Analysis states that stock prices are supposed to reflect the fundamental value of the firm (Brown & Reilly, 2012). A positive difference between the market value and the fundamental value of the firm per share implies an overvaluation of the stock (Belke & Polleit, 2009). Reversely a negative difference translates an undervaluation. Therefore, it is important to know the fundamental, or intrinsic, value of the FinTechs in order to detect an overvaluation of the sector. As explained in section 1.3, the analysis is focused on the FinTechs operating in the payment industry. The firms have been valued at the date of December 31, 2015 in order to have sufficient data available to carry out the valuation.

There are three main valuation approaches: the asset approach, the market approach and the income approach. Each approach is based on different methodologies.

Firstly, the asset approach relies on the firms' assets and liabilities. Briefly, the value of the firm is the difference between the assets and the liabilities and known as "book value" or "shareholders' equity". The approach does not take into account the future potential of the firm and can be biased by accounting and fiscal rules that affect the balance sheet. It is usually only used for capital-incentive companies.

Secondly, the market approach is based on relative valuation. It values a company by using some comparable firms' multiples (i.e. ratios) such as Price to Sale (EV[9]/Sales), Price to Earning (EV/Net Income), and so forth. This method might not be relevant in the case where an industry or a sector is thought to be over or undervalued. Moreover, this method tends to be highly volatile (Wilson, 2017).

Finally, the income approach depends on the expected future cash flows of the company. The value of the firm represents the present value of the cumulative future cash flows. According to Wilson (2017), the income approach is the most appropriate to value FinTech companies.

The income approach is mainly based on the discounted cash flow model (DCF). By definition, the DCF model estimates the intrinsic value of a firm by the cumulative present values of its future cash flows (Gajek & Kucinski, 2016). According to Belke & Polleit (2009), it is the most relevant method to determine the fundamental value of stocks. It is, therefore, relevant to use

[9] EV stands for Enterprise Value

this method to evaluate the firms' intrinsic value. The cash flows which are discounted can either be the dividends or free cash flow generated by the company. The Dividend Discount Model (DDM) consists in cumulating the present values of the expected future dividends in order to evaluate the firm's equity value. According to Zhang (2014), this model is only relevant when there is a close link between the generation of value and its distribution. Moreover, the DDM cannot be used in this thesis' framework since a major part of the companies in the sample do not have paid dividend at the date of the valuation. In consequence, there is no dividend to discount and no clear dividend policy established.

Albouy, Dubreuille, Kergoat & Mchawrab (2015) carried out a study on 15 high-tech companies and tested three valuation methods in order to determine the more relevant one for technology incentive companies. The methods tested were the revenue multiple, a DCF model with the use of the cost of capital to discount the free cash flows and the real options model from Schwartz and Moon. From a multiple regression model, they demonstrated that the DCF model was the most accurate to value high-tech firms.

Consequently, the model used in this thesis is the Free Cash Flow to Firm (FCFF) model This model first computes the value of the firm which is the present value of expected future free cash flows. The discount factor used is based on the cost of capital. Once the value of the firm is retrieved, the financial debt and minority interests are subtracted from it while the cash and equivalents are added in order to find the firm's equity. The equity value is then divided by the number of shares outstanding to give the estimated firm's intrinsic value per share. It should be noted that the number of shares outstanding does not take into account preferred shares but only the common shares.

The FCFF model has been applied for a 10-years period. The description of the valuation process used to assess the firms' value follows a backward approach. To be noted that this model has been inspired by the work of Aswath Damodaran[10] and by the book "Valuation: Theories and Concepts" of Rajesh Kumar (2015).

[10] Aswath Damodaran is Professor of Corporate Finance and Valuation at the Stern School of Business at New York University and has a website dedicated to teaching business valuation. http://pages.stern.nyu.edu/~adamodar/

3.1.1.1. Valuation Process

This section aims at summarising the methodology used to value the companies. The whole valuation process is available in Appendix 1.

The firms' values have been computed by the equation below. It reflects Damodaran's (1999) definition of firms' value: "[…] the present value of expected cash flows generated by it, discounted back at a composite cost of capital […]".

$$FV = \sum_{t=1}^{t=10} FCF_t \, \delta_t \; + TV\delta_{10}$$

In the equation, *FV* stands for firm's value, *FCF* for free cash flow, *TV* for terminal value and δ for the cumulative discount rate. The cumulative discount rate is computed as $\delta_t = \frac{\delta_{t-1}}{(1-\omega_t)}$ where ω is the cost of capital. The terminal value is equal to $\frac{FCF_{11}}{(\omega_{11}-r_f)}$ where r_f is the risk-free rate.

The free cash flow (FCF) at time t is the difference between the operating income after tax (OIAT) and the reinvestment (RT) at time t. The reinvestment is the difference in revenue from the previous year multiplied by the reinvestment rate. The operating income after taxes is equal to the operating income (OI) in the case where the latter is negative or lower than the net operating loss (NOL) from the previous year. However, if it is positive and higher than previous year's loss, the operating income is diminished from the difference of the operating income and the loss multiplied by the tax rates. It implies that a tax is only paid if the operating income is positive and sufficiently high to absorb the previous year net operating loss. Furthermore, the tax is paid on the surplus of the operating income after the absorption of the loss. The second case if formulated as:

$$OIAT_t = OI_t - (OI_t - NOL_{t-1})\tau_t$$

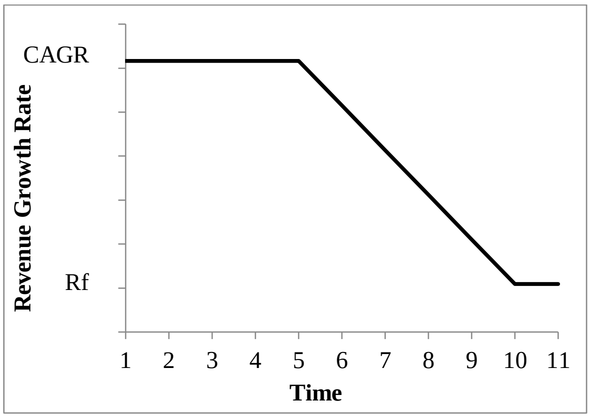
The net operating loss increases over time until the firm generates a sufficient operating income that covers for it. In this case, the NOL is set to zero. Otherwise, the NOL increases when the operating income is a loss and decreases when it is a profit. The operating income is computed as follows: $OI_t = R_t \, \theta_t$ where R_t is the revenue and θ_t is the operating margin.

3.1.1.2. Assumptions

To carry out the valuation, a series of assumptions have been established. These assumptions have been set in order to fit as much as possible to the reality and to the economic conditions. They are mainly based on historical data and industry statistics.

The model used is a three-stage growth model. The firm's revenue is expected to grow at a determined compound annual growth rate for the first five years. The growth rate will then linearly decrease until it reached the risk-free rate in the tenth year. The risk-free rate will be the mature growth rate (Kumar, 2015). Figure 3.1 depicts the three-stage model mechanism.

Figure 3.1 – Three-Stage Growth Model



The expected revenue growth rate for the five years following the valuation date has been set to the companies' revenue compounded average growth rate (CAGR[11]) over the past five years[12].

To stay optimistic about future growth, a minimum of 8% has been set while a maximum also has been imposed to keep realistic assumptions. The maximum is set to 42.76%, which depicts the maximum CAGR over the last 5 years reached by a sample of 23 major companies evolving in the payment market. The payment companies sample and their financial data are available in Appendix 2. For the following periods, the revenue growth rate is calculated as $g_t = CAGR^* - \left(\left(CAGR^* - r_f \right) \left(\frac{t-5}{5} \right) \right)$ where r_f is the risk-free rate, g_t the growth rate of the revenue and $CAGR^*$ is the determined CAGR for the first five years. As explained above, after ten years, the revenue growth rate is set to the risk-free rate.

The three-stage model is also applied to the tax rate and to the cost of capital. For the first five years, the tax rate is set to the effective tax rate (τ^e) which is the ratio between the provision for income taxes and the pre-tax income of the base year. If it is negative, it has been set to 0%. During the second period, the tax rate is computed by $\tau_t = \tau_{t-1} + \left(\frac{\tau^c - \tau^e}{5} \right)$ until it reaches the corporate tax rate (τ^c) of the incorporation country.

[11] The historical CAGR has been computed as follow $CAGR_{past\ N\ years} = \left(\frac{Revenue_t}{Revenue_{t+1-N}} \right)^{\left(\frac{1}{N}\right)} - 1$

[12] The CAGR over the past 5 years has been computed when data was available. The lack of some historical financial data implied that some CAGR has been computed for a shorter period of time, with a minimum of 3 years.

The cost of capital follows the same pattern. The cost of capital is common for the five first years and is established to the industry's average[13]. Given that ω^* is the first stage's cost of capital while ω_T is the one of the terminal year; the second stage's cost of capital is $\omega_t = \omega_{t-1} - \left(\frac{\omega^* - \omega_T}{5}\right)$.

An expected pre-tax operating margin that will be achieved after ten years has been set. It is assumed that it will be the same for all the firms valued and will be of 19.79%. It corresponds to the average pre-tax operating margin over 10 years of the above-mentioned payment companies. This assumption seems reasonable since the pre-tax unadjusted operating margins reported in Damodaran's database for 2015 for the industries represented in the sample range between 15.14% and 22.70%.

