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Penny stocks attractiveness for retail investors

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I. Introduction

The study of the survival of an IPO, especially small size company's IPO, is getting more and more attention in the academic world recently. On one hand, investors are showing a growing interest in lottery-like stocks such as penny stocks (Kumar, 2009). On the other hand, during the last decades, we have seen a shortening of the survival time of companies after their listing on public exchanges (Fama and French, 2004). At the same time, Junior Markets are becoming more and more popular amongst retail and institutional investors, and companies are allowed to list on these markets although they do not report profits, revenues or operational history. Jain, Jayaraman and Kini (2008) explain the extensive development of such markets by a shift in the way investors see companies and on what ground they base their investment decisions. Before, the profitability and what the company could offer in the present were the two most important things to consider for investors. Nowadays, for many investors, what a company can offer in the future, or in other words its growth potential is the most interesting thing for investors. However, even if Junior Markets can offer amazing growth for investors with a greater number of IPOs, these exchanges are often characterized by a high degree of illiquidity, small amount of money raised, and quite poor long-term performance compared to main markets.

The main academic works published on the survival of small size IPOs were done by Audretsch and Lehmann (2005) who focused on the survival of companies on the Neuer Markt in Germany and mainly considered the intangible characteristics of the companies to explain their survival. A second piece of work was done by Jain et al (2008) where they focused on technological companies listed on the NASDAQ. They mainly used the backgrounds of the C-suite to explain the success of the studied companies. Finally, Carpentier and Suret (2011) tried to demonstrate that the basic listing requirements such as profitability, shareholders' equity, etc. have an influence on the survival and success of newly listed companies on the Canadian market.

Searching for companies' characteristics at the time of IPO that can foster the success or at least the survival of a company is a real challenge that the three previously cited articles tried to tackle. This work is a continuation of these researches and its objective is to determine if some factors that can easily be identified by investors, such as the profitability, the size or the operational history can explain the survival or success of a penny stock company. To do so, this work is inspired by the research conducted by Carpentier and Suret in 2011 where they conducted a survival analysis using the Cox Proportional Hazard regression model (Cox, 1972). This work uses a sample composed of 439 penny stock IPOs conducted on the Alternative Investment Market (AIM) of

London between 2005 and 2014. The AIM was chosen for this study in order to have enough IPOs to conduct robust analysis. Moreover, it is the biggest growth market in Europe and one of the most successful growth markets in the world. The empirical part of this work was done by using the statistical language R (R Core team, 2013) and the *survival* package developed by Professors Therneau, Lumley, Atkinson and Crowson (Therneau, 2020). This particular package contains all the tools to conduct a survival analysis including a Cox regression, the test of its assumptions and the graphical representations of them. The influence of the different variables selected on both the failure probability and the success probability will be examined in order to determine if the same factors can explain the survival and the success.

This master thesis is organized as follow. Firstly, a general introduction to the penny stocks with the different definitions used in the world and their history with a focus on the Penny Stock Reform Act of 1990. Secondly, the historical development of junior markets in Europe will be given, with a focus on the Alternative Investment Market. All its particularities and its original organization will be explained in detail. Thirdly, the review of the literature with a more detailed part on the work of Carpentier and Suret realized in 2011 will be done. The hypotheses that will be tested in this work are then exposed followed by a section on the sample used for the study and the variables used in the model. The methodology will then be exposed and the way the model was created will be explained in detail. Following the methodology, the results will be showed and discussed to finally end with the conclusion of this work.

II. Penny Stocks in general

A. Definition

Penny stocks are one type of equity securities having a price falling below a certain level. The definition of a penny stock is not universal, it may vary depending on the place where it is issued. However, the most widely used is formulated by the Penny Stocks Reform Act (PSRA) published by the Security and Exchange Commission (SEC) in 1990 which states that a penny stocks is any equity securities that is:

- traded under $5 per share
- not traded on a National Exchange or Market (which corresponds to the NYSE or AMEX in the US)
- and have a low net tangible asset level

Although this is the most common definition, some flexibility can still be applied to decide whether or not a security is a penny stock. For example, researchers like Carpentier and Suret (2011) consider every stock issued under $5 per share as a penny stock without taking into account the two other requirements, or Konku, Bhargava and Malhotra (2012) only consider the two first requirements. The cut-off price can also vary from $1 per share to $8 per share (Konku, 2006) depending on the place where the study or the definition is made and often, the choice of the researcher. In Europe, the threshold price is often fixed at €1 per share.

From what can be observed in some studies, it is however possible to find some general characteristics that penny stocks share: low price, low trading volume, low sales, limited information available, small balance sheet, relatively new companies with few operating history, etc. This is why penny stocks are often considered as a highly speculative investment and are not among the investment products sought by of conservative and long-term investors. Penny Stocks are investment vehicles more suited to experienced investors who wish to manage actively their portfolios (Nofsinger and Varma, 2014).

However, regardless of the definition chosen or the study examined, the price is the only characteristic which is always considered by the researchers. For this reason, in this work, any stocks issued at a price lower than €5 on the Alternative Investment Market will be classified as a penny stock.

B. Penny Stock Reform Act

The Penny Stock Reform Act issued in 1990 is the first legal document that tried to give a general accepted definition of a penny stock. Their goal was also to diminish the fraudulent activity related to penny stock issues (Beatty and Kadiyala, 2003).

The penny stocks market has always been associated with a high level of fraudulent activity because of its lack of regulation and transparency. Before the creation of markets dedicated to smaller companies, micro capitalization enterprises who wanted to raise equity had to be listed on over-the-counter (OTC) markets, which are unregulated. According to the Penny Stock Reform Report Act, the lack of information about the traded companies was the main reason that can explain the fraudulent activities. The majority of the concerned stocks were not followed by any analysts and no useful information was available for small investors on which they could rely for their investment decisions.

The report also mentioned the inexistent effort of the National Quotation Bureau to verify whether the quoted bid-ask prices were the ones actually paid by investors, which offers a lot of room for fraudulent dealers and market makers. It also highlights the fact that most of the low requirements for OTC markets were ignored by the listed companies, or that they were not even aware of them, and that this negligence had no consequences for them. Regarding all of the above, the Report classified the penny stock market as "inefficient" or at least less efficient than main markets like the New York Stock Exchange or the American Stock Exchange. An additional argument that supports the inefficiency of penny stock markets is the limited arbitrage opportunities due to very expensive short-selling for penny stock securities (Rock, 1986).

Consequently, penny stock markets are characterized by a very high degree of fraudulent activities, in addition to the fact that share prices and market capitalization are quite low, which make manipulation activities easier for investors.

There were mainly two different schemes that fraudulent investors used to make money with penny stocks. Those two schemes are not exclusive to penny stocks but often target micro capitalization stocks because these are easily manipulated.

The first one is called Bump-and-Dump schemes, and it refers to a stock price manipulation where an investor buys a huge amount of stock and releases at the same time some misleading or fraudulent information, in order to inflate the stock price. He then sells it when the price is sufficiently high (Dhir, 2019). Other investors will buy the stock by fear of missing a good opportunity or because they trust the released information.

The second one is named Churning. It is an illegal and unethical activity which is characterized by an overtrading carried out by a broker on behalf of the client's name in order to generate commissions (Hayes, 2019). Churning activities were very popular in the penny stock market because of the rather high transaction fees, that are due to the fact that these stocks were traded over-the-counter.

As Beatty and Kadiyala (2003) explained, those two kinds of fraudulent activities became more and more popular during the 80's in the United-States. It is estimated that this fraud costed several billions dollar to small investors, which led to a situation where the legislator could not ignore it (Beatty and Kadiyala, 2003). Therefore, the SEC decided to draft the Penny Stock Reform Act in 1990 with the objective of reducing the fraudulent activities related to the penny stock market. However, the PSRA regulation only became effective on January 1th of 1993 (Beatty and Kadiyala, 2003).

The PSRA focuses on two major axes for reforming the penny stock market. On the one hand, the objective is to limit the actions of the brokers and dealers, and to make investments in penny stocks less easy for them. On the other hand, the goal is also to increase the power of the SEC and the possible sanctions in case of law infringements.

With these new regulations, brokers and dealers are now obligated to ask for a signed permission from their clients before making any transactions related to penny stocks. In addition, they have to provide investors with a specific risk disclosure for the investment they want to make. More specifically, it has to contain a disclosure of the risks related to penny stock investments, a description of the dealer/broker's duties to its clients, the remedies and the rights of the client in case of violation, and the disciplinary history of the broker/dealer (Penny Stock Reform Act: Report, 1990). After that, for each client who possesses penny stocks in his portfolio, the broker/dealer has to make a monthly account statement with the market value of each penny stock contained in the portfolio or disclose if this value is unavailable because of the absence of quotation. It provides more accurate up-to-date information to investors about their holdings (Penny Stock Reform Act: Report, 1990).

On the SEC side, before the Penny Stocks Reform Act, in case of violations, they could only take sanctions against the broker/dealer and the third party who was directly involved in the infringements. Since 1990, the SEC has the right to take sanctions against all the affiliates including the broker/dealer, third parties directly linked to the fraud, the promoter, the finder and the consultant (Penny Stock Reform Act: Report, 1990).

As Beatty and Kadiyala have shown in 2003, the reform had a limited impact on the penny stocks market. They observed that most of the brokers/dealers avoided the reform by issuing stocks that did not comply with the technical definition of a penny stock by simply setting a higher issuance price. By doing that they did not had to fulfil all the obligations linked to penny stocks. According to the authors, no fundamental changes could be observed in the issuances after PSRA but these were rather cosmetic adjustments made by the brokers/dealers and the issuers (Beatty and Kadyiala, 2003).

Nevertheless, they noted a small increase in the issuer quality in the post-PSRA period, as well as a significant decrease in the number of IPO priced below $5 in the US and a decrease in the failure rate for these companies. However, this did not reflect an amelioration of the situation, as there were still more fraudulent activities for stocks priced below $5 in 2003. From a financial point of view, the risk-adjusted return and the failure risk of penny stocks did not improve as a result of the Reform (Beatty and Kadiyala, 2003).

Ironically, the PSRA had a negative impact on non-penny stocks investors because of the issuance of false “non-penny stocks” shares that had a price greater than $5 just to avoid the regulation. There was a decrease in returns, an increase in risks and an increase of the bid-ask spread for non-penny stocks after the issuance of the PSRA (Beatty and Kadiyala, 2003).

To the best of my knowledge, there are no similar regulations in Europe concerning penny stocks. As mentioned before, the definition of a penny stock comes from the PSRA and it is also used in Europe as there are no legal definition or legal papers about penny stocks. Therefore, in Europe, there are no limitations for brokers or traders like in the United States. However, penny stocks are often traded on junior exchanges managed by large stock exchanges such as the London Stock Exchange, the Euronext markets or the Nasdaq in Northern Europe that regulate indirectly those markets, but for securities that are traded over-the-counter, nothing is in place in order to protect investors. Taking that into account, there is a significant difference between Europe and the United States concerning the treatment of such securities and the trading conditions that are set to protect small investors.

III. Junior markets

The development of penny stocks is intrinsically linked to the development of junior markets, which are markets affiliated to a main market with less listing constraints and requirements, and on which smaller firms are traded (Granier, Revest and Sapio, 2019). The evolution of junior markets in Europe followed different steps often characterized by the creation of several markets around the continent in a short time frame which will close after some years due to a crisis.

A. Development of junior markets in Europe

The development of junior markets began with the foundation of the NASDAQ in 1971 in the United-States. The NASDAQ was the first junior market, and it has influenced the structure of all other junior markets around the world. In Europe, the two first junior markets were the "Mercato Ristretto" in Italy and the "Compartiment Spécial" in France. The aim was for these to become screeners, in order to identify promising companies that would be able to enter the main markets after a few years. This kind of market is called feeder markets (Revest and Sapio, 2016), as their only objective is to select the most promising companies and to feed them through the main markets. Those markets were characterized by low listing requirements and low information standards for listed companies (Posner, 2006). Eventually, the two markets closed due to the financial crisis of 1987.

In the early 90's, the European Union wanted to unify and structure the European financial markets with the publication of the Investment Services Directive (Europa, 2020). This directive has had a huge impact on junior markets as it authorized an exchange regulated in one European country to operate in another via an electronic platform (Revest and Sapio, 2016). It caused the first pan-European market dedicated to young high-tech companies to be created in 1996 under the Easdaq name. It took the characteristics of the NASDAQ and was promoted by the European Commission (Revest and Sapio, 2016).

The creation of the Easdaq was perceived as a threat by national markets across Europe. In reaction to that, a new wave of junior markets emerged in Europe with the foundation of the Euro Markets Alliance, regrouping different markets spread across Europe: the Nieuwe Markt in Amsterdam, the Euro:NM in Brussels, the Neuer Markt in Frankfurt, the Nuovo Mercato in Milan and the Nouveau Marché in Paris. Those junior markets were based on the NASDAQ model: it allowed to create an exit solution for Venture Capitalists to sell their participations in high growth and innovative companies (Bottazzi and Da Rin, 2002). In United-Kingdom, the Alternative Investment

Market was created during the same period. In comparison with the first generation of European junior markets, they had lighter listing requirements than main markets in terms of age, size, profitability, etc. but they had more stringent disclosure obligations (Granier, Revest and Sapio; 2019).

Most of those markets were closed due to the Dot.com bubble of 1999-2000, between 2000 and 2002, Revest and Sapio (2016) reported a drop in market capitalization of -91% for the Neuer Markt, -68% for the Nuovo Mercato and Nouveau Marché in Italy and France and -25% in the Alternative Investment Market. The last one was the only one that managed to survive under its existing form.

During the 2000's, new junior markets were created based on the AIM model. The Alternative Investment Market is the junior market of the London Stock Exchange and is devoted to young companies on the supply side and qualified institutional investors on the demand side (Vismara, Paleari and Ritter, 2012). Those markets have minimal regulatory requirements and are characterized by a high degree of activity from Venture Capitalists. It is during this period that exchange markets like the Nasdaq First North, or the Euronext Growth and Access markets were born.

As of today, the two biggest junior markets in Europe are the Alternative Investment Market and the Euronext Growth and Access markets.

B. The Alternative Investment Market

For the purpose of this work, I choose to analyze stocks quoted on the Alternative Investment Market, which is the junior market of the London Stock Exchange. More information on the history and the specific characteristics of this market will therefore be provided in the following paragraphs.

In the beginning, this study was supposed to use IPOs conducted on the Euronext Growth and Access markets but the number of companies that fulfilled the definition of a penny stock was not enough to have robust statistical results. The AIM was the logical choice after the Euronext as there are much more IPOs than on Euronext Growth and Access, their issue prices are in average far smaller and the information about the companies are easier to gather. The main reasons for choosing the Alternative Investment Market for the study are therefore very pragmatic.

The Alternative Investment Market was established as the junior market of the London Stock Exchange in 1995 in order to attract smaller companies that couldn't fulfill all the conditions to be listed on the major market. As mentioned earlier, the fundamental idea behind the creation of the AIM was to reunite young promising companies on the demand side and institutional qualified investors in the supply side (Vismara et al, 2012).