3.1.1.3. Operating Income Adjustments

In the balance sheet, the operating income is computed as the revenue less the operating expenses. This computation does not take into account the capital expenditure neither the financial expenses (Kumar, 2015). The research and development (R&D) expenditures and operating leases commitments are treated as operating expenses and have therefore been subtracted from the revenue to obtain the operating income. However, they should be accounted as capital expenditures. It implies that the operating income has to be adjusted.

For the R&D, the adjustment is simply made by adding to the base year's operating income the R&D expenditure of the year minus the cumulative depreciation of the previous periods' R&D expenses. The amortisation is made linearly and over 5 years.

The same type of adjustment is made for the operating leases. The operating lease expense of the current year is added back to the operating income while the depreciation of future commitments is subtracted. Moreover, the cumulative present value of the operating leases commitments has to be added to the financial debt to retrieve the firm' equity (Kumar, 2015).

3.1.1.4. Firm's Equity Value

Once an estimation of the firm's value has been computed, it is important to reflect the firms' possibility of failure in this valuation. The assumption is that there is a probability of 10% that the company will not succeed and that the liquidation value will amount to 50% of the firm's value. The final firm's value is therefore computed as:

$$FFV = 0.9\ FV + 0.1(0.5\ FV)$$

[13] More details are provided in the data section

The final firm's value has to be diminished from the adjusted financial debt[14] and the minority interests that the firm could have in other companies and augmented of the cash and short-term investments to retrieve the firm's value of equity.

Since the 1990's, it has been a common practice, especially in the technology sector (Zhang, 2006), to grant call options to employees. These employee stock options (ESOs) give the employees the right to buy firm's stocks at a certain price (strike price) for a determined period of time[15]. This type of compensation allows start-up companies which are unable to provide high wages to attract talented people. Unlike regular options, ESOs have an impact on the firm's valuation. This is why the total value of these options has to be subtracted from the value of equity in the firm's valuation process. This option valuation has been computed for all the companies reporting ESOs in their financial reports. It is based on the Black-Scholes-Merton Model while adding the dividend yield as an additional input as modified by Merton (1973).

The inputs are the followings:

$\boldsymbol{S_t = stock\ price}$ [16]

$\boldsymbol{K = weighted\ average\ strike\ price}$ [17]

$\boldsymbol{r = risk - free\ rate}$[18]

$\boldsymbol{\sigma^2 = volatility}$ [19]

$\boldsymbol{N = number\ of\ shares\ outstanding}$ [17]

$M = number\ of\ options\ outstanding$

$q = dividend\ yield\ (\%)$ [20]

$T = weighted\ average\ maturity\ (in\ years)$ [18]

The stock price must be adjusted to reflect the fact that the stock price will decrease following the options exercise. It will do so because the number of shares outstanding will increase and because the exercise price is lower than the stock price. The adjustment is done as follow:

$$S^* = Adjusted\ Stock\ Price = \frac{NS_t + MK}{N + M}$$

The call option value is computed with the following formula:

$$c = S^* e^{-qT} N(d_1) - K e^{-rT} N(d_2)$$

where,

$$d_1 = \frac{\ln\left(\frac{S^*}{K}\right) + \left(r - q + \frac{\sigma^2}{2}\right)T}{\sigma\sqrt{T}}$$

[14] The financial debt is the sum of the notes payable, the current portion of long-term debts and the non-current portion of long-term debts while the adjusted financial debt is the financial debt increased by the cumulative present value of future operating leases commitments.

[15] American options can be exercised during the whole period of the option while European options can only be exercised at the expiration date.

[16] The stock price and the number of stock outstanding are the ones at the date at which the firm is valued (i.e. December 31, 2015).

[17] The strike price and the maturity are the weighted averages reported in the firms' Option Plan in order to ease the computation. Nevertheless, they still give a relevant approximation of the options' value.

[18] The risk-free rates are the annual averages of the last twelve months. The data used to compute them is available in Appendix 3.

[19] The volatility and the dividend yield are those estimated by the companies in their reports.

$$d_2 = \frac{\ln\left(\frac{S^*}{K}\right) + \left(r - q - \frac{\sigma^2}{2}\right)T}{\sigma\sqrt{T}} d_1 - \sigma\sqrt{T}$$

$$N(d_1) = NORMSDIST(d_1)$$

and

$$N(d_2) = NORMSDIST(d_2).$$

$N(x)$ is a cumulative probability distribution function[20] for a standardized normal distribution (Hull, 2012).

Finally, the total value of option is found by multiplying the call option value (c) by the number of options outstanding (M).

The final firm's value of equity is finally found by subtracting the options value of the firm's value of equity. This amount is then divided by the number of stocks outstanding to have the stocks' estimated value.

The estimated value can be compared to the market price in order to detect under or overvaluation of the firm's stocks. The difference between the intrinsic value estimated and the market stock price will be measured as a percentage of the former. The relative spread is $\varphi = \frac{Market\ Price}{Estimated\ value} - 1$. A positive value implies that the market price is higher than the estimated value while a negative implies the reverse. If φ is around zero, the firm's stock is fairly valued. In this thesis' framework, a φ statistically higher than 0% implies an overvaluation while a φ statistically lower than 0% implies an undervaluation. The stock is supposed to be significantly overvalued if φ exceed 25%[21] while a significant undervaluation is detected under -25%.

The hypotheses will be tested statistically in section 4. For the bilateral test, the null hypothesis is rejected if the t-statistic is higher than the critical value. The t-statistics being computed as $\left|\frac{\bar{x}-\mu_0}{s/\sqrt{n-1}}\right|$ where $\bar{x}$ is the average of the sample, μ_0 is the specified hypothesis value, s is the sample standard deviation and n is the number of observations. The critical value is the $100(1-\frac{\alpha}{2})$ percentile in a t-distribution with a α% level of significance. The level of significance can be defined as the probability to reject the null hypothesis while it is true. For unilateral tests, the rejection rules are as follow:

If $H_0: \mu \leq \mu_0$, the null hypothesis is rejected if $\frac{\bar{x}-\mu_0}{s/\sqrt{n-1}} > z_{t-\alpha}$

If $H_0: \mu \geq \mu_0$, the null hypothesis is rejected if $\frac{\bar{x}-\mu_0}{s/\sqrt{n-1}} < z_\alpha = -z_{-\alpha}$

If the rejection rules are not verified, the sample failed to reject the null-hypothesis.

[20] In the valuation process, it has been computed with the NORMSDIST function in Excel.

[21] These significance thresholds are assumptions, there are not based on any convention.

3.1.2. Data

3.1.2.1. Firms Selection

The selection of the twelve companies has been made randomly among publicly traded Payment FinTechs. No criterion of country, maturity, stock exchange or market capitalisation size has been imposed. However, the companies for which 2015 financial data was not available have been rejected. These companies have been found thanks to research carried out through various sources. The sample of companies is available in Table 3.1.

Table 3.1 – Payment FinTechs Sample

	Country	Stock Exchange	Ticker symbol
AppFolio, Inc.	USA	NASDAQ	APPF
CPI Card Group	USA	NASDAQ	PMTS
FairFX Group Plc	UK	LSE	FFX
FirstData Corp.	USA	NYSE	FDC
HiPay	France	EPA	HIPAY
MindBody Inc.	USA	NASDAQ	MB
Mint Payments Limited	Australia	ASE	MNW
MYOB	Australia	ASE	MYO
PayPal Holdings Inc.	USA	NASDAQ	PYPL
Shopify	Canada	NYSE	SHOP
Square Inc.	Canada	NYSE	SQ
WorldPay Group PLC	UK	LSE	WPG

Source: Author's research

The sample is made of twelve companies incorporated in five different countries, traded in five different stock exchanges. The largest market capitalisation is reached by PayPal while the smallest by HiPay. The sample is made of 6 small-cap[22] companies, 4 mid-cap[23] and 2 large-cap[24]. It is also composed of firms at different phases of their life cycle. The more recently created is Square in 2009 while the more mature is First Data created in 1969. All the companies in the sample, except Square, were incorporated more than ten years ago.

3.1.2.2. Valuation Inputs

The valuation process requires a certain amount of the firms' financial historical data coming from annual reports. For the free cash flow model; the revenues, the operating incomes and research and development expenditures have been retrieved from the firms' income statements. The firms' equity computation required the collection of financial data from the firms' balance sheets and their notes[25]. The notes used are the Operating Lease Commitments and the Option

[22] The market capitalisation is lower than $300 million
[23] The market capitalisation ranges between $300 million and $2 billion
[24] The market capitalisation is larger than $2 billion

Plan. The numbers of shares outstanding were also retrieved from annual reports while the stock prices at the time of the valuation have been collected in Yahoo! Finance.

The risk-free rates have been computed as the past twelve months' average of the 10-year government bond yield of the country where the firm is traded[26]. The historical data of the 10-year government bond yield from the four countries are available in Appendix 3.

The corporate tax rates were retrieved from the Corporate Tax Rates Tables from the KPMG's website and are available in Appendix 4. Each firm has been imposed the tax rate of its country of incorporation.

3.1.2.3. Industry Data

The reinvestment rates have been considered as the reverse of sales to capital ratio. The sales to capital ratio, the cost of capital and the cost of debt were retrieved from Damodaran's database and are set to the firm's industry average as classified in the database. The firms' industry classification and the industries' data are available respectively in Table 3.2 and Table 3.3.

Table 3.2 – Industry Classification

Company	Country	Geographical area	Industry
AppFolio	US	US	Software (Internet)
CPI Card Group	US	US	Computers/Peripherals
FaixFX	UK	Europe	Information Services
First Data	US	US	Information Services
HiPay	France	Europe	Information Services
MindBody	US	US	Software (Internet)
Mint Payment Ltd	Australia	Global	Software (System & Application)
MYOB	Australia	Global	Software (System & Application)
PayPal	US	US	Information Services
Shopify	Canada	US	Software (Internet)
Square	Canada	US	Information Services
WorldPay	UK	UK	Information Services

Source: Damodaran's database

In the database, data is classified by industry and by geographical area. There are five geographical areas represented: the US, Europe, Japan, Emerging Markets and Global. Therefore, Canadian companies have assumptions based on the industries data from the US while the Australians' rely on the Global database.

[26] Note that for the two Canadian firms, the risk-free rate has been considered as the same of US companies since they are traded on US stock exchanges. Furthermore, in their annual reports, they state that they used the US 10-year Treasury bond for their risk-free rate.

Table 3.3 – Industries Data

Area	*Industry*	Sales/Capital	Cost of Capital	Cost of Debt
Global	Software (System & Application)	0.94	10.77%	5.10%
Europe	Information Services	1.69	9.85%	4.88%
United States	Computers/Peripherals	1.90	9.01%	4.02%
	Information Services	1.93	7.44%	3.52%
	Software (Internet)	0.68	9.97%	4.02%

Source: Damodaran's database

The sets of assumptions made for each firm are available in Appendix 6 with the valuations results.

3.2. Linear Regressions

3.2.1. Methodology

A first simple linear regression has been carried out in order to determine whether the valuation method chosen gives consistent results on the sample of companies valued. It takes the form of the following equation:

$$mp = \beta_0 + \beta_1 ev + u$$

where the explained variable, mp is the market price of the shares on December 31, 2015 while the explanatory variable, ev is the estimated intrinsic value on a valuation based on the same date. As for any other simple linear regression β_0 is the intercept, β_1 the coefficient associated to the ev variable and u is the error term. This regression allows assessing the consistency of the valuation process. Indeed, as the fundamental analysis asserts, the stock price is supposed to be closely linked to the firm's intrinsic value. Since the estimated value is an estimation of the firm's intrinsic value, this regression should provide significant evidence that the intrinsic value has a high impact on the stock price. In the case where the R-Square, which measures the goodness of fit, would be low, it would suggest that the valuation model used did not provide consistent results.

Even though the stock prices are supposed to perfectly reflect the intrinsic value in an efficient market, it is rational to think that other factors can affect the market price. In this thesis' research question framework, the second regression attempts to detect whether the hype around the FinTech sector has an impact on Payment FinTechs' market prices. Consequently, the dependent variable (y) is the market value of FinTechs' stocks while the independent variable (x) is the "hype" surrounding FinTechs. The latter can also be interpreted as the FinTechs' visibility.

$$y = \beta_0 + \beta_1 x + u$$

In this regression, the time is taken as an observation. The interest is just to assess if a high level of hype causes an increase in the stock prices. The evolution over time is not of interest in this regression.

The market value of FinTechs' stocks (y) has been computed as an index of the twelve companies previously valued. This index tracks the FinTechs' stock prices between January 2016 and June 2017. The index is price-weighted such as the Dow Jones index. It implies that the volume of stocks for each firm is not taken into account. This type of index has been chosen since this thesis aims at testing if the hype as an impact on the stock prices, not on the volume of trading. The index has been computed as the sum of the twelve firms' monthly stock prices. This second regression takes the following form:

$$findex = \beta_0 + \beta_1 hype + u$$

The dependent variable is named $findex$ while the independent variable is named *hype*. However, this latter is hard to quantify and is not actually observed. The Google Trends indicator will, therefore, be used as a proxy variable for the hype. This is considered to be a good proxy since it is rational and relevant to think that the hype and the number of searches of the keyword "FinTech" on Google are positively correlated. It implies that in the following regression:

$$hype = \delta_0 + \delta_1 google\_trend + v_1$$

where $v_1$is the error term and δ_0 is the intercept, $\delta_1$has to be strictly positive ($\delta_1 > 0$). The assumption is assumed to be verified and the variable, named *google_trend* is, therefore, the proxy variable for the dependent variable *hype*. The simple linear regression equation is then the following:

$$findex = \alpha_0 + \alpha_1 google\_trend + e$$

To be noted that the use of the proxy implies that the intercept is $\alpha_0 = \beta_0 + \beta_1 \delta_0$, the coefficient of *google_trend* is $\alpha_1 = \beta_1 \delta_1$ and that the error term in this equation is a composite error term and is composed as follows: $e = u + \beta_1 v_1$. The results of the regression will report α_0 and not β_0 since Google Trends is not a perfect quantification of the hype.

In order to have a consistent interpretation of the regression, both the independent and the dependent variables are expressed in terms of their natural logarithms. It transforms the previous regression equation into the following:

$$\ln(findex) = \alpha_0 + \alpha_1 \ln(google\_trend) + e$$

The fourth null hypothesis can be formulated as $H4_0: \alpha_1 \leq 0$ while its alternative hypothesis is $H4_1: \alpha_1 > 0$. The null hypothesis will be rejected if its t-statistic is higher than the critical value. This critical value is the value corresponding to the significance level and the degree of freedom in the *t-distribution*[27]. The significance level is set to 5% while the degree of freedom is the number of observations diminished of one and is therefore equal to 17[28].

3.2.2. Data

To build the FinTech index, the monthly stock prices of the ten firms have been retrieved from Yahoo Finance. The period of interests is of 18 months, from January 2016 to June 2017. The ten firms' stocks are traded in four different countries; Australia, France, the United Kingdom and the United States. These countries have each their own domestic currency, respectively, the Australian Dollar, the Euro, the British Pound and the US Dollar. In order to be consistent, all stock prices have been expressed in a sole currency, namely the US Dollar. It has been chosen since the majority (7) of the firms are traded in the US. The exchange rates used to convert the stock prices are available in Appendix 5.

The Google Trends were retrieved from the Google Trends' website. It is a measure tracking the number of searches for specified combination of words. It is normalised to a minimum of 0 and a maximum of 100, which serves as the reference for the rest of the series. The maximum varies with the determined periods.

[27] The t-distribution of Student.
[28] Between January 2016 and June 2017, there are 18 months. Therefore, the degree of freedom is equal to 17 (18-1=17).

4. Results

4.1. FinTechs' Valuation

The free cash flow to firm model previously described gives the results available in Table 4.1. The first column is the stock price in local currency at the last trading day of 2015. The second column depicts the estimation of the intrinsic value of the firms' stocks in local currency. Column three and four provide respectively the same output than the two first but in a common currency, the US dollar. The adjustment has been made in order to have consistent descriptive statistics. There is, as a matter of fact, no point in computing an average of prices or comparing prices if they are not expressed in the same currency. The exchange rates used were those from December 2015. Finally, the last column represents the relative spread between the market price (mp) and the estimated value (ev). It is defined as $\varphi = \left|\frac{mp}{ev}\right| - 1$. The absolute value of the ratio has to be imposed in order to avoid misinterpretations. In fact, if the estimated value is negative and that the absolute value is not imposed, the relative spread would be negative which would suggest an undervaluation while the stock is actually overvalued.

Table 4.1 – Valuation Results

	Market Price (LC)	**Estimated Value (LC)**	**Market Price (USD)**	**Estimated Value (USD)**	**Relative Spread (φ)**
AppFolio, Inc.	$14.60	$9.05	$14.60	$9.05	61.33%
CPI Card Group	$9.98	$11.31	$9.98	$11.31	-11.76%
FairFX Group Plc	£0.21	£0.13	$0.14	$0.09	63.46%
First Data Corp.	$ 16.02	$6.66	$16.02	$6.66	140.54%
HiPay	€8.95	€6.67	$8.22	$6.12	34.18%
MindBody Inc.	$15.13	$7.99	$15.13	$7.99	89.36%
Mint Payments Ltd	AU$0.10	AU$(0.04)	$0.14	$(0.06)	150.00%
MYOB	AU$3.11	AU$ 0.64	$4.29	$0.88	385.94%
PayPal Holdings Inc.	$36.20	$27.36	$36.20	$27.36	32.31%
Shopify	$25.80	$16.02	$25.80	$16.02	61.05%
Square Inc.	$13.09	$12.76	$13.09	$12.76	2.59%
WorldPay Group Plc	£3.05	£0.81	$2.03	$0.54	276.54%
Average					**107.13%**
Standard Deviation					**1.1748**

Source: Author's computations

Taking a first look at the valuation results in Table 4.1, some observations can already be made. It appears that, in the sample, one stock is undervalued; one is approximatively fairly valued while the remaining ten are overvalued. It can also be noted that an estimated value is negative. In business valuation, it is not unusual to find negative values. It can either reflect the fact that the company is generating negative cash flows or that the firms have a too high level of debt or a combination of both.