At its foundation in 1995, only 10 companies were listed on the AIM with a combined market capitalization of £82m. The Alternative Investment Market has shown a strong growth since its creation, particularly after the 2000 Dot.com bubble. After the crisis, the AIM experienced a surprisingly high level of activity compared to other markets, especially those in America. During the 2001 – 2004 period, the number of non-financial IPOs on the AIM was more important than the combined number of IPOs in the New York Stock Exchange, the American Stock Exchange and the NASDAQ (Espenlaub, Khurshed and Mohamed, 2012). After the 2000 bubble, the London Stock Exchange expanded its reach by opening new markets in Japan with a joint venture with the Tokyo Stock Exchange and in Italy by buying the Borsa Italiana. These new markets in Japan and Italy were effective in 2009.

Figure 1

Number of companies listed, and money raised on the AIM from 1995 to 2004

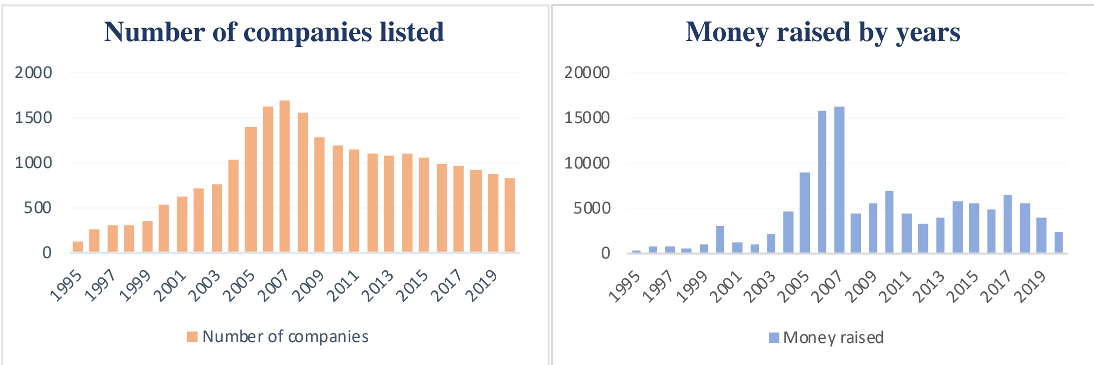

Figure 1 shows the number of companies listed on the Alternative Investment Market from 1995 to 2014 and the money raise by the issuers for each year denominated in million Pound. Data retrieved from the London Stock Exchange monthly report (London Stock Exchange, 2020).

As we can see on Figure 1 showing the evolution of the number of company quoted and the money raised through time, from the 10 original companies listed on the AIM, in May 2020, 832 companies were quoted on the junior market, which represents a total market capitalization of £98,611.7m. A peak for the number of quoted firms was reached just before the financial crisis in 2007 with 1694 companies quoted on the AIM and £16,183.10 million raised the same year. However, the peak in term of market capitalization was achieved in 2017 with a total market capitalization of £108,882.3 million.

The effect of the 2007-2008 financial crisis on the number of companies listed is quite strong, as it can be seen in Figure 1. In the aftermath of the crisis, the number of quoted companies has decreased, passing from 1694 in 2007 to 832 in May 2020. In addition, the crisis also affected the market value and the money raised, for which the shock was considerably more brutal than for the number of quoted entities which decreased gradually over time. The total market capitalization dropped from £97,561m in 2007 to £37,731.9m in 2008, which represents a decrease of 61.3% and the money raised dropped from £16,183.1m in 2007 to £4,322.3m in 2008, that is a decrease of 73% in one year.

One of the particularities of the Alternative Investment Market compared to other growth market is the presence of nominated advisers, also called Nomads, that listed companies must appoint. Each company listed on the AIM must be supported by a nominated adviser or it will be suspended. A nominated adviser is usually an investment bank company that is approved by the London Stock Exchange and that has a dual role. Firstly, the advisers manage the admission of new companies on the Alternative Investment Market and accompany them during the whole process. This is quite similar to the role of the Listing Sponsor on the Euronext Access and Growth markets. Their second role is the most important one, because Nomads act as regulatory agents that must make sure that the principles that govern the AIM are respected (Espenlaub et al, 2012). This is why the AIM is called a principle-based stock exchange as opposed to the rule-based stock-exchange. Nomads play the role of gatekeepers, advisors and regulators for the AIM-listed companies that does not have to comply with the UK Listing authority or EU Directives (Revest and Sapio, 2016). However, companies listed on the AIM have the right to sue their nominated advisers if they have been misled or badly advised. As for all the other markets in Europe, the Alternative Investment Market does not have a clear regulation for penny stocks, but it is indirectly watched by the nominated advisers.

The nominated adviser system works based on the reputation of the Nomads and they try to do everything they can to maintain it at its best in order to attract and keep new clients. Moreover, a listed company must have a Nomad until it delists from the market, hence the nominated adviser has also an incentive to keep the company quoted and will do his best to advise the company and help it across the time. Therefore, he will be reluctant to back IPOs that are not likely to survive a long time after their introduction (Espenlaub et al, 2012).

As of today, there are 30 companies listed in the register of nominated advisers published by the London Stock Exchange. You can find the name of these 30 companies in Appendix 1.

As the Alternative Investment Market is a principle-based stock exchange, there are no explicit listing requirements. The only two conditions a company must fulfil is to find a nominated adviser and issue a listing document with historical audited financial information and profit forecast. These documents do not need to be verified by a certain authority before admission of the company. Aside from the Nomad and the admission document, there are no other obligation that a company must fulfill. There is no minimum for the issue or quoting price, no minimum for the initial equity or market capitalization and no minimum for the operational history. Actually, it can be seen that several companies are seeking to increase their capital even before starting their operations.

However, companies must comply to some continuing requirements when they are quoted on the AIM. These requirements can be found in the AIM rules for companies (2019). It mainly concerns the disclosure of sensible information for the shareholders. Firstly, the company must in all time retain a broker and a nominated adviser which can be the same institution. They have to disclose any public information that can be price sensitive without delay. The companies have to publish audited annual reports and accounts, and unaudited half-year reports. They have to notify the shareholders for each significant transaction concerning the equity of the company and for each related party transaction. The companies must disclose their corporate governance code and how it is applied concretely in the company. Finally, all relevant information must be posted on the website of the company for at least 12 months after they were communicated to the shareholders even if the company decides to delist from the exchange.

IV. Review of the literature

The literature concerning penny stock IPOs is rather limited. In general, the studies examining the performance of a company post-IPO are not numerous and focus mainly on US companies and markets (Carpentier and Suret, 2011). The lack of interest by investors, and particularly by institutional investors, did not encourage analysts and researchers to work on penny stocks. As a consequence, many researchers deliberately decided not to include securities priced below $5 in their studies (Seguin and Smoller, 1997).

We have seen an increase from the beginning of the 2000's in the number of papers willing to understand the post-IPO return of penny stocks and micro capitalization companies in the European area (see Audretsch and Lehmann, 2005; Vanacker and Manigart, 2010; Vismara et al, 2012; Espenlaub et al, 2012; Amini and Keasey, 2012; Kashefi and Lasfer, 2013). One of the first modern piece of literature on penny stocks (as defined by the Penny Stocks Reform Act) was done in the beginning of the 2000's by Beatty and Kadyiala (2003) on the impact of the new reform on the US penny stocks market. They found that penny stocks had still a higher failure probability than non-penny stock securities after the reform, and that the risk-adjusted return did not change because of the regulation. However, researchers have been interested in understanding explicative factors of IPO returns before studying penny stocks in particular (Rock, 1986; Beatty and Ritter, 1986; Carter and Manaster, 1990).

Carter and Manaster (1990) issued a paper studying the impact of the underwriters' reputation on the long-term survivability of an IPO. They ranked the underwriters by reputation by analyzing a large number of tombstone announcements provided for public offerings. Nowadays, this ranking is still considered by many as the reference for this kind of researches. Carter and Manaster (1990) found that the reputation of the underwriters has a significant impact on the IPOs performance. To keep their reputations, prestigious underwriters will select only low dispersion IPOs which will decrease the volatility of the company's price while it is quoted.

More recent studies are consistent with what Carter and Manaster have found. The participation of a prestigious underwriter has a significant impact on the survival probability of a quoted company (Carter, Dark and Singh, 1998; Dalbor and Sulivan, 2005; Carpentier and Suret, 2011; Espenlaub et al, 2012) but has no significant impact on its post-IPO profitability (Jain, Jayaraman and Kini, 2008). These results can be explained by the potentially more accurate information provided by prestigious underwriters (Dalbor and Sulivan, 2005). Bradley, Cooney, Dolvin and Jordan (2005) studied the impact of fraudulent underwriters on companies' performance post-IPO in the penny stock market specifically. They also noted that long-term performance of penny stocks is lower than for normal stocks, but their short-term performance right after the IPOs are usually better than for ordinary stocks.

Other studies showed a general pattern for penny stock IPOs: they show higher abnormal returns in the short-term than non-penny-stock IPOs, which are mainly due to underpricing and poorer performance in the longer-term. The lower the issue price, the greater the underpricing effect (Konku, Bhargava and Malhotra, 2012). The prices set at IPOs have a real impact on the long-term performance of a company: the higher the initial price, the higher long-term returns (Bradley, Cooney, Dolvin and Jordan, 2006).

If we take a look at the probability of failure instead of the probability of success, penny stock companies have a higher probability to fail than ordinary companies. Bradley et al (2006) found a failure rate of 51.4% for their sample compared to 14.3% for ordinary IPOs. Carpentier and Suret (2011) found similar results in their study with a failure rate of 48.5%.

Auditors play an important role in the financial industry and this role is even more important in the penny stock market where information about companies is a scarce resource (Carter, Dark and Singh, 1998). Studies have shown that auditors have a significant impact on the companies' post-IPO performance. In the literature, prestigious auditors often correspond to the big four (Michaely and Shaw, 1995; Weber and Willenborg, 2003).

More recently, numerous studies have appeared in the literature on the activity of Venture Capitalists, their role and the implication they have in public exchange markets. As mentioned earlier, junior markets are characterized by a high activity of Venture Capitalists as they were designed to be an exit way for their investments (Beatty and Kadyiala, 2003). According to some researches, the fact that an IPO is backed by a Venture Capitalist has a huge influence on its survival: a VC-backed IPO has 1.8 times more likely to upgrade on a higher-tier market than non-VC-backed companies and could therefore offer better performance in the long-term (Carpentier and Suret, 2011). Other works suggest that Venture Capitalist participation increases the probability of survival of an IPO although, this probability decreases when the size of the participation becomes larger. The bigger the participation of the Venture Capitalist is, the lower is the probability of success and profitability (Audretsch and Lehmann, 2005; Jain et al, 2008).

Audretsch and Lehmann (2005) based their study on three theories to explain the success of an IPO. The first one is the Industrial Organization theory which states that a firm must have revenues greater than their costs in order to survive. This theory focusses on firm characteristics such as size, growth, etc. The second one is the Agency theory which states that the performance of a company depends on the competences of its management. Finally, the last theory is the Economics of knowledge where the key factor determining the success of a company is its human capital and intellectual properties (Audretsch and Lehmann, 2005). Based on companies listed on the Neuer Markt (Germany), they found that traditional determinants of firm performance (size, growth, profitability, etc.) are not significant for new firms, and that knowledge shared inside the company is the key factor to success. The competence of the board, having a CEO coming from the technological world and intellectual property are the three main criteria influencing the performance of a company.

In another study investigating the impact of the executives on the post-IPO performance of a company, researchers found that the CEO and CFO background, experience and age have no significant influence on profitability and performance (Jain et al, 2008). Other corporate governance factors have been studied, such as the board composition and more particularly the impact of independent and insider directors. Surprisingly, the presence of independent board members decreases the probability for high tech companies to become profitable. This is due to the very specific knowledge required to fully understand the business of these companies having a high level of technical expertise (Jain et al, 2008). Insiders ownership and particularly executive ownership have a significant impact on the post-IPO profitability (Audretsch and Lehmann, 2005; Jain et al, 2008).

The impact of the financial situation of penny stocks and companies at the time of the IPO has been discussed extensively by academicians. It has thus been shown that positive earnings at the time of IPO have a huge impact on the post-IPOs performance and survival (Carpentier and Suret, 2011; Amini and Keasey, 2012).

Carpentier and Suret (2011) found that unprofitable companies are 1.77 times more likely to fail than companies with positive earnings. Firms with negative earnings also tend to have a higher valuation than firms with positive earnings, which can be partially explained by the higher potential of negative earnings firms (Aggarwal, Bhagat and Rangan, 2009). However, it is important to note that positive earnings will influence the failure risks but have no significant impact on the probability of remaining profitable after the IPO (Carpentier and Suret, 2011). Another factor implicitly linked to positive earnings concerns the revenues, companies that do not report sales have a failure risk 1.23 times greater than companies that do, no matter if they make profits or loss

(Carpentier and Suret, 2011) and the greater the sales, the higher the probability of survival (Espenlaub et al, 2012). The debt structure has also a significant role. Young companies often see junior markets as a mean to decrease their debt, even though it does not work in most cases. Companies with greater Capex and leverage are more likely to be delisted than companies with healthier financial structure (Kashefi and Lasfer, 2013).

A rationale in favor of pre-IPO shareholders' equity was developed by Vanacker and Manigart (2010). They showed that positive equity at the time of the IPO has a significant impact on the probability of failure. Companies with high equity prior to IPO are less likely to need cash and will manage their fund raising with more care. Other studies have shown the importance of positive shareholders' equity at the time of the IPO, which is a key characteristic for reducing the probability of failure (Hensler, Rutherford and Springer, 1997; Jaskiewicz, González, Menéndez and Schiereck, 2005; Carpentier and Suret, 2011).

The moment when company decides to proceed with its IPO plays an important role in the firm's post-IPO survival. IPOs conducted during hot markets are expected to have poorer long-term performance and survivability than IPOs conducted during cold markets (Carpentier and Suret, 2011; Espenlaub et al, 2012). Hot markets are characterized by high volume of offerings, severe underpricing, and sometimes high concentration in one industry sector (Helwege and Liang, 2004). Hot markets periods are very active times in stock markets, especially for junior markets that attract a lot of new investors and new companies compared to cold markets periods (Vismara et al, 2012).

The majority of the studies concerning penny stocks try to understand how some qualitative factors and characteristics will influence the post-IPO performance of a company. However, another approach was adopted by Konku, Bhargava and Malhotra (2012), as they used technical analysis to find some patterns that can be applied to penny stock IPOs.

By using Buy and Hold and Dollar Weighted method of allocation[1], they found that the optimal holding period for a penny stock is 11 months. According to the authors, penny stocks tend to experience sharp rise in the short-term, with their peak period between 11 and 13 months, and then fall quickly after reaching that peak. In accordance with these results, the authors found that actively managed portfolios perform better

[1] The weights allocated to each stock depends on the gross proceeds of the IPOs. The authors decided to invest 10,000$ each month and the allocation was done at the end of each month as a function of the gross proceeds of the IPOs. The authors allocated a bigger weight to companies that had the biggest gross proceeds.

than passively managed portfolios when it comes to penny stocks investments. The findings of Konku, Bhargava and Malhotra (2012) are consistent with what other researchers have found concerning the underpricing effects of penny stocks IPOs and their poor long-term performance (see Bradley et al, 2006).

Another aspect of the literature on penny stocks concerns the study of the people who invest in this kind of security, their behavior and the lottery-like characteristics of penny stocks. Unfortunately, there are very few works done in this field for penny stocks.

The most renowned work done on the lottery-like components of penny stocks was done by Kumar (2009). In his article, he identified lottery-like stocks as low priced securities with high idiosyncratic volatility and high skewness, which meets characteristics of penny stocks. He found that lottery-like stocks, in average, have at least 4% lower return on any benchmark chosen, and that the risk return of a portfolio always worsens when lottery-like stocks are added to it. People investing in lottery-like securities are in average less wealthy, less educated and have lower income than people who do not invest in lottery-like stocks.

Nofsinger and Varma (2014) studied the behavior and characteristics of Over-The-Counter investors and found that they are older, wealthier and more experienced investors than people who do not invest in this type of securities. The authors tried to explain the fact that people chose to invest in OTC markets by three different theories. The first one is the Gambling theory (Kumar, 2009), which says that people invest in OTC markets because they like to gamble. The second one is the Behavioral Portfolio Theory (Shefrin and Statman, 2000) which states that investors divide their portfolios in different layers that correspond to different aspirations and have different purposes. The part invested in OTC securities correspond to the wealth aspirations. The last theory is based on sensation seeking investors. People invest in OTC markets because of the volatility that keeps them entertained and they seek the thrill and excitement that is associated with OTC trading (Grinblatt and Keloharju, 2009). They found that penny stocks investors are usually much younger and have less diversified portfolios than traditional OTC investors. Hence, these investors have a preference for lottery-like stocks, which corresponds to the Gambling theory (Kumar, 2009; Carpentier and Suret, 2016).

V. Carpentier and Suret: *The survival and success of Canadian IPOs*

The methodology that will be used in this work to analyze the European penny stock market is derived from the research of Carpentier and Suret (2011) on Canadian IPOs. Their study will be developed in more detail in this chapter/section, in order to have a better understanding of their methodology and the choices and hypotheses that were subsequently formulated in this work.

Through this article, their objective was to "Analyze the survival and success of a large sample of Canadian penny stock IPOs, launched mostly by small and unprofitable firms from 1986 to 2003" (Carpentier and Suret, 2011). The authors also investigate the impact of the listing requirements on the survival and failure of issuers by analyzing the impact of simple factors as revenues, positive earnings, or the size of the company on the failure risk of a company.

The sample created by Carpentier and Suret (2011) is composed of 2373 IPOs realized on the Canadian market from 1986 to 2003. It is important to understand the distinctive characteristics of the Canadian market to fully understand the study and the results they obtained.

The Canadian exchange market is divided into two parts: the main market, the Toronto Stock Exchange (TSX), and a junior market, the TSX Venture Exchange (TSXV). The last one is dedicated to small companies, with the particularity that almost any company can be listed. Indeed there are very few listing requirements: the only two listing requirements are, on the one hand, to have an issue price greater than CAN$ 0.15 (€0.098 as of 19th May 2020) and, on the other hand, to have a post-IPO Net Tangible Asset greater than CAN$ 500,000 (€327,850 as of 19th May 2020). Even in the main market, the companies are often quite small and there is a very little institutional investor activity. Most of the large Canadian companies decide to be listed on the NASDAQ, the New York Stock Exchange, or the American Stock Exchange because they seek more visibility and a much larger pool of potential investors.

From the sample selected by Carpentier and Suret (2011), 48% of the issuers reported no revenues at the time of the IPO and 71% of the 2373 issuers reported negative earnings. The gross median proceeds were equal to CAN$ 800,000 (€524,560 as of 19th May 2020) and 86.01% of the securities were considered as penny stocks, which means that their issue price was smaller or equal to CAN$ 5.

The main hypothesis made in their research is that minimum listing requirements that a company must fulfill to be quoted on a stock exchange have an impact on the survival and the success of the issuer. The fact that the authors decided to study the impact of risk factors on both the probability to succeed and the probability to fail at the same time is rather new. It is very interesting to have both parts in the same work because, for example, it allows to see that factors influencing failure will not necessarily influence the success of a company and inversely.

Additional hypotheses were also used, which the authors classified into different categories: the first one concerns the basic financial situation of companies, the second one included hypotheses about the impact of third parties such as underwriters, auditors and Venture Capitalists, the third one is related to some general companies' characteristics and the last one refers to the assumptions concerning the general condition of the market at the time of issue.

Hypotheses 1 to 4 focus on the financial situation of the company at the time of the IPO. The authors state that companies that list at a post-revenue stage, that report positive earnings, and that have a certain amount of equity before the IPO have more chance of succeeding and a lower probability of failing than companies that do not. The general idea behind those hypotheses is that if companies have a better financial situation, they will be able to be more resilient, and they will be able to retain the best talents and better cope with the costly obligations of quoted companies.

The second group of hypotheses (Hypotheses 5a, 5b, and 5c) concerns the impact of prestigious underwriters, auditors, and Venture Capitalists on the success and failure of an IPO. Basically, those hypotheses state that IPOs with prestigious underwriters and prestigious auditors, have a lower probability of failure and a larger probability of success as they will reduce information asymmetries, give investors a better view of the company, and thereby they will allow to decrease the underpricing for the IPO. Concerning the Venture Capitalists' participation, it is expected to have a positive impact on the post-IPO performance of a company as Venture Capitalists are supposed to be able to select the best prospects.

Hypotheses 6 and 7 are related to the maturity of the company. Logically, the authors made the assumption that bigger and more mature companies are more likely to succeed and less likely to fail than small and young companies.

Finally, the two last hypotheses (Hypotheses 8 and 9) are about the general conditions of the market when the companies go public. Firstly, it should be noted that the Canadian equity market is composed of numerous companies active in the Energy and Materials sector due to the large amount of natural resources available. At the time the article was written by Carpentier and Suret, 13% of the listed companies on the TSXV were active in the Energy sector and represented 25.22% of the total market capitalization. The Materials sector represented 46.74% of the listed companies for 50.7% of the total market capitalization. The authors wanted to assess whether the sector of activity has an impact on the survival of an IPO. Secondly, the time at which the IPO was executed has often an impact on the post-IPO performance of a company. Their initial hypothesis was that IPOs conducted during Hot market periods have a greater (lower) probability to fail (succeed) than IPOs conducted during Cold market periods.

In order to conduct a survival analysis, Carpentier and Suret (2011) had to choose the success and failure factors that can be applied to each company in their sample.

They considered each company that was delisted, suspended or bankrupted at the time of analysis as a failure. The ongoing requirements for the TSXV are very lax, as companies must keep a market capitalization over CAN$ 100,000 and a Working Capital superior to CAN$ 50,000. If a company cannot fulfill those conditions, it has 18 months to recover and get back to a correct level before being delisted. According to the authors, these ongoing requirements are too lax compared to what can be found in other markets. Consequently, they wanted to mimic the ongoing requirements of the NASDAQ where a company is delisted if its price is below US$ 1 for 30 consecutive days. Taking into account the particularities of the Canadian market, and especially the size of the listed companies, they chose CAN$ 0.1 as a threshold over a period of 7 months. Therefore, if a company had a price smaller than CAN$ 0.1 for 7 consecutive months, the authors considered the issue as a failure.

For the success factors, they used what they called “Graduation” as a measure of success. A company graduates when they evolve from a junior market to the main market. A company listed on the TSVX can also succeed by listing abroad (in the United-States for instance) on a bigger market. They identified three main reasons that encourage companies to list abroad: the potentially reduced marketability costs, the improvement in visibility and in the investor base, and the signaling of favorable future performance.

The second factor of success they used is the cross-listing on a main exchange. As some of the companies in their sample were already quoted on the TSX they had to find factors that can be applied to them. They found several reasons that can explain the cross-listing decision by Canadian companies: it increases the pool of investors, the visibility, the liquidity of the stock and it decreases the cost of capital.

Another point Carpentier and Suret had to take into account in their work concerns the treatment of mergers and acquisitions. They considered that when a merger occurred, the company resulting from the merger will be considered as the successor to the original one and will continue to be included in the sample. In the case of an acquisition, the authors decided to take the same price threshold as for the failure and considered any acquisitions with a price greater than CAN$ 0.1 as a success.

Taking into account all the success and failure factors cited above, Carpentier and Suret (2011) found that 48.52% of the companies in their sample did not survive, 13.81% succeeded and 37.67% stayed "neutral". It means that the total survival rate of the sample is 51.48% (success + neutral).

The methodology used by Carpentier and Suret can be divided into two steps. Firstly, they used the Kaplan-Meier estimator, which is a non-parametric estimator, to study the survival function of the sample and assess the individual effects of the main variables on the survival function (Carpentier and Suret, 2011).

Secondly, the authors used the Proportional Hazard Regression (Cox, 1972) developed by Cox in 1972. Briefly, the Proportional Hazard Regression is able to model the survival function and estimate the impact of the explicative variables on the time-to-failure and the time-to-success for categorical and continuous variables without making any assumptions on the distribution of the data.

The results Carpentier and Suret (2011) obtained will not be explained in detail here but later with the results of this study to compare both of them. Nevertheless, the most interesting result they found is that the factors influencing the time-to-failure are not the same as those influencing the time-to-success. Nearly all the factors used in the research have a significant impact on the time-to-failure. More precisely, the factor having the most significant impact on the failure risk of an issuer is the financial position of the company at the time of the IPO. On the contrary, for the time-to-success, the most significant factors are the size of the company, the timing of the issue (hot or cold markets) and the third parties involved in the issue. For the timing of the issue, only the Hot market variable has a significant negative impact on the probability to succeed. Moreover, as expected, prestigious auditors and Venture Capitalists increase significantly the success probability of an issuer. By contrast, they found that the involvement of prestigious underwriters decreases the probability of success of an IPO. This result is the opposite of what the authors expected, and they do not have any explications for it.

VI. Hypotheses

The objective of this work is to identify some qualitative and quantitative factors that can have a significant effect on the probability of success and/or failure of a penny stock security. If that kind of factors can be identified by retail investors, it can allow them to screen the pool of available penny stocks to limit their downside risks. To do so, the Cox Proportional Hazard Model method which is widely used in the academic world to study the survival of a sample will be used.

A. Hypotheses to test

The first step in the process is to define the hypotheses that have to be tested to see whether or not the chosen factors have a significant influence on the probabilities of success and failure of the companies.

The hypotheses selection is based on some characteristics widely used by researchers studying the IPOs' survival. More specifically, this choice is inspired by the work realized by Carpentier and Suret (2011). Moreover, as the objective of this work is to find if penny stocks can be attractive for retail investors, simple factors that are available for all investors, that can be found easily and that do not require any specific or advanced knowledge in finance were selected. A good source of inspiration for these factors are the basic listing requirements applied by major exchange markets around the world. Those listings requirements are used to ensure that listed companies have the basic characteristics needed to operate in the future. Consequently, some factors used in the hypotheses below are inspired by the listing requirements from renowned markets such as the NYSE or the AMEX.

H1: Companies that show positive revenue at the time of IPO have a significantly lower (higher) probability to fail (succeed) than firms that list without reporting any revenue.

There is an increasing number of companies searching for financing in the pre-revenue stage. Given this trend becoming apparent, it could be interesting to see if companies in the pre-revenue stage have a greater probability to fail.

Having sales is often an implicit requirement in most of the main exchange markets in the world because legislators want to protect investors who are supposedly not qualified to value this kind of company (Carpentier and Suret, 2011). As Audretsch and Lehmann (2005) mentioned in their work, from an economical point of view, the Industrial Organization literature assumes that having more revenues than costs is a pre-requisite for a company to exist in the long-term. In other words, companies have to grow to a certain size to be sustainable in the long run.

H2: Companies that show positive earnings at the time of IPO have a significantly lower (higher) probability to fail (succeed) than firms that list without reporting positive earnings.

Profitability is often included in the listing requirements for most of the major stock exchanges. For example, to be listed on the New York Stock Exchange, a company must have an aggregate pre-tax income of $10 million for the previous three years with at least a pre-tax income greater than $2 million for the two most recent fiscal years (New York Stock Exchange, 2020). On the American Stock Exchange, which is recognized to be more flexible than the NYSE, a company must have a pre-tax income of at least $750,000 in the most recent fiscal year before the introduction. There are similar listing requirements on the Tokyo and Osaka stock exchange (Japan Stock Exchange Group, 2020), and on the Shanghai Stock Exchange (Shanghai Stock Exchange, 2020), etc. Quite surprisingly, there are no listing requirements concerning profitability for the Euronext markets and the London Stock Exchange main market.

Starting from the middle of the nineties, we have seen a new trend with listed companies that are not making any profit. This type of IPO slowly became the norm, so that today the majority of new IPOs are done by unprofitable companies. In 2019, most of the biggest IPOs were carried out by tech companies that are unprofitable, such as Uber Technologies, WeWork, Lyft, Pinterest, etc. (Zacks investment research, 2019).

H3: Amongst companies that report positive earnings at the time of IPO, those which report a shareholders' equity greater than €18.09 million have a significantly lower (higher) probability to fail (succeed) than those who do not.

The hypothesis that the size of newly listed companies is relevant to analyze its success/failure is often used by researchers. Many of them used the revenue of the companies to assert their size (Audretsch and Lehmann, 2011), but in their research, Carpentier and Suret (2011) added the pre-IPO shareholders' equity as a benchmark for the companies' size. As the first hypothesis already takes the revenue into account, this third hypothesis will be complementary to the first one to assess the influence of companies' size at IPO on the failure/success.

According to previous researches, the company size is negatively proportional to the probability of failure of an IPO (Hensler et al, 1997 and Jaskiewicz et al, 2005).

Another rationale in favor of the equity size is that companies having more equity will be much more resilient to bad events and will be less desperate to raise cash (Vanacker and Manigart, 2010). In Berger and Udell's study released in 1998, they found that companies with less than US$10 million in equity have a higher failure probability than bigger companies. This threshold found in the early nineties would be equal today to US$19.75 million if we take the inflation into account. Using the current exchange rate of US$1.09 for €1[2] (retrieved from the European Central Bank Database on the 14th May), it would be equal to €18.09 million. All relevant monetary information was transformed into Euro for the remaining of this work. As different monetary denominations were used in the data base, it was important to use a single currency for better comparison.

H4: Companies that have at least five years of operational history at the time of IPO have a significantly lesser (greater) probability to fail (succeed) than companies that do not.