Table 4.2 – Statistics of the Sample

	Minimum	**Maximum**	**Average**	**Standard deviation**
Market Price	0.14	36.20	12.14	10.74
Estimated Value	(0.06)	27.36	8.23	8.05
Relative spread	-11.76%	385.94%	107.13%	1.1748

Source: Author's computations

The descriptive statistics of the sample are available in Table 4.2. They highlight some interesting facts. First, the maximum market price and estimated value correspond to the same company namely PayPal. The minimums of both variables are also from the same firm, Mint Payments. These facts demonstrate evidence of the consistency of the valuation process. Nevertheless, the minimum estimated valued is negative. This is explained by a substantial operating loss that represents 187% of the revenues as well as an important level of debt that amounts to 81.64% of the assets.

The relative spread has a minimum of -11.76%. It corresponds to an undervaluation of the CPI Card Group company. The maximum spread between the market price and the estimated value is reached by MYOB, an Australian FinTech with an overvaluation of over 385%. The average spread is 107.13% which suggests a quite important overvaluation of the companies in the sample.

The hypotheses established in section 3.1.1 can now be tested using data from Table 4.2. The first null hypothesis states that FinTech firms are fairly valued. This statement would imply that the relative spread would be around zero. The first null hypothesis can, therefore, be written as $(H1)_0 : \varphi = 0$ against the alternative hypothesis $(H1)_1 : \varphi \neq 0$. The test gives the following results:

t-statistic	95^{th} (α=10%)	97.5^{th} (α=5%)	99^{th} (α=2%)	p-value
3.024389	1.796	2.201	2.718	0.0116

Source: Author's computations

The rejection rule for this test is $t > z_{1-\frac{\alpha}{2}}$. The t-statistic is 3.024389, which means that the null hypothesis is rejected even at 2% level of significance. The p-value is 0.0116, which set the maximum level of significance for which the null hypothesis would be rejected to 1.16%. Another interpretation is that the null hypothesis will be rejected for all value of α higher than the p-value. This suggests strong evidence to reject the hypothesis according to which the Payment FinTechs would be fairly valued.

The second null hypothesis which puts forward an undervaluation of the Payment FinTechs can be formulated as $(H2)_0 : \varphi \leq 0$ and the alternative hypothesis is $(H2)_1 : \varphi > 0$. This unilateral test provides the outputs in the table below.

t-statistic	90^{th} (α=10%)	95^{th} (α=5%)	97.5^{th} (α=2.5%)	99^{th} (α=1%)	p-value
3.024389	1.363	1.796	2.201	2.718	0.0058

Source: Author's computations

The second hypothesis is rejected at 10%, 5%, 2.5% and even 1% level of significance. The t-statistic is slightly lower for this test than for the previous one. Nevertheless, since it is a unilateral test while the first one was bilateral, it gives a better p-value of 0.58% instead of 1.16% for the first test.

The third hypothesis that attempts to detect a substantial overvaluation is even more relevant once the two first null hypotheses have been rejected with strong statistical evidence.

Since a significance threshold for the relative valuation spread has been established in section 3.1.1, the third null hypothesis can be formulated as $(H3)_0 : \varphi \leq 0.25$ while the alternative hypothesis is $(H3)_1 : \varphi > 0.25$. This test tries to assess whether the FinTechs are substantially overvalued or not. The t-statistic and the p-value of the third test are available in the table below.

t-statistic	90th (α=10%)	95th (α=5%)	97.5th (α=2.5%)	99th (α=1%)	p-value
2.318602	1.363	1.796	2.201	2.718	0.0203

Source: Author's computations

This test rejects the null hypothesis for a 10%, 5% and 2.5% level of significance. The p-value is 2.03%, which is the highest from the three tests. The test fails to reject the null hypothesis at 1% level of significance while the two firsts do not.

The three same tests have been carried out withdrawing two potential outliers from the sample; MYOB and WorldPay with, respectively, a relative spread of 385.94% and 276.54%. The average falls to 64.08% and the standard deviation to 0.5301. These tests provide the t-statistic and p-value available in the below-table.

	t-statistic	90th (α=10%)	95th (α=5%)	97.5th (α=2.5%)	99th (α=1%)	p-value
$(H1)_0$	3.626347	1.833	2.262	2.821	3.250	0.0055
$(H2)_0$	3.626347	1.383	1.833	2.262	2.821	0.0028
$(H3)_0$	2.211493	1.383	1.833	2.262	2.821	0.0279

Source: Author's computations

The withdraw of the two potential outliers reduces the number of observations to 10 and the degree of freedom to 9. The first null hypothesis is rejected with strong evidence since it is even rejected at the 1% level of significance. The second hypothesis is also rejected, with a lower p-value of 0.0028. Unlike the two first hypotheses, the third one is rejected but only at a 5% significance level. At 2.5% or 1% level of significance, the test fails to reject the null hypothesis.

It is to be noted that the p-values have been carried out using the t-distribution of the Student with the *TDIST* function of Excel. The number of observations is not sufficient to use the normal distribution.

4.2. Linear Regressions

The first regression mentioned in section 3.2.1 aims at detecting whether the model used to value the companies was relevant or not. Since a stock price is supposed to be firstly driven by its intrinsic value, the regression of the market price over the intrinsic value is supposed to give statistically significant results. This regression provides the results available in Table 4.3 and 4.4.

Table 4.3 – First Regression Results (1)

Regression Statistics	
Multiple R	0.94724156
R Square	0.89726658
Adjusted R Square	0.88699323
Standard Error	3.60899765
Observations	12

Source: Author's computations

Table 4.4 – First Regression Results (2)

	Coefficients	*Standard Error*	*t-Stat*	*p-value*
Intercept	1.73896187	1.52439499	1.14075543	0.28055496
ev	1.26382414	0.13523272	9.34554997	2.9453E-06

Source: Author's computations

The R-Square is of 0.8973 which proves that the estimated value has a high impact on the market price of the stock. From R-Square definition, it implies that 89.73% of the sample variation in the market price of a stock is explained by the intrinsic value. These results suggest that the valuation model used provided consistent outcomes. The regression equation can be written as:

$$\widehat{mp} = 1.739 + 1.264\, ev$$

The coefficient of the *estimated value* variable is 1.264 with a t-statistic of 9.3455, which implies that the coefficient is statistically significant. The estimated values are assumed to be the intrinsic values of the firms. Therefore, a coefficient of 1.264 suggests that the intrinsic value has a positive impact on the market value, as it should be. Moreover, since the coefficient is higher than 1, it puts forward an overreaction of market prices to changes in the intrinsic values.

The R-Square of the regression, even if high, also suggests that around 10.27% of the market prices' variation remain unexplained. The second regression attempts to detect if the hype surrounding the sector could have a positive impact on the market prices. The results of this regression are available in Table 4.5 and 4.6.

Table 4.5 – Second Regression Results (1)

Regression Statistics	
Multiple R	0.827684394
R Square	0.685061456
Adjusted R Square	0.665377797
Standard Error	0.135752315
Observations	18

Source: Author's computations

Table 4.6 – Second Regression Results (2)

	Coefficients	*Standard Error*	*t-Stat*	*p-value*
Intercept	0.659869567	0.79503869	0.82998422	0.41875989
google_trend	1.066291591	0.1807441	5.89945443	2.2414E-05

Source: Author's computations

These results can be summarised by the following equation:

$$\ln(\widehat{findex}) = 0.659869 + 1.0663 \ln(google\_trend)$$

The R Square of the regression is 0.6851, which suggests that the indicator of the number of searches on Google of the keyword "FinTech" explains around 68.51% of the variation in the price of the FinTech index. The coefficient of *google_trend* is 1.0662. Since the variables are expressed in logarithmic form: an increase of 1% in the *google_trend* index implies a 1.066% change in the FinTech index price. The coefficient $\alpha_1$is statistically significant with a t-stat of 5.89945 and a very small p-value. The table below sum-up the critical values depending on the level of significance.

t-statistic	90^{th} (α=10%)	95^{th} (α=5%)	97.5^{th} (α=2.5%)	99^{th} (α=1%)
5.899454	1.333	1.740	2.110	2.567

Source: Author's computations

These results demonstrate that the null hypothesis $(H4)_0 : \alpha_1 \leq 0$ can be rejected even at 1% level of significance. This strongly suggests that the amount of hype does have a positive effect on the Payment FinTechs' stock prices.

5. Discussion

5.1. Limitations

The model used to estimate firms' intrinsic values has its limitations. Indeed, business valuation is not an exact science. Different methods present sometimes different results. The fundamental value of a firm's stock will certainly not be the same using different methodologies. There is, therefore, no exact intrinsic value but rather consistent estimations based on historical data and economic factors. Some limitations are pointed out in this section.

Firstly, the DCF model relies on the collection of a range of financial data which is not always as straightforward as expected. In the sample, some companies have more standardised and complete annual reports, which make financial and historical data easily accessible. This is principally the case for the companies traded on the US stock exchanges since they have the obligation to provide and publish their annual and quarterly reports to the Security and Exchange Commission (SEC) in a standardised format. However, this is not the case for the companies traded in other countries. Consequently, their valuation might not be as accurate as the ones of the US companies.

Secondly, the model strongly relies on a series of assumptions. Some of these have substantial weight in the valuation process such as the expected revenue CAGR over the first five years, the expected pre-tax operating income in 10 years, the reinvestment rate and the cost of capital. Even though these assumptions are based on historical data and industry averages, they cannot perfectly predict the future of the economy neither of the firms.

Thirdly, the income approach has a glaring lack of qualitative factors in its conception. Since, the model mainly relies on financial data it does not take into account a series of qualitative factors that could affect firms' valuation such as quality of management, quality of staff, brand recognition, customers' loyalty or customer base. It is of common awareness that two firms with the exact same financial data but with two different management styles will not provide the same results at the end. The same conclusion can be drawn when considering quality of staff. Talented, innovative and enthusiastic employees might help the company to generate higher revenue. Brand recognition, customer loyalty, and customer base are also important factors since they are closely linked to revenue generation. The regulation faced by the firms can also be considered as a qualitative factor affecting firms' valuation. The regulation, as explained in the introduction, might be a financial burden for highly regulated entities. However, it can also represent a range of opportunities. For instance, in Europe, the revised Payment Services Directive (PSD2) could offer market opportunities to FinTechs. The Directive's implementation in 2018 will compel financial institutions to share customers' financial data to Third Party

Providers, which are mainly FinTech companies. Therefore, it will allow FinTechs to initiate payments on customers' behalves more easily.

Even though it has several limitations, the DCF model has been recognised as a consistent model to value technology incentive companies (Albouy et al., 2015). Moreover, the model includes a series of adjustments and assumptions that allow to fit as close as possible to the economic reality and the above-mentioned qualitative factors are hardly measurable and difficult to incorporate in business valuation models.

The linear regressions also have their limitations. Even though they provide a high level of goodness of fit, they remain simple regressions. It implies that the regressions only consider one variable to explain another one. It is reasonable to think that there are possible omitted variables that could lead to an omitted variable bias. Furthermore, too much significance should not be attributed to the R-Square indicator since it also has its limitations. Nevertheless, it should be reminded that the first regression does not aim at making any breakthrough but rather at evaluating whether the valuation process used is relevant or not. The second regression, on the other hand, tries to assess whether a higher level of hype around FinTech is associated with a higher level of prices in the Payment FinTech index. It does not attempt to precisely measure the impact of the former on the latter.

The sample size is one of the major limitations of this study. It is partially inherent to the fact that many FinTechs are privately owned which implies that their financial data are not publicly available. Even though the sample provided consistent results, they might have been more statistically significant with a wider sample of companies. A higher number of observations would have led to a higher degree of freedom and the hypotheses might have been rejected with a higher significance level.

Finally, in this thesis' framework, only FinTechs operating in the payment industry have been tested. These results can, in consequence, not be applied to the whole sector. It gives, nevertheless, a consistent insight of the impact of the hype surrounding the whole sector on the valuation of companies composing it.

5.2. Interpretation of the Results

The results depicted in section 4 can now be further investigated. Firstly the DCF model applied to the twelve companies of the sample provides results regarding the valuation of the Payment FinTechs. The first observation derived from the first hypothesis rejection is that the companies in the Payment FinTech sub-sector are not fairly valued. The rejection of this bilateral hypothesis either suggests that there is overvaluation or undervaluation in this sub-sector. The second test sheds light on this uncertainty. Indeed, the second hypothesis according to which the sector would be undervalued is rejected against the hypothesis stating that it is overvalued. Finally, the third test revealed a significant overvaluation of the FinTechs evolving in the payment market. The term "significant" relies on the threshold established in section 3.1.1 according to which companies are significantly overvalued if the relative spread is higher than 25%. The first test is rejected at a maximum of 1.16% level of significance, the second at 0.58% and the third at 2.03%. Therefore, the three first hypotheses are all rejected at the 5% level of significance. After the withdraw of the two outliers, the conclusions are almost exactly the same, only the p-values slightly change. From these statistical tests, it is relevant to think that the sub-sector is overvalued. Furthermore, the results available in Table 4.1 also emphasise that, on average, only around 53.97% of the stock prices are explained by their intrinsic values while the remaining 46.03% stay unexplained.

The first linear regression then highlights that the model used to estimate the intrinsic value is consistent. The firms' fundamental values explained around 89.73% of the variation in the market prices. This conclusion is consistent with the concept that the market price is supposed to be firstly driven by the firm's intrinsic value. Nevertheless, this regression linked to the overvaluation of the sector brings light to a gap between the market price and the intrinsic value. Indeed, the regression's results suggest that around 10.27% of the valuation in the market prices are not explained by their intrinsic values. Furthermore, the coefficient of the estimated intrinsic value is around 1.2, which implies that the market prices tend to overreact to changes in the intrinsic values.

The second linear regression, intended to assess whether the gap between the market prices and the fundamental values of the stocks might be caused by an overreaction of unsophisticated investors in response to an increasing hype surrounding the sector. The regression's results demonstrate that a higher level of hype tends to increase the price of the FinTech index. At least it highlights a positive correlation between hype and the level of stock prices.

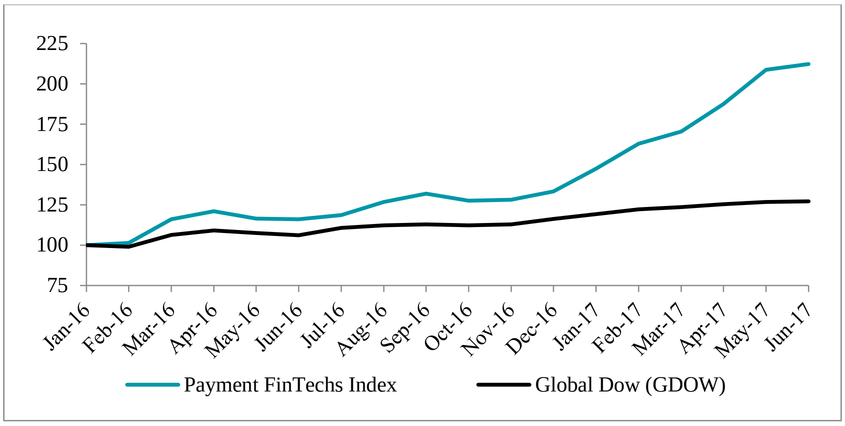
The set of tests carried out and their results provide evidence that the Payment FinTech sub-sector is overvalued and that the hype surrounding the whole FinTech sector might be causing this overvaluation.

5.3. Is There a Bubble Emerging?

The results of the various tests carried out in this thesis suggest that FinTechs are going through a hyped period, which creates an upward pressure on their market stocks. As mentioned in the introduction, this phenomenon already occurred for the Internet companies during the last years of the 20th century. The overvaluations formed the so-called *dotcom bubble*, which finally burst in 2001. In his book "*Bubbles and Contagions in Financial Market*", Eva Porras (2016) established the following formula: $x_t = F_t + B_t$ where x_t is the stock price, F_t is the fundamental value of this stock and B_t is the part of the market price that constitutes the bubble. Following this reasoning, since the market price does not equalise the fundamental value in the valuations of the firms' sample; it would mean that the remainder of the market price is probably explained by a bubble.

In academic literature, there is no homogeneous definition of the word "bubble". Nevertheless, it is common to refer to a bubble when an asset price exceeds its fundamental value. As demonstrated in section 4, it was the case for the Payment FinTechs in December 2015. To detect whether this potential bubble still exists or not, a closer look at the evolution of the stock prices seems relevant. Figure 5.1 depicts the evolution of the equally weighted index[29] built with the twelve stocks studied in this paper for the period following their valuations (i.e. between January 2016 and June 2017).

Figure 5.1 – Stock Indices Evolution

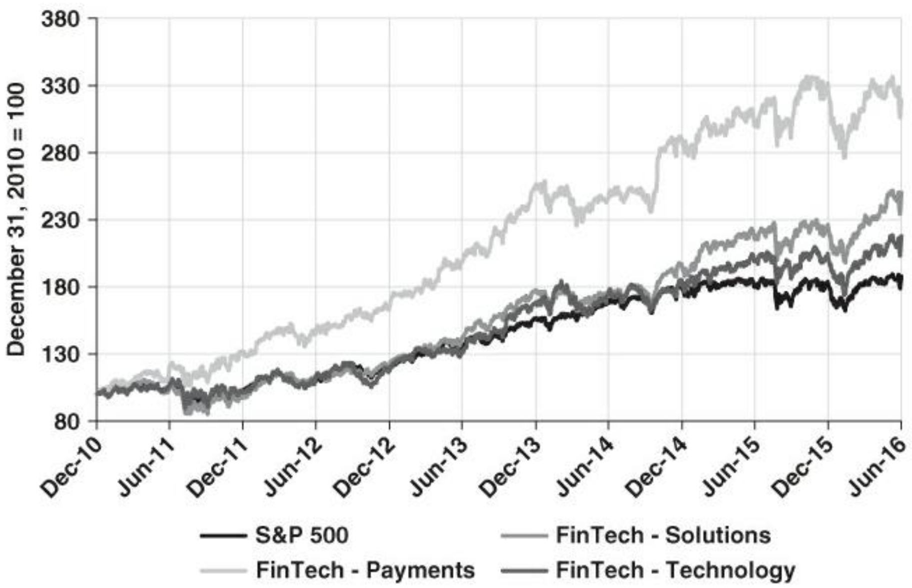


Source: Authors' computations based on Yahoo Finance data

[29] This equally-weighted index has been built with monthly stock prices of the twelve firms studied in previous sections. All the stock prices are expressed in USD. The aggregation of the stock prices on January 2016 is used as the basis of the index at is set to 100 in order to ease the comparison with the Global Dow Index.