The operational history corresponds to the years of activity of the company in its specific sector and it is a listing requirement widely used in main markets. The threshold is often set at three years of activity, which is an indirect constraint linked to the profitability requirements of the market exchange (e.g. profitability for at least the three previous years for the NYSE).

The operational history is an important component of a firm's capacity to survive through time and hence it will have the effect of decreasing the probability of failure of the company (Weber and Willenborg, 2003; Demers and Joos, 2007). The more active time the company has in its specific sector, the more knowledge and information they will have about how their sector operates. Hence, they will be more able to respond correctly to unwanted events (Audretsch, 1995). Over time, the firm will learn more and more about its own strengths and weaknesses, the best way to operate, how to improve its products/services or its managerial capabilities, etc. Another rationale in favor of this hypothesis is that if the company has more operational history, it usually had more time to gather resources useful to its survival, like financial resources, human resources, intellectual resources, etc. (Audretsch and Lehman, 2005).

The cutoff value was arbitrarily fixed at five years as a conservative hypothesis compared to what is currently asked in most of the exchange markets around the world. Moreover, in order to easily compare the results with those obtained by Carpentier and Suret in 2011, it also makes sense to choose the same threshold as theirs.

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[2] http://sdw.ecb.europa.eu/browse.do?node=9691296

H5: IPOs with a bigger offering size have a significantly lower (higher) probability to fail (succeed) than IPO with a lower offering size.

The offering size is another benchmark for the size of the company and for the size of the IPO. It is calculated as the total number of shares issued multiplied by the IPO price. The gross proceeds for IPOs conducted on the Alternative Investment Market are directly reported by the London Stock Exchange in their monthly report which can be found on their website.

As mentioned earlier, many researchers have found that the size of the company is an important determinant of its success (Hensler et al, 1997 and Jaskiewicz et al, 2005; Espenlaub et al, 2012). However, Jain, Jayaraman, and Kini (2008) found that there is a negative correlation between the offering size and the probability of achieving profitability for a company.

H6: Companies that are backed by Venture Capitalists at the time of IPO have a significantly lower (higher) probability to fail (succeed) than companies that are not VC-backed.

Recently, numerous new articles about the impact and the role of the Venture Capitalist in the IPO success or failure were written. It is expected that this subject will continue to interest researchers in the future as private equity investment and Venture Capital funds are becoming more and more popular. However, Venture Capitalists (VC) are a very specific type of capital investment and is usually available to a very limited group of investors due to the important risk you bear when you invest in young companies.

The impact of VC on IPO performance is widely debated in the academic communities. On the one hand, some researchers have found that VC-backed companies are more successful than non-VC-backed companies (Carpentier and Suret, 2011). The explanation is that Venture Capitalists have knowledge and tools that common investors do not have, and the companies targeted by these kinds of funds are extremely hard to analyze and require specific knowledge which can be provided by Venture Capitalists. Moreover, the company will receive help, advice, and support from the Venture Capitalists.

On the other hand, some researchers have found that, on the contrary, participation of Venture Capitalists in an IPO decreases the probability of post-IPO profitability (Jain et al., 2008). In accordance with Jain, Jayaraman, and Kini (2008), Audretsch and Lehmann (2005) also found that the greater is the risk, the bigger the participation of the Venture Capitalists in the company. It supposes that companies backed by Venture Capitalists have a greater probability of failure than companies that are not.

The participation of VC is an interesting factor to look at because of the different opinions and results that have been found. Moreover, Venture Capitalists are very active in the penny stocks market as most of the junior exchange markets in Europe are designed to provide an exit way for their investments.

H7: Companies that are audited by a prestigious auditor at the time of IPO have a significantly lower (higher) probability to fail (succeed) than companies that are not audited by a prestigious auditor.

Several researches have been done on the influence of third-party institutions on the performance of an IPO, the influence of the auditors being one of these third parties. The rationale behind this hypothesis is that auditors have the ability to decrease the information asymmetries and help the company to achieve better performance (Carter et al, 1998; Jain et al, 2008). As Carter and Manaster (1990) have found in their researches, companies with more available information for investors at the time of IPO, show significantly better post-IPO performance.

For the purpose of this work, the Big Four were considered as prestigious auditors, that is namely Deloitte, KPMG, Ernst & Young, and PriceWaterhouseCoopers (PwC), because they are the biggest and most well-known audit companies in the world.

H8: The probability for a company to fail (succeed) is significantly lower (higher) when a prestigious investment banker/nominated adviser is involved in the IPO.

As for the influence of the auditors, the underwriter is one third party, and its impact on the performance of an IPO has been studied a lot in the past. The participation of a prestigious underwriter is supposed to decrease the information asymmetries and has a positive effect on the post-IPO survival of a company (Bradley et al, 2006).

Often, researchers who want to study the impact of underwriters on IPO performance determine the prestigious underwriters on the basis of the ranking made by Carter and Manaster in 1990. However, the subjects of their study are American underwriters, which is not relevant in our case. Indeed, most of the IPOs analyzed in this work come from small companies, whereas the big underwriters mentioned in Carter and Manaster study (1990) are not really active in that kind of IPO. Even when taking the European market as a whole, underwriters mentioned in the ranking of Carter and

Manaster (1990) only represents 67.5% of European IPOs (Migliorati and Vismara, 2014).

Moreover, as explained earlier in this work, the particularity of the Alternative Investment Market is the existence of the nominated advisers which play a central role in the listing and the survival of the companies. Therefore, it was decided to take into account the reputation of the nominated adviser instead of the underwriter, as the nominated adviser plays a more important role in the Alternative Investment Market. In addition, the Nomad is often the same financial institution as the underwriter.

B. Success and Failure criteria

In order to study the impact of the different factors mentioned above on the survival of companies, and to see whether the hypotheses can be confirmed or refuted, some criteria for success and failure had to be determined for the companies included in the sample.

1. Success

Defining success factors for small and newly listed companies is not an easy task. Using the evolution of the financial situation of a company is not a good estimator for success as all the companies do not start at the same point. For instance, taking into account revenue or profit does not make much sense as every company does not report revenues, and some of them have negative earnings at the beginning. Hence, as the initial financial situation of the companies can vary considerably, it is not a good point of comparison (Audretsch and Lehmann, 2005). Moreover, returns and adjusted returns of the stocks are not considered as good estimators of the success of a penny stock company either, because of their high idiosyncratic volatility and low volume. It has also been discussed in detail by Carpentier and Suret (2011) who drew the exact same conclusions as Audretsch and Lehmann (2005).

The choice of success factors for this work is based on the study done by Carpentier and Suret (2011). The first mentioned success factor is the graduation, that is, in other words, the upgrade to a more prestigious market.

If we look back at the presentation of the junior markets earlier in this work, this success factor makes sense as the Alternative Investment Market positioned itself as the bridge between private investments and public markets for small promising companies. Moreover, the AIM was created as a feeder market in order to provide resources to small companies until they can afford to be quoted on a major market.

Another success factor that can be taken into account is the cross-listing from the companies on another exchange market. Some companies traded on junior market do not want to graduate on the affiliated main market and decide to cross-list on another market in another country. As graduation is not a valid criterion for these companies, it is therefore important to take into account another success factor that can be applied to them. To make sure that upgrades and cross-listing are good estimators of success, Carpentier and Suret (2011) compared the abnormal returns for companies that graduated or cross-listed during their study to companies that didn't graduated, and saw that these companies had significant higher abnormal returns than companies that do not.

Mergers and acquisitions must also be taken into account in the success or failure of a company. First of all, when a company comprised in the sample was involved in a merger during the studied period, the company resulting from the merger was considered as the continuity of the original company in the sample. The number of mergers in the sample was not really important compared to the number of acquisitions.

Concerning the acquisitions, the difference between the IPO prices and the acquisition prices was analyzed to determine if an acquisition was defined as a success or a failure. If the acquirer offered an acquisition price higher than the issue price at which investors could have bought the shares, the transaction was considered as a success. On the contrary, if the price offered by the acquirer was smaller than the issue price, the acquisition accounted for as a failure. During the studied period, 87 companies were the targets of acquisition. Amongst these 87 acquisitions, only 25 had an acquisition price greater than their issue price and thus are considered as success for this study.

In the whole sample, taking into account graduation, cross-listing, and acquisitions with a price greater than the original issue price, only 29 companies succeeded during the covered period of time which corresponds to a success rate of 6.6%.

2. Failure

Failure factors are far easier to define than success factors. The first estimator for the failure of a company is bankruptcy. All companies that were delisted during the studied period were examined in order to assess whether or not they are still active. Each company that was delisted due to insolvency problems or because they decided to go bankrupt was considered as a failure for the study. The same logic applies to companies that have a suspension of trading because they did not comply with the legislation or the ongoing disclosure requirements of the Alternative Investment Market.

Sometimes, companies decided to delist willingly from the AIM, most of the time because they did not want to incur the costs of being a public company. Often, when a company has decided to delist, a major shareholder, the management, or the company itself, has offered to acquire the share of investors who do not want to keep their ownership if the company is not public anymore. In this case, it was considered as an acquisition. However, sometimes, the company does not offer a way out for the investors. When no exit prices were offered to the investors, the cancellation was automatically accounted as a failure for this study.

As for defining success factors, mergers and acquisitions have to be taken into account when setting the criteria for failure for this study. As mentioned before, if a company in the sample has merged with another company, the resulting entity will be considered as a continuation of the original company. And with the same logic as for success criteria, a company bought at a price lower than its issue price will be considered as a failure. In the whole sample, 62 companies were acquired for an amount below their issue prices and are thus considered to have failed.

Considering the whole sample, if all the companies delisted due to bankruptcy, liquidations, trading suspensions, or acquisitions at a price lower than the issue price are taken into account, 181 firms failed, which corresponds to a failure rate of 41.23%. Given that 29 companies succeeded, and 181 companies failed during the course of this study, the remaining firms (229) are considered as neutral, having neither passed nor failed, which gives a survival rate of 58.77% for the entire sample. These results will be explained in detail and compared to what other researchers found later in this work.

VII. Sample

A. Creating the sample

The purpose of this work is to analyze penny stocks IPOs listed on the Alternative Investment Market and to determine if some factors influencing the quality of the companies can have an impact on their success or failure. These factors, if they have a significant impact on the failure/success rates of the companies studied, can be seen as good benchmarks for investors willing to invest in penny stocks securities.

This study was conducted on a sample which is composed of 439 companies listed on the Alternative Investment Market. The IPO date of these firms are comprised between January 2005 and December 2014, which represents a period of 10 years, leaving at least 5 years of operational history after the introduction of the newest company in the sample. In order to establish which companies could be included in the sample, certain conditions have been set.

First of all, the IPO prices must be equal to or less than €5. As mentioned earlier in this work, penny stocks are considered to be any securities issued by companies that had an IPO price inferior to €5 and not quoted on a national stock exchange. To find the IPO prices of the companies, the issue prices reported by the AIM were used. The AIM provides indeed monthly fact sheets containing all information and statistics about the stock exchange, including a list of new IPOs for the month. I chose not to take into account the condition concerning the level of net tangible assets for two reasons. Firstly, the definition of a penny stock given by the Penny Stocks Reform Act of 1990 says that a penny stock is characterized by a low level of net tangible assets, but no quantitative value is given, and no number is widely used among academicians or analysts. This restriction is therefore highly subjective and is left to the discretion of the authors, which is not rigorous. And secondly, the addition of such a condition could have eliminated many companies, resulting in a sample that would have been too small.

The second condition concerned the date of IPO. In order to have at least five full years of operational history, IPOs occurring after December 2014 were not included in the sample. This minimum time period was chosen as other studies generally use periods of three to five years to compute their survival rate. Hence, taking a similar time interval will allow the results to be compared more easily.

The third condition was a more practical one: if there was not access to sufficient information on the companies at the time of the IPO, not all the necessary data on the different factors studied could be collected. Consequently, the companies concerned could not be added to the sample. This was the most constraining condition as it is often quite difficult to have access to the IPO information for various reasons.

If the companies are still quoted on the AIM or have delisted less than 12 months before the day the data was collected, the information could be found easily in their admission documents. The latter are always available on the companies' websites, as they are obliged by the AIM rule 26 to disclose this information for at least 12 months after the publication date. However, for companies that were delisted more than 12 months after the publication of the information or that are bankrupted, liquidated, etc. the relevant information could be found on the Companies House database website[3]. The Companies House is a governmental agency that centralizes and registers all legal and mandatory information that companies incorporated in the United-Kingdom have to submit. For some companies, you can even find their prospectuses or admission documents or at least their annual reports and accounts. However, when the companies were listed just after their incorporation, their full annual reports were not always available or did not include all the relevant information. The companies for which all the information needed for the study could not be found were eliminated from the sample. Another issue related to companies that were delisted, is that many of them are registered in the Channel Islands (Jersey, Guernsey), in the British Virgin Islands or in the Isle of Man, which are British dependencies with really soft accounting disclosure policies. If a company was incorporated in one of these British dependencies and was delisted, it had to be excluded from the sample as it was not possible to find any documentation on it.

Finally, the information gathered for this work come mainly from four different sources. First of all, the exhaustive list of the IPOs over the period studied was found on the database provided by the London Stock Exchange[4], which publishes every month all the IPOs and their main characteristics such as issue prices, gross proceeds, market capitalizations at initiation, etc. (London Stock Exchange, 2020). All the financial information was expressed in Pound Sterling or American Dollar. The historical monthly exchange rates provided by the European Central Bank on their Statistical Data Warehouse were then used to convert all monetary information into Euro currency[5].

As mentioned before, the Companies House database and the documents provided on the companies' websites were also two sources used to gather information about the companies composing the sample. The last source of information was the Investegate

[3] https://www.gov.uk/government/organisations/companies-house

[4] https://www.londonstockexchange.com/reports?tab=aim

[5] http://sdw.ecb.europa.eu/browse.do?node=9691296

website, which collects and stores all the regulatory announcements ever made by companies quoted on the Alternative Investment Market, FTESE 100 and FTSE 250[6]. It was used to verify why and when a company decided to delist from the AIM, as all the Offer/Acquisition, Scheme, and Cancellation Documents published by the companies can be found on this website. These documents also provide the price at which a company was sold in case of an acquisition.

Moreover, it must be noted that the Alternative Investment Market is characterized by a high number of reverse takeovers compared to other markets. A reverse takeover is a type of merger that private companies use to become public without going through the steps of an Initial Public Offering (Hargrave, 2019). It is often done through a shell corporation, which is a company that has no assets and no activities before the placement (Kenton, 2019). The private company buys enough share of the shell corporation to gain control and the shareholders exchange their shares in the private company against shares in the public company. It allows private companies to become public in a very short period of time without bearing all the heavy costs and the regulatory constraints linked to their IPO (Hargrave, 2019). Shell corporations are quite common on the AIM and are regulated by the AIM rules for companies (2019) and more precisely by the AIM rule 14. If a company is a shell corporation with the objective of proceeding with a reverse takeover, it has to be notified in the admission document. Shell companies were excluded from the study as they are "empty" companies without activities. Exceptions were made when the target company could be identified and the consolidated financial statements of the group after the acquisition were provided with the admission documents.

Finally, after applying all these filters, there were 439 companies left that were eligible for the study. They composed the sample used in this work. In Appendix 2, one can find the list of the 439 companies selected for this work with basic information such as the IPO date, etc.

B. Variables descriptions

In Table 1, one can find all the explicative variables used in the regression model of this work, a brief description of them, and their expected relationship with the independent variable. For the time-to-failure model, a positive relationship means that the variable is expected to increase the probability of failure and thus to decrease the time-to-failure. On the contrary, a negative relationship will decrease the probability of failure and therefore increase the time-to-failure. For the time-to-success model, a positive relationship means that the variable is expected to increase the probability of

[6] https://www.investegate.co.uk

success and thus to decrease the time-to-success. On the contrary, a negative relationship will decrease the probability of success and therefore increase the time-to-success.

Table 1

Description of the variables

Variable	Expected influence	Description	Measure
Basic listing requirements			
LIST1 (no Rev)	(+)	Company who doesn't report revenues at the time of IPO	Dummy variable which takes the value 1 if revenue is inferior to 0
LIST2 (Rev > 0; EPS < 0)	(+)	Company reporting revenues at the time of IPO but no positive Earning per share	Dummy variable which takes the value 1 if revenue is greater than 0 and EPS are inferior to 0
LIST3 (Rev > 0; EPS > 0; SE < 0)	(-)	Company reporting positive earnings per share but a shareholders' equity inferior to €18.09 million	Dummy variable which takes the value 1 if EPS is greater than 0 and SE is inferior to €18.09 million
LIST4 (Rev > 0; EPS > 0; SE > 0)	(-)	Company reporting positive EPS with a shareholders' equity greater than €18.09 million	Dummy variable which takes the value 1 if EPS is greater than 0 and SE is greater than €18.09 million
PROFIT	(-)	Company reporting profit at the time of IPO	Dummy variable which takes the value 1 if the company reported profits at the time of IPO
Characteristics of the companies			
D_AGE	(-)	Age of the company at the time of IPO	Dummy variable which takes the value 1 if the company had more than 5 years of operational history at the time of IPO
Ln (GP)	(-)	Natural logarithm of the IPO's gross proceeds	Continuous variable which is equal to the natural logarithm of the IPO's gross proceeds / offering size
D_GP	(-)	Offering size / Gross proceeds	Dummy variable which takes the value 1 if the gross proceed of the IPO is greater than €7,604,627.869 and 0 otherwise
Third parties			
D_VCB	(-)	The IPO is Venture Capitalist backed or not	Dummy variable which takes the value 1 if the IPO is VC-backed
D_AUD	(-)	The company is audited by a prestigious auditors or not	Dummy variable which takes the value 1 if the company is audited by one of the Big 4 at the time of IPO
D_NOM	(-)	A prestigious underwriter/listing sponsor is involved in the IPO process	Dummy variable which takes the value 1 if a prestigious underwriter/listing sponsor is involved in the IPO
Time			
Time		The length of time between the introduction of the company in the sample and its success or fail.	Number of months between the IPO date of the company and its delisting date or the date of the end of the study (April 2020)
Events			
FAIL		If the company failed or not during the studied period of time according to the selected factors	Dummy variable which takes the value 1 if the company has failed during the studied period of time
SUCCESS		If the company succeeded or not during the studied period of time according to the selected factors	Dummy variable which takes the value 1 if the company has succeeded during the studied period of time

Table 1 shows the different variables that are used in this study as well as their expected relationship with the time to fail (probability of failure), the description of these variables, and how they are computed.

The *LIST* variables describe the basic listing requirements from major stock exchanges around the world and correspond to the first three hypotheses. These dummy variables will be used to estimate the impact of the financial situation before IPO on the failure probability of the issuer. As they are dummy variables, they simply take the value 1 if the condition is fulfilled or 0 if not. The *PROFIT* variable is an additional dummy variable used to assess the financial situation of the issuer at the time of IPO. The variable *PROFIT* corresponds to the second hypothesis and takes the value 1 if the issuer reports profit at the IPO.

The *D_AGE* dummy variable corresponds to hypothesis number four and takes the value of 1 if the company has more than five years of operational history. As mentioned earlier on this work, the cutoff value was set at 5 years to build the dummy variable in order to be able to compare the results more easily to those obtained by Carpentier and Suret (2011) in their study.

Three other dummy variables are used in the model to estimate the impact of third parties on the probability of failure (success). Variables *D_VCB*, *D_AUD*, and *D_NOM* correspond to hypotheses 6,7 and 8 respectively.

The first variable takes the value 1 if the company is backed by a Venture Capitalist at the time of IPO. The second one takes the value 1 if a prestigious auditor is involved in the IPO. As explained earlier, the Big Four (Deloitte, KPMG, PwC, and Ernst & Young) are considered prestigious, similar to what has been done in previous studies (see Weber and Willenborg, 2003; Carpentier and Suret, 2011). The third variable takes the value 1 if the issuer is accompanied by a prestigious nominated adviser and 0 otherwise. Different processes are used to determine if a nominated adviser or an underwriter is prestigious. As mentioned earlier, the Carter-Manaster ratio is the most widely used but is irrelevant in this particular study. In another study, Espenlaub et al (2012) focus on the Alternative Investment Market and the reputation of the nominated advisers. They measured their reputation by the total gross proceeds underwritten or by the number of IPO underwritten. This second method has been used as the total gross proceeds can be strongly influenced by some big IPOs during the studied period. A ranking was constructed by reporting the total number of IPOs underwritten by each nominated adviser in the sample, and the top 10 is considered as prestigious. The names of the ten nominated advisers and the number of IPOs they have underwritten are given in Table 2. In Appendix 3, the list of the top 65 Nomads and the number of underwritten IPOs by each one of them during the 2005 – 2014 period of time can be found. Nomads after the 65th place underwrote a very small number of IPOs, it is therefore not interesting to mention them.

Table 2

Top 10 Nominated Advisers based on the number IPO underwritten

#	Nominated Adviser	Number of IPO
1	Collins Stewart Europe Limited	69
2	Seymour Pierce Limited	62
3	Grant Thornton UK LLP	54
4	W.H. Ireland Limited	51
5	Canaccord Genuity Ltd	48
6	Nabarro Wells & Co. Limited	48
7	KBC Peel Hunt Limited	46
8	Evolution Securities Limited	43
9	Numis Securities Limited	42
10	Cenkos Securities plc	37

Table 2 gives the top 10 nominated advisers based on the number of IPOs underwritten from 2005 to 2014. The number of IPOs underwritten for each Nomad is computed based on the monthly report issued by the London Stock Exchange which provides the name of the nominated adviser in charge of each IPO conducted on the AIM (London Stock Exchange, 2020).

Ln (GP) is a continuous variable that is equal to the natural logarithm of the IPO's gross proceeds. The last risk factor of the model is the *D_GP* variable which is a dummy variable that takes the value 1 when the offering size is greater than €7,604,627.869 and corresponds to hypothesis number 5. The cutoff value used for the *D_GP* variable corresponds to the median of the sample. In the beginning, the model included the continuous variable *ln(GP)* but it didn't fulfill the assumptions of the model used and it has to be transformed into a categorical variable. This will be explained in detail further in the *Linearity hypothesis* part of this work.

C. Characteristics of the sample

In this section, the sample is described by means of some descriptive characteristics. The different variables and several KPIs will be compared according to the date on which the companies were first listed. The surviving and success rates for key characteristics of the sample will also be analyzed in more detail.

In Table 3, one can find the distribution of the sample as a function of the dates at which the IPO was conducted. The sample was divided by year, which allows to see the evolution of the different characteristics through time. It is thus possible to observe the changes in the characteristics and whether some trends over the 10 years of public issues. It is especially interesting since the great financial crisis of 2008 is comprised within the duration of the study, and it had a large effect in the financial world, which is expected to be reflected in the characteristics of the IPOs at that time.

Table 3

Descriptive Statistics of the sample by IPO date

IPO Date distribution	Issuer	Porportion in %	Median Issue Price	Median Age at IPO	Median SE	Median Gross Proceed	Median Market Cap (€m)
2005	133	30.3%	0.61 €	3	964,978.84 €	6,524,765.11 €	23.64 €
2006	90	20.5%	0.86 €	4	1,082,877.05 €	6,691,051.83 €	20.53 €
2007	52	11.8%	0.90 €	3.5	1,748,399.29 €	6,574,020.59 €	34.92 €
2008	10	2.3%	0.72 €	3	15,614,230.98 €	14,542,651.79 €	59.86 €
2009	3	0.7%	0.96 €	1	108,481.51 €	1,426,700.22 €	11.01 €
2010	20	4.6%	0.74 €	4	3,339,519.55 €	7,879,803.33 €	21.27 €
2011	23	5.2%	0.36 €	5	1,555,474.13 €	3,825,769.74 €	18.65 €
2012	20	4.6%	0.80 €	6	495,996.52 €	8,431,229.57 €	26.13 €
2013	33	7.5%	0.74 €	11	858,343.60 €	5,968,011.46 €	25.26 €
2014	55	12.5%	1.26 €	8	1,001,853.76 €	14,493,456.13 €	68.01 €
Whole sample	439	100%	0.75 €	5	1,321,487.60 €	7,604,627.87 €	26.99 €

Table 3 shows the distribution of the IPOs and their characteristics by dates. The median issue price is computed by transforming the issue price given by the London Stock Exchange in pound sterling in their monthly report as well as the market capitalization (London Stock Exchange, 2020). The median Shareholders' equity is computed using the equity reported in the admission documents or in the last annual report before IPO of the issuers. Median SE corresponds to the median shareholders' equity of the companies just before the IPOs, before raising any cash from the listing. The median Market Cap is the median market capitalization of the companies using the first share price given by the London Stock Exchange just after the introduction.

As we can see in Table 3, some trends can clearly be distinguished during the studied period. The two first years are characterized by a high degree of activity with many new IPOs. There were 133 and 90 new IPOs in 2005 and 2006 respectively, which represents more than 50% of the whole sample. Moreover, during these two years, many companies active in the natural resource sector (oil, gas, and mining) that were in development stage and went public. Then in 2008, the number of IPOs decreased dramatically, as well as the other factors. The lowest number of issues was achieved in 2009 with only 3 companies going public. Between 2010 and 2014, the number of IPOs slowly increased, but it is still far from its peak in 2005.

In 2006, Bradley et al. observed a mean gross proceeds of US$ 5.7 million for penny stock IPOs on the US markets and a mean issue price of US$4.42 for penny stock IPOs which corresponds to a mean gross proceeds of €4.54 million and a mean issue price of €3.52 using the average annual historical exchange rate of 2006 retrieved from the European Central Bank Database[7]. Carpentier and Suret (2011) studied the IPOs on the Canadian market and they found a mean gross proceeds of CAN$ 0.8 million with a mean offering price of CAN$ 0.75, which correspond to €0.58 million and €0.54 using the average annual historical exchange rate of 2011 retrieved from the European Central Bank Database[8]. Carpentier, L'Her and Suret (2010) reported an average gross proceeds of €19.5 million on the NASDAQ North First, a branch of the NASDAQ Nordic for small businesses (Nasdaq, 2020) and a median gross proceeds of €4.4 million for the Alternative Investment Market in London.

The median gross proceeds derived from the sample of this study is equal to €7,604,627.87 which is slightly higher than what is observed on other junior markets, except for the NASDAQ North First. As one can see in Table 3, except in 2008 and 2014 where the median gross proceeds are much larger than the other years, the median gross proceeds are each year quite close to that of the entire sample. The median IPO price of the sample is €0.75, which is quite similar than what was found on the Canadian market by Carpentier and Suret (2011), but far smaller than what Bradley et al. (2006) obtained for the North American market. Other studies similar to the one realized by Jain et al. (2008) have much higher values for those variables, but these studies do not focus only on penny stocks IPOs. They obtained median gross proceeds of US$99.48 million and a median IPO price of US$ 16.12, which corresponds to €67.63 million and €10.96 respectively when using the average annual historical exchange rate retrieved from the European Central Bank Database[9].

Concerning the shareholders' equity, the mean for the whole sample is equal to €1,321,487.6. In comparison, Carpentier and Suret (2011) reported a pre-IPO shareholders' equity of CAN$ 0.3 million (or €0.218 million using annual historical exchange rate). This extremely small value is due to the fact that the size of the companies listed on the TSVX is extremely small compared to other markets. Unfortunately, to the best of my knowledge, the study done by Carpentier and Suret in 2011 is the only one where the pre-IPO equity of penny stocks is reported, but it does not constitute a good basis for comparison due to the extraordinarily small size of the companies listed on the TSVX.

[7] http://sdw.ecb.europa.eu/browse.do?node=9691296

[8] http://sdw.ecb.europa.eu/browse.do?node=9691296

[9] http://sdw.ecb.europa.eu/browse.do?node=9691296

The mean age of the company at the time of IPO derived from the sample is equal to 5 years. The median age reported in this work is surprisingly lower than what can be observed in other similar studies. For instance, Jain et al. (2008) reported a median age at IPO of 5.9 years for the US market. Carpentier and Suret (2011) observed a median age of 7.11 years at IPO. Similar observations are also found by Audretsch and Lehmann (2005) with a median age of 7.6 and 11.06 years for delisting firms and surviving firms respectively. In comparison, the median age for failed and surviving firms in the sample are 3 and 6 years respectively, both of which are lower than what Audretsch and Lehmann (2005) found for the Neuer Mark. This low median age of the sample is probably strongly influenced by the numerous quotations of natural resources companies in 2005 and 2006, because these companies went public just after their incorporation, that is without operating history.

Table 4

Survival status three, four and five years after IPO

	Non surviving		Surviving unsuccessful		Surviving succesfull		Total surviving	
	#	proportion in %	#	proportion in %	#	proportion in %	#	proportion in %
Whole sample	181	41.23%	229	52.16%	29	6.61%	258	58.77%
5 years	79	18.00%	350	79.73%	10	2.28%	360	82.00%
4 years	56	12.76%	376	85.65%	7	1.59%	383	87.24%
3 years	28	6.38%	407	92.71%	4	0.91%	411	93.62%

Table 4 shows the failure, success and survival rates three, four and five years after the IPO and for the whole sample. The end date for the study is the first June 2020.

To compare the results with similar studies and to make consistent comparisons, the failure and success rates three, four, and five years after the IPO dates were computed for the companies in the sample. In Table 4, it can be seen that a 5-year failure rate of 18.0%, a 4-year failure rate of 12.76%, and a 3-year failure rate of 6.38% are obtained.