From Figure 5.1, it can be observed that the Payment FinTechs index dramatically increased between January 2016 and June 2017. It more than doubled in eighteen months. The average growth rate is 81.34%[30], which is highly substantial in such a short period of time. The Global Dow Index, an equally weighted-index, is also plotted in Figure 5.1 in order to compare it with the Payment FinTechs index. It appears that the FinTech index has been outperforming the market and that this outperformance substantially increases over time. Note that the Global Dow has been chosen since it is also composed of firms publicly traded in various countries such as it is the case for the FinTechs index. In his recent book "Creating Strategic Value Through Financial Technology", Wilson (2017) plots a FinTech Payment index that he compares to other FinTech indices and especially to the Standard & Poor's 500 Index between December 2010 and June 2016. This chart is available in Figure 5.2; ss Figure 5.1, it attests that FinTechs are outperforming the market for a few years now. It also must be emphasised that the Payment FinTech index performs better than the others FinTech indices. It could mean that overvaluation is more substantial in this FinTech's sub-sector than in the others.

Figure 5.2 – FinTech Indices and S&P500 Evolution



Source: Creating Strategic Value Through Financial Technology (Wilson, 2017)

The set of evidence provided in this thesis suggests that a bubble is effectively emerging in the Payment FinTech sub-sector. It is supported by the observation from Wilson (2017), that the margins are going down while the valuation multiples are on the rise. According to Porras (2016), bubbles have a life cycle, which is made of four phases. The first one is the *stealth* phase during which the potential of the innovation is only noticed by a few informed market participants that invest in it. It is then followed by the *awareness* period during which the

[30] The average growth rate has been computed in local currency.

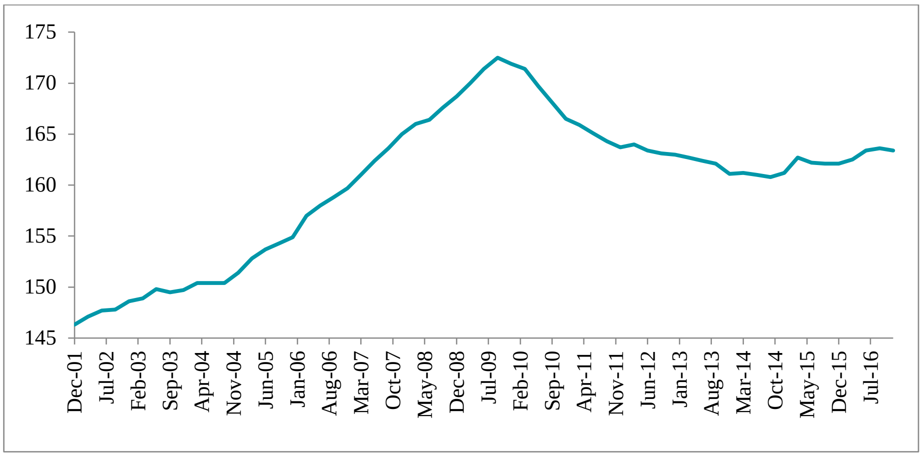
investments seem more and more promising and the informed investors strengthen their positions while the media start to communicate to the public about it. The intervention of the media initiates the *mania* phase. This phase is characterised by a dramatic increase in prices and a disconnection between the stock prices and their fundamental values. The unsophisticated investors then largely dominate the market. This phase ends with the sudden realisation that the market prices do not reflect the fundamentals and implies the last phase, the *blow off*. The investors start to sell their positions, the demand decreases and the prices collapse.

By referring to the investments data, the quantification of the hype for FinTechs by the Google Trends and the sample's valuation results, the FinTech bubble that is suggested in this paper might be situated in the bubble life cycle of Porras (2016). Before 2013, the FinTech sector would have been in the *stealth* phase; a slight increase in the investment but no particular attention from the public. In 2015, the investments continued to increase but at a much higher rate, and the public interest in the sector started to raise; it would be the *awareness* phase. Finally, 2016 would have been the starting point of the *mania* phase with a high level of investments, a dramatic increase in the stock prices and an abnormal attention from the public.

5.4. Economic Consequences

The overvaluation of a sector, and more precisely the emergence of a bubble, might cause economic damages. One of the main features of bubbles is that they cannot subsist indefinitely. They will ultimately burst and that burst will harm the economy. In an article for the World Economic Forum, Jordá et al. (2014) stated that equity bubbles are damaging for the economy. They also brought to the fore that a substantial level of credits in the economy strengthens the adverse effects of the explosion of an asset price bubble. Figure 5.3 aims at detecting whether the economy is currently in a credit-incentive period or not. The chart plots the market values of credits in the nonfinancial private sector (households and businesses) in advanced economies as a percentage of the GDP using PPP exchange rates.

Figure 5.3 – Evolution of Credit (% of GDP)



Source: BIS database

Figure 5.3 demonstrates that the 2008 financial crisis is partially due to a house price bubble lined with a credit boom. However, there is no evidence of credit boom for the recent years. Consequently, if a bubble would blow up, it would not create as many devastating damages in the economy as the 2008-crisis caused. Even though the effects of the burst of a bubble in the economy are sometimes well contained, such as for the *dotcom bubble* (Jordá et al, 2016), bubbles do not have positive impacts on the economy. Especially not for investors who invested their money in what they thought to be a lucrative investment in a high-potential sector.

According to Shiller (2000), the burst of a bubble does not automatically imply a stock market crash. The burst does not have to be sudden; the bubble might slightly decrease over time while the investors progressively change their opinion about the potential of the firms. Moreover, Jean-Claud Trichet, former President of the European Central Bank, in a 2005-speech also alleged that not all asset price bubbles are threats to the financial stability.

Aside from a potential bubble formation, the emergence of innovative financial technologies could have beneficial consequences on the economy. FinTechs are able to provide customised financial services at lower cost and to a wider public. The disruption of the financial industry by technological and digital innovations might help to reduce the inefficiencies (Wilkins, 2016). FinTechs give for instance more attention to economic agents underserved by traditional providers, such as the SMEs. (Drummer, Koenitzer, Stein, Tufano, & Ventura, 2015). They also might drive financial inclusion in developing countries and therefore help to reduce the gap with developed economies (Buckley & Webster, 2016). Indeed, developing economies have a substantial part of the population that is “unbanked” but have high adoption rates for mobile devices (Wilson, 2014). The new era in the financial technology sector might have several positive economic and social payoffs.

6. Conclusion

The growing interest in the financial technology sector, recently referred as FinTech, raised a series of question. One of these, constitute the research question of this thesis; does the hype surrounding FinTechs caused an overvaluation of their stock prices? The reasoning built to respond this question relies on a sample of twelve FinTechs evolving in the payment sub-sector.

Firstly, the intrinsic values of the stocks had to be determined in order to detect whether the stocks prices reflect their fundamental values or not. A three-stage growth DCF model based on assumptions relying on economic factors, historical data and industries averages, revealed an overvaluation of the sub-sector. The hypotheses testing emphasised that is was a substantial overvaluation since the average relative spread between the estimated values and the market prices was statistically higher than 25%.

Secondly, a simple regression allowed demonstrating that a higher level of hype around FinTech implies a rise in the price of the Payment FinTech index. The hype has been quantified by using the Google Trends, which provides an indicator of the number of searches for the keyword “FinTech”. On the other hand, the Payment FinTech index was a price-weighted index composed of the twelve firms studied in the first part.

From the findings of the two methodologies, it appears that the hype surrounding the FinTech phenomenon could, in fact, push up the market prices of Payments FinTechs’ stocks. This first conclusion brought the idea that a speculative bubble might be emerging. Indeed, there is evidence for a possible formation of a bubble in the FinTech sectors. Firstly, the market prices are disconnected from their fundamentals causing overvaluations. Secondly, the stock prices are dramatically rising because of an ever-growing interest from the public for this innovative sector. In consequence, the Payment FinTechs’ stocks have been increasingly outperforming the broad market for a few years. This phenomenon is somewhat reminiscent of the high-tech bubble that emerged in the last years of the 20th century.

This thesis, in spite of its models’ limitations, brings elements of response to a possible overvaluation of the FinTech sector. Nevertheless, a deeper study on the topic should be performed to claim that a bubble is effectively forming and to assess the potential consequences. FinTech is widely covered in popular media but not sufficiently addressed in academic literature. This thesis aimed at bringing its contribution to fill this gap.