Carpentier and Suret (2011) reported a 5-year failure rate of 11.6% which is significantly lower than what is obtained for this study. However, Weber and Willenborg (2003) observed a 4-year failure rate of 25.3% and Bradley et al (2006) reported a failure rate of 31.5% 3 years after the IPO. These two last studies focus only on US penny stocks and as we can see, the failure rates they obtained are much larger than what is found for the Alternative Investment Market.

Carpentier and Suret (2011) explained their lower failure rates compared to US studies by the large proportion of the natural resources sector in the Canadian market and the laxer regulations regarding delisting companies. For the Alternative Investment Market, although many natural resource companies were listed in 2005 and 2006, the impact of the natural resources sector is difficult to assess. However, the second explanation given by the authors is also valid for the AIM because it is a principle-based stock exchange with very few delisting rules, which is quite similar to the Canadian market. To be delisted from the AIM, a company must either no longer have a nominated adviser, stop publishing the regulatory information they have to disclose under the AIM rule 26, or have serious regulatory issues.

In Table 5, one can find the number of issuers reporting revenues, profits, and that have more than 5 years of existence at the time of IPO as a function of the issue year.

Table 5

Issuers characteristics by IPO dates

IPO Date distribution	Issuer with Revenue	Proportion with revenue in %	Issuers with Profit	Proportion with profit in %	Issuer with Age > 5	Proportion with Age > 5 in %
2005	91	68.4%	46	34.6%	54	40.6%
2006	70	77.8%	37	41.1%	43	47.8%
2007	31	59.6%	19	36.5%	32	61.5%
2008	5	50.0%	4	40.0%	3	30.0%
2009	1	33.3%	1	33.3%	1	33.3%
2010	12	60.0%	5	25.0%	10	50.0%
2011	13	56.5%	5	21.7%	14	60.9%
2012	12	60.0%	5	25.0%	11	55.0%
2013	26	78.8%	15	45.5%	24	72.7%
2014	51	92.7%	26	47.3%	41	74.5%

Table 5 reports the different characteristics of the issuers as a function of the IPO dates to see how they change over the studied period of time. The revenues and the profits of the companies were found in their admission documents. The age of the issuers was found in their admission documents or on their websites.

As we can see in Table 5, the financial situation of the companies that went public changed during the studied period and it can be assumed that the turning point was the great financial crisis of 2008, which had a strong impact on the quality of the issuers. Between 2008 to 2010, the financial situations of the companies worsened compared to the pre-crisis period, with a lower proportion of companies going public while reporting revenues, positive earnings, and having more than five years of experience. However, this tendency slowly changed with the recovery from the crisis. The financial situations of the issuers got better years after years. In 2014, 92.7% of the issuers reporting revenue, 47.3% have positive earnings, and 74.5% of them had more than 5 years of operational history. These proportions were respectively equal to 68.4%, 34.6%, and 40.6% in 2005, which means that, in 2014, the financial situation of companies has globally returned to its pre-crisis level.

The improvement of the financial situation of the issuers over the years is an interesting thing to notice. It would be really useful to look at the reasons behind this particular change and see if this trend continues nowadays. As the Alternative Investment Market is a principle-based stock exchange without a strict set of rules to follow. The hypothesis of the tightening of the rules by the London Stock Exchange can be excluded. One explanation could be that the profile of the companies seeking to raise capital has changed over the years. Another explanation would be that, after the 2008 crisis, nominated advisers are less keen to list new companies with weaker financial situation on the AIM as they benefit much more from companies that are registered during a long time.

In Table 6, one can find the failure, success, and survival rates for the whole sample and for subgroups based on the different variables studied in this work.

It can be seen in Table 6 that a total failure rate of 41.23% and a success rate of 6.61% are obtained for the whole sample. This means that in 52.16% of the cases, the company survived but did not manage to succeed. In other words, out of the 439 companies in the sample, 181 did not survive until June 2020, 29 succeeded and 229 managed to survive without being successful. Overall, we get a survival rate of 58.77%, which is quite similar to what other researches on penny stocks found, but much lower than what is obtained in studies that do not focus on penny stocks. For example, Carpentier and Suret (2011) reported an overall survival rate of 51.48% for penny stocks IPOs while Jain et al. (2008) found a survival rate of 70.6% for their sample composed of all kinds of technological IPOs in the United-States.

Table 6

Failure rates, surviving rates and success rates by issuers' characteristics

	Issuers number	Proportion *in %*	Non-surviving *in %*	Surviving unsuccessful *in %*	Surviving successful *in %*	Surviving total *in %*	Total *in %*
Whole sample	439	100%	41.23%	52.16%	6.61%	58.77%	100%
Revenue							
LIST234	312	71.1%	41.99%	50.32%	7.69%	58.01%	100%
LIST1 (no Rev)	127	28.9%	39.37%	56.69%	3.94%	60.63%	100%
Profit							
LIST34	162	36.9%	31.48% ***	58.64% .	9.87% .	68.51% **	100%
LIST12 (no profits)	276	62.9%	47.10%	48.55%	4.71%	53.26%	100%
Equity							
LIST4 (SE > €18.04)	38	8.7%	36.84%	52.63%	10.53%	63.16%	100%
LIST123	401	91.3%	41.65%	52.12%	6.23%	58.35%	100%
AGE							
Age < 5y	215	49.0%	50.23% ***	45.58% **	4.18% .	49.76% ***	100%
Age > 5y	224	51.0%	32.59%	58.48%	8.93%	67.41%	100%
SIZE							
Offer size < €7.6m	220	50.1%	42.3%	54.5%	3.18% **	57.73%	100%
Offer size > €7.6m	219	49.9%	40.2%	49.8%	10.0%	59.82%	100%
Auditors							
Prestigious	111	25.3%	38.74%	50.45%	10.81% .	61.26%	100%
Not prestigious	328	74.7%	42.07%	52.74%	5.18%	57.93%	100%
Nomad							
Prestigious	150	34.2%	41.33%	48.00%	10.66% *	58.67%	100%
Not prestigious	289	65.8%	41.18%	54.33%	4.50%	58.82%	100%
Venture Capitalist							
VC-Backed	151	34.4%	28.47% ***	64.90% ***	6.62%	71.52% ***	100%
Not VC-Backed	288	65.6%	47.92%	45.49%	6.60%	52.08%	100%

Signifiance codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Table 6 shows the failure, survival and success rates for the sample based on the characteristics of the issuers at the time of IPO. The rates provided in Table 6 are based on the status of the companies on the 1st June 2020. *LIST1*, *LIST2*, *LIST3* and *LIST4* are dummy variables that characterize the financial situation of the issuers at the time of IPO. The four variables are described in detail further in this work. SE stands for Shareholders' equity of the issuers at the time of IPO. VC-Backed means that the company is backed by a Venture Capitalist at the time of IPO. A simple proportion test was conducted on each pair of percentage. For example, for the revenue line, the test was conducted for the non-surviving proportion to see if the difference between 41.99% and 39.37% is significant or not. In this particular case, the test was not significant. If the difference between the two proportions is significant, it is indicated on the higher line only.

As we can see in Table 6, 127 issuers (28.9% of the sample) reported no revenue at the time of IPO. In comparison, Carpentier and Suret (2011) observed that 45.32% of their sample reported no revenues at the time of IPO. The high number of pre-revenue quotations found by Carpentier and Suret (2011) is mainly due to the high number of private placements that take place on the TSXV. Unfortunately, to the best of my knowledge, no other study reported companies without sales. Some studies on the survival of IPOs have even excluded companies without revenues from their samples. For the AIM, the number of companies that went public without reporting any revenues is probably influenced by the high number of companies active in the natural resources sector that listed while they were still in the development phase, just after obtaining the license for the operation of a natural resource site. Surprisingly, the failure rate seems to be greater for companies that reported revenue than for companies that listed on a pre-revenue stage, with failure rates of 41.99% and 39.37% respectively but unfortunately the difference is not statistically significant therefore no conclusion can be made. However, the highest success rate is found for companies that reported revenues at the time of introduction. The success rate for companies with revenues is equal to 7.69% against 3.94% for firms without revenues. Once more, the proportion test is not significant at any level for the success rates.

In the sample, 62.9% of the companies (276) reported negative earnings at the time of the IPO, which means that more than 6 companies out of 10 were making losses when they decided to list on the AIM. Knowing that, on a major market, companies must have been profitable for at least three years before going public, it means that 62.9% of the sample could not be quoted on a major market based on this condition only. The difference between major markets and second-tier markets is therefore quite pronounced. Logically, the survival rate for profitable companies is higher than for unprofitable companies, with survival rates of 68.51% and 53.26% respectively. As we can see on Table 6, the difference between these two surviving rates is significant at the 10% level. Moreover, the success rate of profitable companies at the time of IPO is equal to 9.87% while it is equal to 4.71% for firms with no profits. As for the surviving rates, the difference between the two percentage is significant but only at a 10% level.

Only 38 companies in the sample had shareholders' equity greater than €18.04 million while showing positive earnings. For these companies, the failure rate is 36.84% compared to 41.65% for companies that do not fulfill these two conditions. The success rate for these 38 companies is equal to 10.53% against 6.23% for the rest of the sample. However, the differences are not significant for both the success rates and the failure rates.

The proportion of companies having more than five years of operational history is quite similar to the proportion of companies with less than five years of operational history as 51% of the sample (224 companies) fulfilled the first condition. The oldest companies of the sample have a survival rate of 67.41% against 49.76% for younger companies with a statistical significance at the 0.1% level for the difference between the two percentages. These results are quite similar to what Carpentier and Suret (2011) reported in their study, that is a survival rate of 67.5% for companies existing for five years or more and 43.4% for the others. The probability of success follows the same trends with success rates of 4.18% against 8.93% in favor of older companies. The difference between the two proportion is also statistically significant but only at the 10% level.

As one can see in Table 6, 49.9% of the sample had an IPO gross proceeds superior to €7,604,627.87. For these companies, the surviving rate is equal to 59.82% compared to 57.73% for companies with an IPO gross proceeds lower than the cutoff value. The difference between the two surviving rate is not statistically significant according to the proportion test. However, the difference between the success rates is significant at the 1% level. The success rate for companies with a higher gross proceeds is equal to 10% while the success rate for IPO with gross proceeds smaller than €7,604,627.87 is 3.18%.

Concerning the involvement of prestigious third parties, we can see in Table 6 that only a minority of issuers are backed by prestigious Venture Capitalists, auditors or nominated advisers at the time of IPO.

For the auditors, only 111 issuers in the sample (25.3%) are characterized by the involvement of one of the Big Four. Amongst these companies, 78 did manage to survive during the studied period of time, which gives a survival rate of 61.26%. In comparison, for the 328 other companies in the sample, 190 of them did survive which corresponds to a survival rate of 57.93%. The difference between these two survival rates is quite small and it is not statistically significant. However, for the success rate, we can see in Table 6 that IPOs involving of a prestigious auditor have a success rate of 10.81%, while issues without the involvement of one of the four prestigious auditors have a success rate of only 5.18% and it is significant at the 10% level only.

Over the ten years covered by the study, 150 issues (34.2%) were conducted with the participation of a prestigious Nomad and 289 (65.8%) without. The presence of a prestigious nominated adviser does not seem to have a lot of influence on the survival of the company after the issue as the survival rates with a prestigious Nomad is 58.67% against 58.82% without and the difference between these survival rates is not statistically significant. The difference in success rates is more pronounced and statistically significant, with success rates of 10.66% and 4.50% respectively with and without prestigious nominated advisers respectively.

Finally, 151 companies were backed by Venture Capitalists at the time of IPO, which corresponds to 34.4% of the sample. The difference between VC-backed and non-VC-backed issues is quite important compared to other variables, as the survival rates is equal to 71.52% when a Venture Capitalist is involved and 52.08% for IPOs not backed by VC. The survival rate for VC-backed IPOs is nearly 50% higher than for non-VC-backed IPOs and the difference between them is highly significant even at the 0.1% level. Surprisingly, the difference in success rates is less significant and not statistically significant as the results are quite similar for VC-backed IPOs and non-VC-backed IPOs: the success rates of 6.62% and 6.60% respectively. The activity of the Venture Capitalists on the AIM is different than what can be found in other studies for other markets. For example, Jain et al (2008) reported that 79% of the issues composing their sample are backed by Venture Capitalists. In contrast, Carpentier and Suret (2011) found that only 145 companies over 2374 were backed by Venture Capitalists at the time of IPO. Bradley et al (2006) reported similar results than Carpentier and Suret (2001) with 16% of their sample backed by VC at the introduction. The Alternative Investment Market is therefore characterized by a high degree of activity of Venture Capital funds, which makes sense as the AIM is located in London, one of the most important financial places in the world.

VIII. Methodology

The objective of this study is to determine if some qualitative and quantitative factors can influence the failure or success of an IPO. To do so, a statistical survival analysis must be conducted using the Proportional Hazard Model developed by Cox in 1972.

A. Cox's Proportional Hazard Model

For the empirical part of this work, I used the Proportional Hazard Model developed by Cox in 1972. This model allows us to study the impact of risk factors (explicative variables) on the occurrence of an event, which is, in this particular case, the failure or the success of an IPO conducted by a penny stock company. In other words, the model links the dates at which an event occurred to the explicative variables.

Cox's model (1972) is an extension of the non-parametric model developed by Kaplan and Meier in 1958. The Kaplan-Meier model allows researchers to build the survival function of a pool of individuals for a specific event. However, this model is not exactly suitable for estimating the impact of one sub-group compared to another and it does not have a solution to treat continuous variables (Cox, 1972).

The Cox Proportional Hazard Model is a semi-parametric regression model. It is composed of a finite component and an infinite component and takes the following form:

$$ln(t;z) = \ln\big(\lambda_0(t)\big) + z_1\beta_1 + z_2\beta_2 + \cdots + z_k\beta_k$$

or

$$\lambda(t;z) = \lambda_0(t)\, exp(z\beta)$$

The dependent variable in this model is the "immediate risk", also called the survival function or the hazard function and is noted $\lambda(t;z)$ in the previous equation. More precisely, the immediate risk is the probability for an individual in the sample to present the event on an infinitesimal period of time after $time\ t_1$ if he has not yet presented the event. In scientific terms, $\lambda(t;z)$ is the occurrence probability of an event over the time interval $[t; t + \Delta t]$ (Cox, 1972). In this work, the function lambda $\lambda(t;z)$ represents either the failure probability or the success probability.

The exponential term of the equation, $exp\,(z\beta)$, corresponds to the finite component of the equation. β is a $p \times 1$ vector of unknown parameters where p is the number of risk factors (explicative variables) taken into account in the model. This vector is what we want to estimate, and it reflects the impact of the explicative variables on the dependent variable $\lambda(t; z)$. z is a vector $1 \times p$ of dummy variables that take the value 1 if the risk factor is present for the individual and 0 otherwise. Therefore, if $\beta_j > 0$, the value of the z_j characteristic will be associated to a higher immediate risk, and inversely, if $\beta_j < 0$, the value of the z_j will be associated to a smaller immediate risk.