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Appendices

Appendix 1 – Valuation Process

	Base year (*t=0*)	*t=1, 2, 3, 4, 5*	*t=6, 7, 8, 9, 10*	Terminal year (*t=T*)
Revenue Growth Rate (*g*)		$g_t = CAGR^*$	$g_t = CAGR^* - \left(\left(CAGR^* - r_f\right)\left(\frac{t-5}{5}\right)\right)$	$g_T = r_f$
Revenues *(R)*	R_0	$R_t = R_{t-1}\,(1 + g_t)$		$R_T = R_{10}(1 + g_T)$
Operating Margin *(θ)*	$\theta_0 = \frac{OI_0}{R_0}$	$\theta_t = \theta^* - \left(\left(\frac{\theta^* - \theta_0}{10}\right)(10 - t)\right)$		$\theta_T = \theta_{10} = \theta^*$
Operating Income *(OI)*	OI_0	$OI_t = R_t\theta_t$		$OI_T = R_T\theta_T$
Tax rate (τ[31])	$\tau_0 = \tau^e$	$\tau_t = \tau^e$	$\tau_t = \tau_{t-1} + \left(\frac{\tau^c - \tau^e}{5}\right)$	$\tau_T = \tau^m$
Operating Income After Taxes (OIAT)	***if*** $\boldsymbol{OI_t \le 0}$ $OIAT_0 = OI_0$ ***if*** $\boldsymbol{OI_t > 0}$ $OIAT_0 = OI_0(1 - \tau_0)$	***If*** $\boldsymbol{OI_t \le 0}$ ***or*** $\boldsymbol{OI_t < NOL_{t-1}}$ $OIAT_t = OI_t$ ***if*** $\boldsymbol{OI_t \ge NOL_{t-1}}$ $OIAT_t = OI_t - \left((OI_t - NOL_{t-1})\tau_t\right)$		$OIAT_T = OI_T(1 - \tau_T)$
Reinvestment *(RI)*[32]		$RI_t = (R_t - R_{t-1})\gamma$		$RI_T = \left(\frac{g_T}{\omega_T}\right)OIAT_T$
Free Cash-Flow *(FCF)*		$FCF_t = OIAT_t - RI_t$		$FCF_T = OIAT_T - RI_T$
Net Operating Loss *(NOL)*[33]	NOL_0	***if*** $\boldsymbol{OI_t < NOL_{\ t-1}}$ $NOL_t = NOL_{t-1} - OI_t$ ***if*** $\boldsymbol{OI_t \ge NOL_{\ t-1}}$ $NOL_t = 0$		
Cost of Capital (ω)[34]		$\omega_t = \omega^*$	$\omega_t = \omega_{t-1} - \left(\frac{\omega^* - \omega_T}{5}\right)$	$\omega_T = r_f + 4.5\%$
Cumulated discount factor (δ)	1	$\delta_t = \frac{\delta_{t-1}}{1 + \omega_t}$		
Present Value of FCF (PV(FCF))		$PV(FCF)_t = \delta_t\,FCF_t$		

[31] τ^e is the effective tax rate reported by the firm on the base year while τ^c is the theoretical going corporate tax rate in the incorporation country
[32] γ is the reinvestment rate, which is the reverse of the sales to capital ratio
[33] The NOLs are considered as positive number even though it constitute losses
[34] ω^* is the average industry's cost of capital

Terminal Value	$TV = \frac{FCF_T}{(\omega_T - r_f)}$
Present Value of the Terminal Value	$PV(TV) = \delta_{10}TV$
Sum of the Present Value of FCF over 10 years	$\sum_{t=1}^{10} PV(FCF)_t$
Firm Value	$FV = \sum_{t=1}^{10} PV(FCF)_t + \delta_{10}TV$
Probability of failure	10%
Proceeds if firm fails (failure Value)	$fV = 50\% * FV$
Final Firm Value	$FFV = FV * 90\% + fV * 10\%$
- Debt	$D_t = Notes\ payables_t + Current\ Portion\ of\ LT\ Debt_t + Non - Current\ Portion\ of\ LT\ Debt_t$
- Minority interests	$M_t = Minority\ Interests$
+ Cash	$C_t = Cash\ and\ Equivalent + Short\ Term\ Investments$
= Value of Equity	
- Value of Options	*The method used to value options is explained in section 3.1.1.*
= Value of Equity in Common Stock	
Number of Shares	N_t
Estimated Value per Share	$\frac{Value\ of\ Equity\ in\ Common\ Stock}{Number\ of\ Shares}$

Appendix 2 – Payment Industry's Historical Data

Table I – Payment Industry Revenues

Revenues in million USD	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**CAGR (2010-2014)**
American Express	27,560	28,360	24,520	27,580	29,960	31,560	32,870	34,190	32,820	32,120	4.39%
Automatic Data processing	7,800	8,776	8,838	8,928	9,833	10,600	9,442	10,230	10,940	11,670	2.76%
Blackhawk Network Holding	-	-	-	578	752	959	1,138	1,445	1,801	1,900	20.12%
Cardtronics	378	493	493	532	625	780	876	1,055	1,200	1,265	14.67%
Cielo	1,232	1,500	1,251	2,242	2,513	2,760	3,127	3,288	3,397	3,547	7.96%
Delux Corp	1,606	1,469	1,344	1,402	1,418	1,515	1,585	1,674	1,773	1,849	3.61%
Euronet WorldWide	903	1,046	1,033	1,038	1,161	1,268	1,413	1,664	1,772	1,959	9.90%
Everi Holdings	601	672	668	606	544	584	582	593	827	859	-0.42%
EVERTEC	-	-	-	-	321	342	358	362	374	390	
Fiserv	3,897	4,587	4,077	4,133	4,289	4,436	4,814	5,066	5,254	5,505	4.15%
Fleetcor	-	341	354	434	520	708	895	1,199	1,703	1,832	22.55%
Global Payments	1,062	1,274	1,462	1,642	1,860	2,204	2,376	2,554	2,774	2,898	9.24%
Green Dot	-	-	113	364	467	546	574	602	695	719	10.58%
JetPay Corporation	-	-	-	-	-	-	31	33	43	56	
MasterCard	4,068	4,992	5,099	5,539	6,714	7,391	8,312	9,441	9,667	10,780	11.25%
Money Gram	158	927	1,162	1,167	1,248	1,341	1,474	1,550	1,539	1,630	5.84%
PaySafe	84	76	62	62	127	178	253	365	613	1,000	**42.76%**
Planet Payment	18	36	47	31	42	44	47	47	53	54	9.17%
Total System Services	1,806	1,722	1,677	1,718	1,809	1,794	2,064	2,447	2,780	4,170	7.33%
Vantiv	-	-	951	1,162	1,622	1,863	2,108	2,577	3,160	3,579	17.27%
VeriFone	903	922	845	1,002	1,304	1,866	1,702	1,869	2,000	1,992	13.28%
Visa	3,590	6,263	6,911	8,065	9,188	10,420	11,780	12,702	13,880	15,082	9.51%
WEX	336	394	315	390	553	623	717	818	855	1,018	15.93%

Source : Ycharts database

Table II – Payment Industry Pre-Tax Operating Incomes

Pre-tax Operating Income in million USD	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
American Express	9,561	7,136	5,048	8,387	9,276	8,677	9,846	10,700	9,561	9,800
Automatic Data processing	1,718	1,892	1,933	1,872	1,927	2,109	1,719	1,885	2,077	2,291
Blackhawk Network Holding	-	-	-	38	62	78	83	79	88	23
Cardtronics	7	-40	43	66	77	91	83	105	140	146
Cielo	694	1,121	1,630	1,331	1,296	1,426	1,478	2,090	2,011	2,071
Delux Corp	273	211	201	280	264	298	319	334	348	363
Euronet WorldWide	108	-164	83	5	84	67	125	154	166	261
Everi Holdings	82	79	72	53	37	56	49	31	-23	-119
EVERTEC	-	-	-	-	46	72	12	101	106	108
Fiserv	746	900	954	991	911	1,055	1,061	1,211	1,227	1,445
Fleet Cor		153	147	172	226	325	421	565	668	754
Global Payments	235	270	300	328	342	317	368	419	462	430
Green Dot	-	-	23	70	84	76	53	70	64	71
JetPay Corporation	-	-	-	-	-	-	-3	-5	0	-8
MasterCard	1,729	-280	2,333	2,809	2,773	3,953	4,514	5,127	5,019	5,741
Money Gram	-982	-242	130	161	126	62	133	117	16	88
PaySafe	-13	6	-2	-4	-25	5	34	61	22	186
Planet Payment	-12	-10	-3	-2	3	-4	0	4	6	10
Total System Services	381	386	751	308	322	355	385	434	538	577
Vantiv	-	-	195	170	243	305	353	315	434	569
VeriFone	27	-323	-122	107	106	148	-66	6	107	33
Visa	-1,307	1,479	4,115	4,710	5,456	2,139	7,239	7,732	8,998	8,439
WEX	210	243	242	156	226	222	272	344	237	213

Source: Ycharts database

Table III – Payment Industry Pre-Tax Operating Incomes in percentage of Revenue

Pre-tax Operating Income as % of revenue	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
American Express	34.69%	25.16%	20.59%	30.41%	30.96%	27.49%	29.95%	31.30%	29.13%	30.51%
Automatic Data processing	22.03%	21.56%	21.87%	20.97%	19.60%	19.90%	18.21%	18.43%	18.99%	19.63%
Blackhawk Network Holding	-	-	-	6.53%	8.20%	8.14%	7.32%	5.45%	4.87%	1.22%
Cardtronics	1.87%	-8.18%	8.72%	12.45%	12.37%	11.60%	9.42%	9.92%	11.66%	11.57%
Cielo	56.31%	74.73%	130.30%	59.37%	51.57%	51.67%	47.27%	63.56%	59.20%	58.39%
Delux Corp	17.00%	14.34%	14.98%	19.98%	18.61%	19.64%	20.15%	19.93%	19.64%	19.62%
Euronet WorldWide	12.02%	-15.71%	8.02%	0.52%	7.25%	5.28%	8.86%	9.24%	9.36%	13.33%
Everi Holdings	13.58%	11.71%	10.79%	8.69%	6.87%	9.58%	8.44%	5.24%	-2.76%	-13.79%
EVERTEC	-	-	-	-	14.31%	21.03%	3.27%	27.87%	28.46%	27.73%
Fiserv	19.14%	19.62%	23.40%	23.98%	21.24%	23.78%	22.04%	23.90%	23.35%	26.25%
Fleet Cor		44.73%	41.51%	39.60%	43.56%	45.92%	46.99%	47.16%	39.20%	41.17%
Global Payments	22.11%	21.16%	20.49%	19.97%	18.41%	14.40%	15.47%	16.41%	16.64%	14.85%
Green Dot	-	-	20.77%	19.15%	18.05%	13.95%	9.16%	11.67%	9.22%	9.83%
JetPay Corporation	-	-	-	-	-	-	-8.75%	-14.78%	-0.32%	-14.61%
MasterCard	42.50%	-5.60%	45.75%	50.71%	41.30%	53.48%	54.31%	54.31%	51.92%	53.26%
Money Gram	-	-26.12%	11.21%	13.75%	10.10%	4.62%	9.00%	7.54%	1.05%	5.40%
PaySafe	-	8.46%	-2.69%	-6.40%	-19.46%	3.06%	13.33%	16.71%	3.56%	18.64%
Planet Payment	-65.59%	-28.41%	-5.49%	-6.09%	7.25%	-9.75%	0.28%	8.50%	12.21%	18.25%
Total System Services	21.09%	22.40%	44.76%	17.92%	17.83%	19.79%	18.65%	17.73%	19.34%	13.83%
Vantiv	-	-	20.49%	14.63%	14.99%	16.36%	16.74%	12.21%	13.75%	15.88%
VeriFone	3.02%	-35.04%	-14.41%	10.69%	8.11%	7.91%	-3.90%	0.31%	5.35%	1.65%
Visa	-36.41%	23.61%	59.54%	58.40%	59.38%	20.53%	61.45%	60.87%	64.83%	55.95%
WEX	62.45%	61.64%	76.68%	39.90%	40.81%	35.56%	37.93%	42.09%	27.70%	20.91%
Average	**15.05%**	**12.78%**	**27.86%**	**21.67%**	**20.51%**	**19.27%**	**19.37%**	**21.55%**	**20.28%**	**19.54%**
Average over 10 years										**19.79%**

Source: Ycharts database

Appendix 3 – Risk-Free Rates

Table IV – Risk-free Rates

	10-Year Government Bond			
Date	Australia	France	UK	US
01-01-16	2.47%	0.55%	1.34%	1.64%
01-02-16	2.49%	0.54%	1.79%	2.00%
01-03-16	2.33%	0.48%	1.58%	1.93%
01-04-16	2.66%	0.63%	1.84%	2.04%
01-05-16	2.74%	0.80%	1.80%	2.12%
01-06-16	2.99%	1.20%	2.03%	2.35%
01-07-16	2.77%	0.94%	1.88%	2.19%
01-08-16	2.69%	1.15%	1.95%	2.21%
01-09-16	2.60%	0.90%	1.77%	2.04%
01-10-16	2.63%	0.87%	1.93%	2.15%
01-11-16	2.86%	0.79%	1.83%	2.21%
01-12-16	2.89%	0.99%	1.96%	2.27%
Average	**2.68%**	**0.82%**	**1.81%**	**2.09%**

Source: investing.com

Appendix 4 – Corporate Tax Rates

Table V – Corporate Tax Rates

Country	***2015***
Australia	30.00%
Canada	26.50%
France	33.33%
United Kingdom (UK)	20.00%
United States (US)	40.00%

Source: KPMG Corporate Tax Rates[35].

[35] Retrieved from https://home.kpmg.com/xx/en/home/services/tax/tax-tools-and-resources/tax-rates-online/corporate-tax-rates-table.html

Appendix 5 – Monthly Exchange Rates

Table VI – Exchange Rates

Date	EUR/USD	GBP/USD	AUD/USD
December 2015	1.089412	1.500192	0.724369
January 2016	1.086531	1.442080	0.702670
February 2016	1.110255	1.431595	0.712866
March 2016	1.112455	1.424819	0.749343
April 2016	1.133822	1.424819	0.766204
May 2016	1.130242	1.451771	0.731660
June 2016	1.124398	1.422832	0.739711
July 2016	1.106476	1.316192	0.752537
August 2016	1.120072	1.309189	0.762205
September, 2016	1.120637	1.315652	0.757825
October 2016	1.104075	1.237009	0.761563
November 2016	1.079586	1.244121	0.752673
December 2016	1.053703	1.248168	0.733930
January 2017	1.062243	1.233802	0.744267
February 2017	1.064986	1.248549	0.766378
March 2017	1.069239	1.233595	0.762244
April 2017	1.070653	1.262660	0.754485
May 2017	1.104907	1.292180	0.743424
June 2017	1.122401	1.279176	0.754445

Source: x-rates.com

Appendix 6 – Valuations' Inputs and Results

AppFolio	2015
Marginal tax rate	40.00%
CAGR	41.23%
Pre-tax operating margin	19.79%
Sales to capital	0.68
Riskfree rate	2.09%
Cost of capital	9.97%
Cost of debt	4.02%
Share Estimated Value	**$ 9.05**
Market Price	**$ 14.60**
Relative spread	**61.33%**

CPI Card Group	2015
Marginal tax rate	40.00%
CAGR	10.93%
Pre-tax operating margin	19.79%
Sales to capital	1.90
Riskfree rate	2.09%
Cost of capital	9.01%
Cost of debt	4.02%
Share Estimated Value	**$ 11.31**
Market Price	**$ 9.98**
Relative spread	**-11.76%**

FairFX	2015
Marginal tax rate	20.00%
CAGR	8.00%
Pre-tax operating margin	19.79%
Sales to capital	1.69
Riskfree rate	1.81%
Cost of capital	9.85%
Cost of debt	4.88%
Share Estimated Value	**£0.13**
Market Price	**£0.21**
Relative spread	**63.46%**

FirstData	2015
Marginal tax rate	40.00%
CAGR	8.00%
Pre-tax operating margin	19.79%
Sales to capital	1.93
Riskfree rate	2.09%
Cost of capital	7.44%
Cost of debt	3.52%
Share Estimated Value	**$ 6.66**
Market Price	**$ 16.02**
Relative spread	**140.54%**

HiPay	2015
Marginal tax rate	33.33%
CAGR	8.00%
Pre-tax operating margin	19.79%
Sales to capital	1.69
Riskfree rate	0.82%
Cost of capital	9.85%
Cost of debt	4.88%
Share Estimated Value	**€ 6.67**
Market Price	**€ 8.95**
Relative spread	**34.18%**

MindBody	2015
Marginal tax rate	40.00%
CAGR	33.41%
Pre-tax operating margin	19.79%
Sales to capital	0.68
Riskfree rate	2.09%
Cost of capital	9.97%
Cost of debt	4.02%
Share Estimated Value	**$ 7.99**
Market Price	**$ 15.13**
Relative spread	**89.36%**

Mint Payments	2015
Marginal tax rate	30.00%
CAGR	8.00%
Pre-tax operating margin	19.79%
Sales to capital	0.94
Riskfree rate	2.68%
Cost of capital	10.77%
Cost of debt	5.10%
Share Estimated Value	**AU$(0.04)**
Market Price	**AU$0.10**
Relative spread	**150.00%**

MYOB	2015
Marginal tax rate	30.00%
CAGR	10.94%
Pre-tax operating margin	19.79%
Sales to capital	0.94
Riskfree rate	2.68%
Cost of capital	10.77%
Cost of debt	5.10%
Share Estimated Value	**AU$ 0.64**
Market Price	**AU$ 3.11**
Relative spread	**385.26%**

PayPal	2015
Marginal tax rate	40.00%
CAGR	13.07%
Pre-tax operating margin	19.79%
Sales to capital	1.93
Riskfree rate	2.09%
Cost of capital	7.44%
Cost of Debt	3.52%
Share Estimated Value	**$ 27.36**
Market Price	**$ 36.20**
Relative spread	**32.31%**

Shopify	2015
Marginal tax rate	26.50%
CAGR	42.76%
Pre-tax operating margin	19.79%
Sales to capital	0.68
Riskfree rate	2.09%
Cost of capital	9.97%
Cost of Debt	4.02%
Share Estimated Value	**$ 16.02**
Market Price	**$ 25.80**
Relative spread	**61.05%**

Square	2015
Marginal tax rate	26.50%
CAGR	42.76%
Pre-tax operating margin	19.79%
Sales to capital	1.93
Riskfree rate	2.09%
Cost of capital	7.44%
Cost of debt	3.52%
Share Estimated Value	**$ 12.76**
Price	**$ 13.09**
Relative spread	**2.59%**

WorldPay	2015
Marginal tax rate	20.00%
CAGR	8.00%
Pre-tax operating margin	19.79%
Sales to capital	1.69
Riskfree rate	1.81%
Cost of capital	9.85%
Cost of debt	4.88%
Share Estimated Value	**£ 0.81**
Price	**£ 3.05**
Relative spread	**276.54%**