The other parameter of the equation, $\lambda_0(t)$, is the infinite-dimensional component of the semi-parametric model and is impacted by the time. In this case, $\lambda_0(t)$ corresponds to the hazard function when $z = 0$. Cox (1972) uses the risk proportionality hypothesis, which states that the time has no impact on the explicative variables, therefore we do not need to know the value of $\lambda_0(t)$ to study the vector β. $\lambda_0(t)$ is thus considered by Cox as a *"Nuisance function"* that has to be taken into account in the model, but that has no impact on the value of Beta, hence on the results sought. Consequently, the Cox Proportional Hazard model never provides the value of the baseline hazard rate $\lambda_0(t)$.

The β_j parameters are estimated using the partial likelihood. Since the model considers the effect of time to be constant, it does not estimate the variable $\lambda_0(t)$. Therefore, Cox only needs to have good estimators for the finite component β. The partial likelihood was invented by Cox in 1972 for this model as he needed maximum likelihood only for one part of the equation he used.

The Cox Proportional Hazard Model relies on different assumptions. The first two are basic assumptions used in all survival analysis models. They state that, on the one hand, censored data are non-informative and, on the other hand, that the survival times (t_j) are independent of the individual in the sample. The first hypothesis means that when the data are censored, that is when the event that we are interested in has not occurred yet for an individual, these data do not give any information about the probability of the event. And the second hypothesis states that the explicative variables z_j cannot change over time.

Then, the two following assumptions are the most important ones as the whole model relies on them. Firstly, Cox assumed that a log-linear relationship exists between the survival function and the explicative variables (Cox, 1972). As in many other statistical models, Cox used this assumption because of the interesting mathematical characteristics of the natural logarithm function (typically its additive properties).

The second assumption used by Cox is the risk proportionality hypothesis which states that the survival function for two individuals noted i and j with characteristics z_i and z_j will only be influenced by z_i and z_j (Cox, 1972). This hypothesis implies that the time has a constant effect on the explicative variables, and it is therefore not interesting to take time into account in the estimations of the explicative variables. From a mathematical point of view, it can be easily demonstrated that the risk ratio for two individuals i and j is not impacted by the time:

$$\frac{\lambda(t;z_i)}{\lambda(t;z_j)} = \frac{\lambda_0(t)\,exp(z_i\beta)}{\lambda_0(t)\,exp(z_j\beta)} = \frac{exp(z_i\beta)}{exp(z_j\beta)} = exp\left((z_i - z_j)\beta\right)$$

As we can see in this short demonstration, the time has no impact on the risk ratio of these two individuals. It is important to note that the hazard can vary over time, but the hazard ratio must remain constant. If the hazards change over time, to fulfill the assumption, they must change in a proportional way to keep their ratio constant.

The Cox's model has two strong advantages that make its use easier for researchers. The first one is that no assumption has to be made about the underlying statistical distribution of the sample. The second one is that the model can deal with censored data.

B. Creating the model and hypotheses testing

Before using the regression model, the first important step is to check whether or not the hypotheses of the Cox Proportional Hazard model are verified. As mentioned earlier, the model relies on two strong assumptions: the linearity (or log linearity) assumption which states that the hazard function has a linear relationship with the risk factors, and the proportional hazard assumption which states that the hazard ratios are constant through time.

As mentioned in the introduction, all the empirical part of this work was conducted on R (R Core team, 2013) and especially by using the *survival* package developed by Pr. Therneau which provides all the analytical and mathematical tools to use a Cox Proportional Hazard Model (Therneau, 2020). In Appendix 4, one can find the code I used to complete this work.

It is important to note that the whole process developed in the following sections was conducted for the two applications of model: for the modeling of both the time-to-failure and the time-to-success. As the same method is used twice, the different steps will only be described in detail for the time-to-failure, not for the time-to-success.

1. Linearity hypothesis

Taking into account the variable notations given earlier in Table 1, the regression model equation for the time-to-failure takes the following form:

$$\lambda(Time, FAIL) = LIST1 + LIST2 + LIST3 + D_{AGE} + \ln(GP) + D_{AUDIT} + D_{NOM} + D_{VCB}$$

(Equation A)

The variable corresponding to the IPOs' gross proceeds was meant to be a continuous variable denoted by the natural logarithm of the gross proceeds of each IPO. As $\ln(GP)$ is a continuous variable, its linearity with the dependent variable must be checked. For categorical/dummy variables, the linearity hypothesis does not need to be tested because their values can only be 0 or 1, so they can only be linear.

Checking the linearity between dependent and independent variables is quite subjective and is done graphically by using the Martingale residuals of the model. The Martingale residuals are widely used in survival analysis to assert the functional form of a covariate and the model adequacy for linearity (Therneau, Grambsch and Fleming, 1990). In our case, Martingale residuals will be used to assert the linearity assumption. Martingale residuals are used instead of residuals commonly employed in linear regression models because the latter do not allow taking into account the censoring of the data.

The Martingale residuals are defined by Therneau and Grambsch (2000) as "*the simple difference between the observed number of events for an individual and the conditionally expected number given the fitted model, follow-up time, and the observed course of any time-varying covariate*", and they are given by the following equation:

$$\widehat{M_\iota} = \delta_i - E_i$$

In this equation, $\widehat{M_\iota}$ represents the estimated Martingale residuals for the *i*-th individual, δ_i is the observed number of events for the *i*-th individual and E_i is the expected number of events for the *i*-th individual given by the Cox model in this case. The Martingale residuals can take any value in the range $[-\infty; 1]$, where a value close to 1 indicates that the individual "*died*" too soon, and a highly negative value indicates that the individual lived too long compared to what was predicted by the model. An important characteristic that Martingale residuals share with common linear residuals is that their mean is equal to 0 (Lin, Wei and Ying, 1993).

The method using Martingale residuals to check the linearity of the model was developed by Therneau et al, (1990) and has been widely used since then. The advantage of this method is that it is possible to consider only the finite form of the equation, that is the $exp(z\beta)$ part.

To do so, two different ways can be used, they are complementary. The first method consists in plotting the residuals of the null regression model on the Y-axis and the continuous predictor on the X-axis. The null regression model is the Cox regression model when the $\hat{\beta}$ associated with the continuous variable we want to test is equal to $\mathbf{0}$, or in other words when the explicative variable is removed from the model. We will obtain a scatter plot with all the Martingale residuals. On this graph, a regression line is inserted that will allow us to better discern the shape formed by the Martingale residuals and whether there is a trend that can be outlined. For instance, the regression line corresponds to the red curve on Figure 2 and its shape shows the nature of the relationship between the hazard and the tested predictor. Hence a straight (linear) line indicates that the relationship between the predictor and the hazard obtained by the model is linear (Therneau et al, 1990).

Figure 2

Martingale residuals for the model without ln(GP)

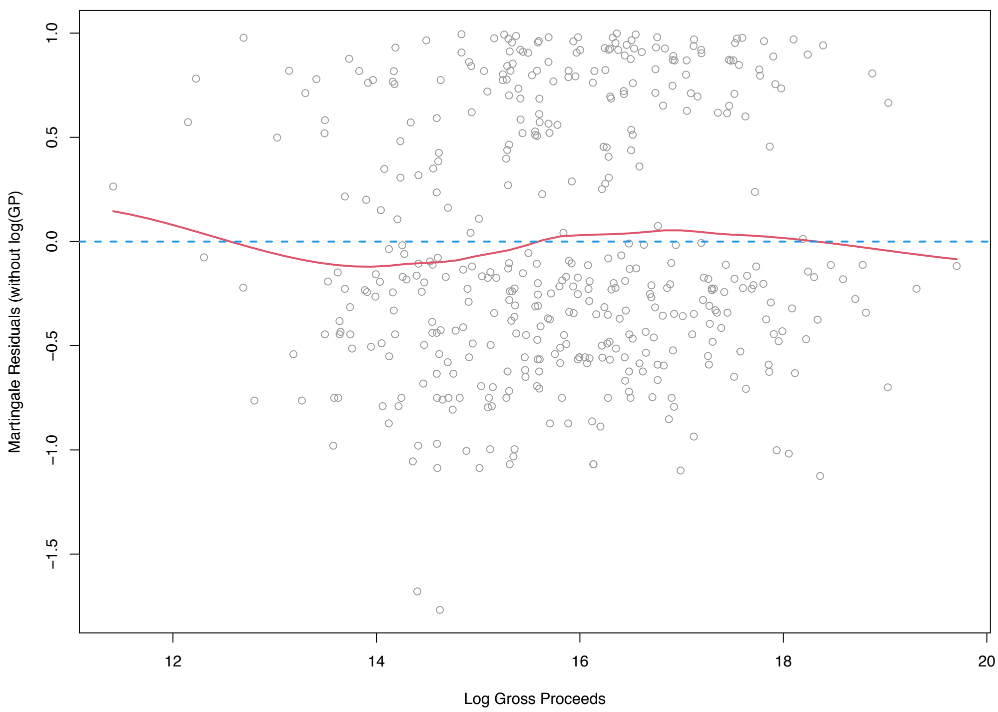


Figure 2 shows the Martingale residuals plot for the time-to-failure model without the *ln(GP)* variable as a function of the natural logarithm of the gross proceeds for the IPOs. The plot is obtained from R using the survival package developed by Pr. Therneau (Therneau, 2020).

On Figure 2, we can see that the regression line is not a straight line but rather has a quadratic shape. It suggests that the variable *ln(GP)* has not a linear relationship with the dependent variable lambda, because its impact on the hazard is not linear. Hence, according to Figure 2, the linearity hypothesis is not respected for the *ln(GP)* variable.

To make sure that the linearity is broken, the Martingale residuals can be used a second time but for the entire model, with the integration of the ln(GP) variable. The graph therefore show the Martingale residuals for the whole model (including *ln(GP)*) on the Y-axis, with the explicative variable *ln(GP)* on the X-axis. Here again, in order to fulfill the linearity hypothesis, the regression line drawn in Figure 3 must be horizontal.

Figure 3

Martingale residuals for the model including ln(GP)

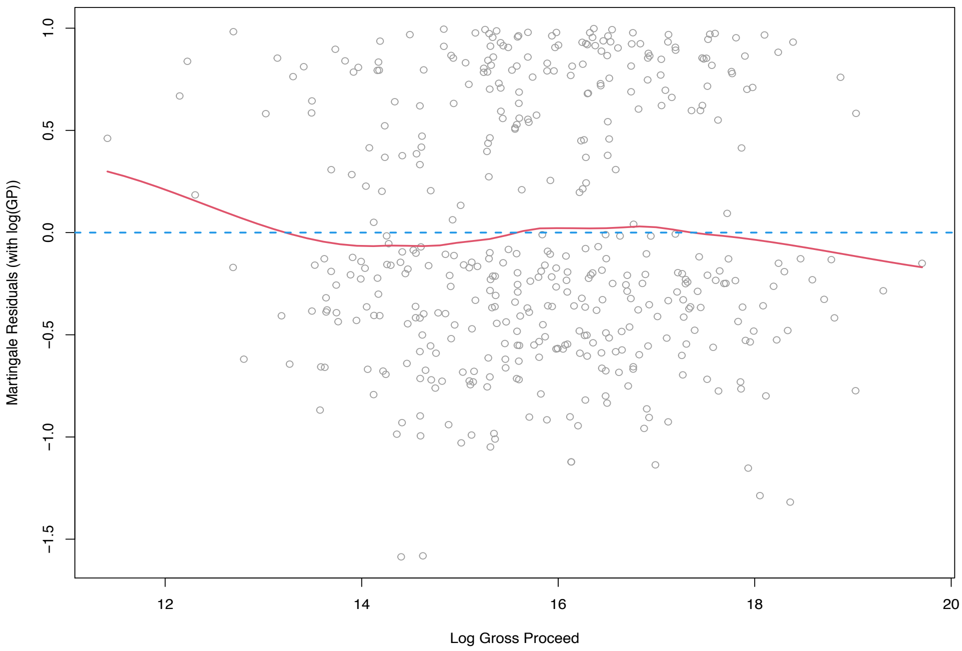


Figure 3 shows the Martingale residuals plot for the time-to-failure model including the *ln(GP)* variable in function of the natural logarithm of the gross proceeds for the IPOs. The plot is obtained from R using the survival package developed by Pr. Therneau (Therneau, 2020).

However, the red line shown in Figure 3 again does not fulfill the linearity hypothesis of the Cox's model as it is not horizontal. Based on the two graphs above, we can conclude that the *ln(GP)* variable does not fulfill the linearity hypothesis. Therefore, this variable cannot be included in the model because the results obtained could not be interpreted properly to understand the survival function.

Several methods can be used to adjust the variable so that the linearity assumption is verified. For example, define a cutoff value and to use a categorical variable instead of a continuous variable, to apply some transformations on the variable like logarithm, square root, etc., or to use different smoothing techniques with polynomial splines. The application of some basic transformations on the variable had no significant effect on the linearity. Consequently, as mentioned in the Variable Description part of this work, another method was used: the continuous variable was transformed into a categorical variable. The *D_GP* variable is therefore introduced in the model to replace *ln(GP)* and takes the value of 1 if the gross proceed of the IPO is greater than €7,604,627.869 or 0 otherwise. As a reminder, €7,604,627.869 is the threshold used for the categorical variable *D_GP* and is equal to the median of the sample's gross proceeds.

The equation used in the Cox's model now takes the form:

$$\lambda(Time, FAIL) = LIST1 + LIST2 + LIST3 + D_{AGE} + \mathrm{D_{GP}} + D_{AUDIT} + D_{NOM} + D_{VCB} \quad \textit{(Equation B)}$$

2. Influential observations

Looking at the presence of influential observations is not part of the testing of the assumptions in the model, but it is still important to consider it. Checking the influence that observations can have on the coefficients of the model can be done quite quickly with a graphical representation of the residuals.

To do so, we have to plot the *dfbeta* residuals for each covariate in the model. The *dfbeta* residuals are a statistical tool which shows the influence that an observation has on the $\hat{\beta}$ of the covariate. More precisely, it will report on the plot the variation of $\hat{\beta}$ when each observation is deleted one by one. A cutoff value has been proposed by Belsley, Kuh, and Welsch (1980), and it is used to determine which observation is influential. The size-adjusted cutoff value they proposed is equal to $\frac{2}{\sqrt{n}}$. In our case, the cutoff value is equal to $\frac{2}{\sqrt{439}} = 0.095$. It means that every observation comprised in the interval [-0.095; 0.095] will be considered as not influential.

Figure 4

Dfbeta residuals for variables 1-4: Time-to-failure

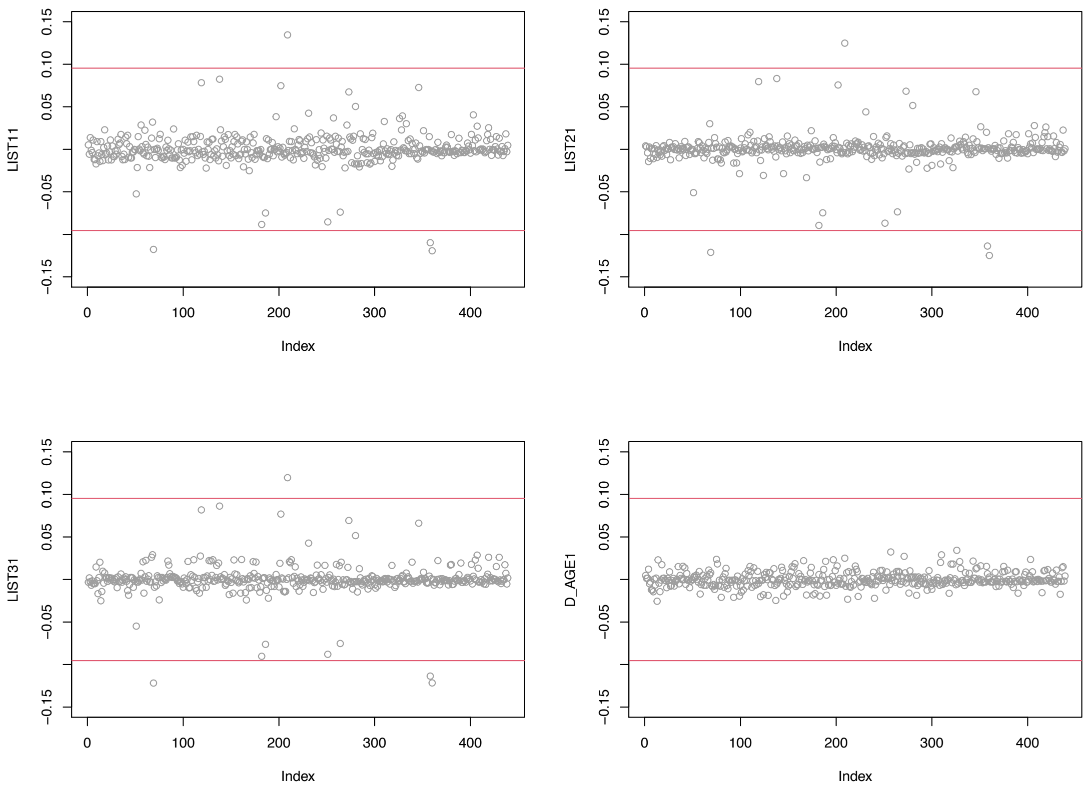


Figure 4 shows the dfbeta residuals for each observation in the sample for the *LIST1*, *LIST2, LIST3* and *D_AGE* variables. The number 1 after each variable is the reference (baseline) category for the dummy variable, which in this case is equal to 1. The Index on the X-axis corresponds to the index of the observation in the database. For example, the dot at the index 1 represents the variation for the coefficient of the variable if the first observation (the first company in the sample) is deleted.

As we can see in Figures 4 and 5, for the *LIST1*, *LIST2* and, *LIST3* variables, some of the observations are influential as they are not comprised in the interval *[-0.095; 0.095]*. For all the other variables, no observations have a significant influence on the coefficient of the explicative variables. Nevertheless, as only very few observations are influential for the three *LIST* variables, and because the *dfbeta* residuals for these observations are not very far from the cutoff value, these four observations will be kept in the sample. In addition to that, the cutoff value for the *dfbeta* residuals proposed by Belsley, Kuh, and Welsch (1980) is quite arbitrary. Moreover, the characteristics of the four companies concerned were subsequently verified and nothing indicates that they have anything particular and should be excluded from the sample.

Figure 5

Dfbeta residuals for variables 5-8: Time-to-failure

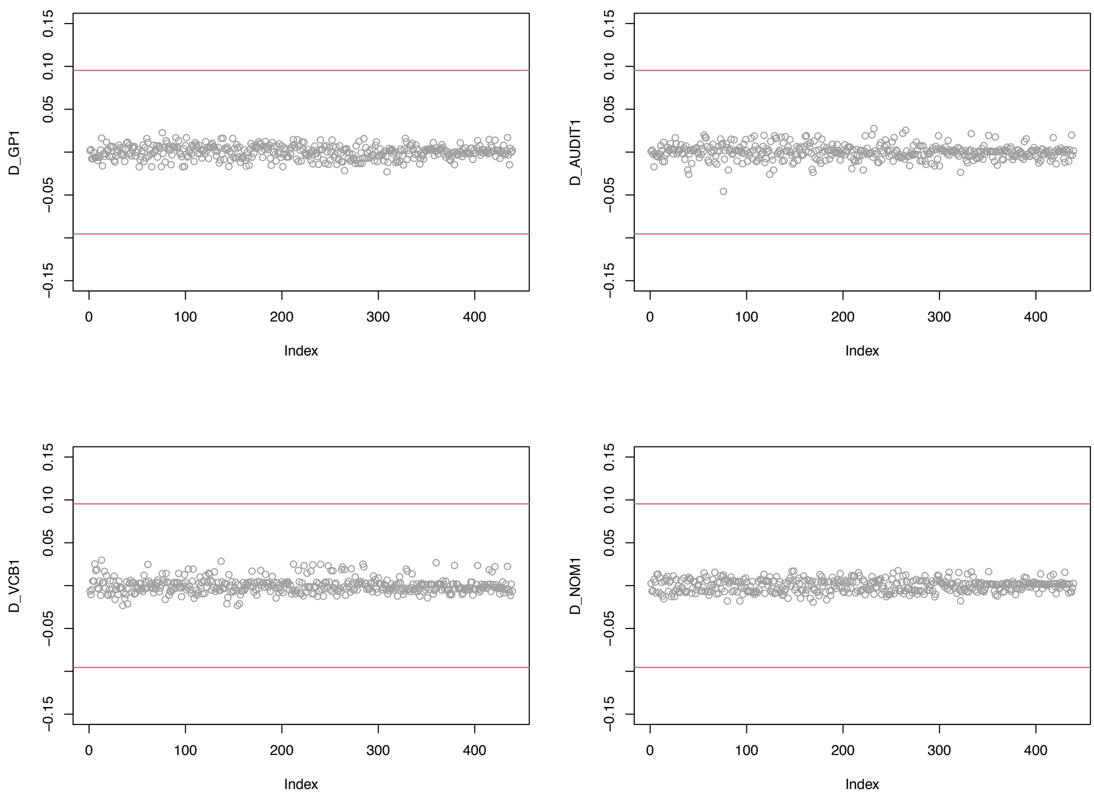


Figure 5 shows the dfbeta residuals for each observation in the sample for the *D_GP*, D_*AUDIT*, *D_VCB* and *D_NOM* variables. The number 1 after each variable is the reference (baseline) category for the dummy variable, which in this case is equal to 1 The Index on the X-axis corresponds to the index of the observation in the database. The dot at index 1 represents the variation of the coefficient of the variable if the first observation (the first company in the sample) is deleted.

3. Proportional Hazard Hypothesis

The last hypothesis that needs to be tested is the proportional hazard hypothesis, which states that the hazard ratios must remain constant through time. Similarly to the other hypotheses discussed above, this can be checked graphically using the scaled Schoenfeld residuals. The method using the scaled Schoenfeld residuals to assess the proportionality for a Cox model was first developed by Schoenfeld in 1982 and then improved and smoothed by Grambsch and Therneau in 1994 (Sasieni and Winnett, 2001).

As opposed to the Martingale residuals, the Schoenfeld residuals are computed for each variable and each individual. The Schoenfeld residuals are defined by the difference between the observed value for a covariate and a weighted mean of the covariate values for all units at risk at time t, which corresponds to individuals in the sample for whom the event hasn't occurred yet (Schoenfield, 1982). In other words, it represents the difference between the observed covariate and the expected covariate given the risk set at time *t*. The Schoenfeld residuals are computed only for the individuals that are uncensored in the sample. Mathematically, Therneau and Grambsch (2000) defined the Schoenfeld residuals as follows:

$$s_k = Z_k - \frac{\sum_i Y_i(t_k) r_i(t_k) Z_i(t_k)}{\sum_i Y_i(t_k) r_i(t_k)}$$

$$s_k = Z_k - \bar{z}(\hat{\beta}, t_k)$$

Where, s_k are the Schoenfeld residuals at the time of event t_k, Z_k is the covariate vector of the unit experiencing the event at time t_k, $Y_i(t_k)$ is an indicator that is equal to 1 if the function is under observation and at risk and 0 otherwise, $Z_i(t_k)$ is the value of the covariate for the *i*-th individual at time of event k and $r_i(t_k)$ is the risk score for unit *i* at time *t* and takes the form $r_i = \exp\,[Z_i(t)\beta]$ (Park and Hendry, 2015).

Schoenfeld (1982) proved that the residuals have a mean of 0 under the Cox model, which means that they are centered around zero and asymptotically uncorrelated with $\hat{\beta}$.

The scaled Schoenfeld residuals are simply obtained from the Schoenfeld residuals scaled by the weighted variance of $\hat{\beta}$ at the time of event t_k. The scaled Schoenfeld residuals are thus given by the following equation (Park and Hendry, 2015):

$$s_k^* = V^{-1}(\beta_i, t_k) s_k(\beta_i)$$

Where $V(\hat{\beta}, t_k)$ is the variance of the coefficient for the variable Z_i at time t_k.

If we plot the scaled Schoenfeld residuals as a function of time, we can see if some trends appear over time for the covariate. If they exist, these trends should be observable on the graph. For example, if $\beta(t)$ increases over time, at the beginning of the period we have $Z_k < \bar{z}(\hat{\beta}, t_k)$ and later on we will have $Z_k > \bar{z}(\hat{\beta}, t_k)$. If a covariate respects the proportional hazard assumption, the plot of its scaled Schoenfeld residuals as a function of time should describe a horizontal line, which means that no trends can be observed across time for the covariate. It is important to note that, in this work, the time is given in months. It corresponds to the number of months the individuals in the sample (i.e. companies in this study) survived before the event occurred (i.e. failure in this case).

However, the graphical evaluation of the proportional assumption is quite subjective, therefore a statistical test can be used in addition to it. The test is a basic zero slope test performed on the line obtained graphically with the scaled Schoenfeld residuals. The null hypothesis is that the slope is equal to 0 and the alternative hypothesis is that the slope is not equal to 0. If the test is significant with a p-value inferior to 0.05 (significant at 5%), we can consider that the line is not horizontal, which means that the proportional hazard assumption is not respected for the covariate.

Hereafter, in Table 7, one can find the different covariates that were tested for the proportional hazard assumption, the Chi-square statistics, and the p-values of the zero-slope test conducted.

Table 7

Zero slope test for the model with D_GP: Time-to-failure

Variables	Chi square	p-value
LIST1	0.542	0.462
LIST2	3.2524	0.071
LIST3	2.5142	0.113
D_AGE	1.5996	0.206
D_AUDIT	0.1841	0.668
D_NOM	2.7596	0.097
D_VCB	0.0541	0.816
D_GP	4.2872	0.038 **
GLOBAL	14.9339	0.06

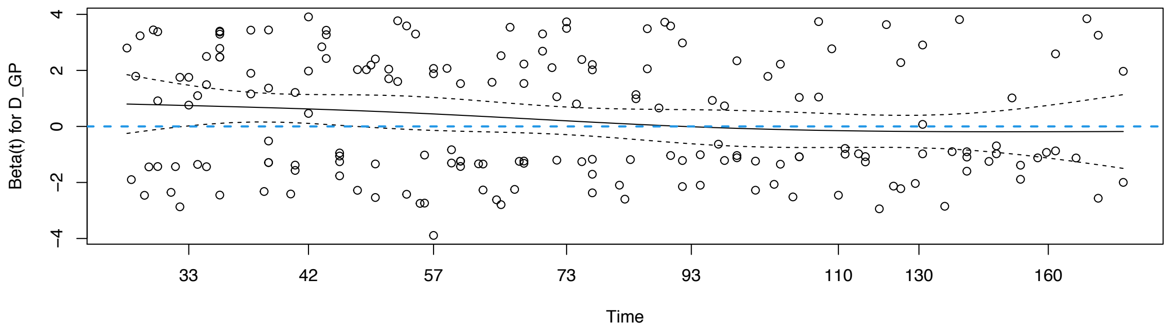
Signifiance codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Table 7 shows the Chi-square statistics and the p-value for the Cox model including *D_GP*. If the p-value for the covariate is significant, the variable does not respect the proportional hazard hypothesis. This table is obtained from R using the cox.zph function in the *survival* package (Therneau, 2020).

As we can see in Table 7, *D_GP* is the only variable having a p-value inferior to 0.05, which is significant for the zero-slope test. The Schoenfeld plot with the smooth line and the 95% confidence interval for the *D_GP* variable can be found below in Figure 6. The plot for the *D_VCB* covariate is also represented on Figure 6 so that we can compare a plot that respects the proportional hazard assumption (*D_VCB*) and one that does not (*D_GP*). The plots for all other variables can be found in Appendix 5 at the end of this work.

Figure 6

Schoenfeld residuals plot for D_GP and D_VCB: Time-to-failure



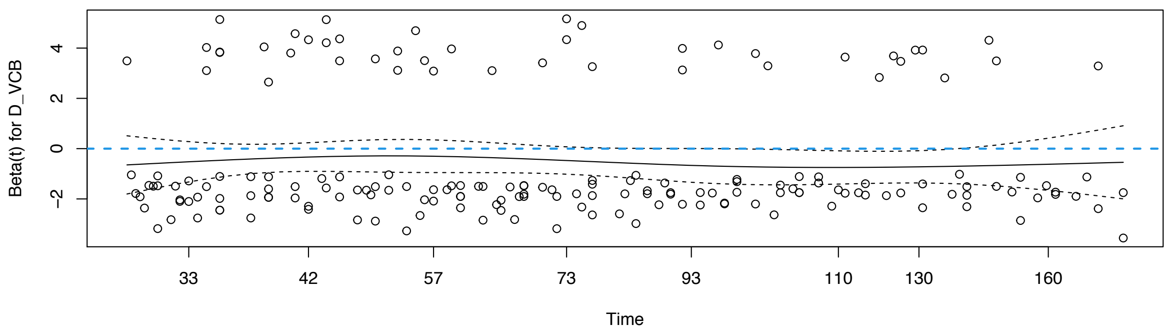


Figure 6 shows the Schoenfeld residuals for the *D_GP* and *D_VCB* variables. Two graphs are provided in order to better compare a variable that comply with the proportional hazard assumption (*D_VCB* on the second graph) and a variable that do not comply with the assumption (*D_GP* on the first graph). The time in the X-axis corresponds to the survival time, or in other words, the time between the introduction of a company in the sample and the event (failure in this case). The blue dotted line on the graph is the zero line to help the comparison and the study of the plot, the dark continuous line is the regression line which is the one that is studied for the hypothesis check and the dark dotted lines are the 95% confidence interval. The plot for these two variables can also be found in Appendix 5. The plots are obtained from R using the *cox.zph* function from the *survival* package (Therneau, 2020).

As we can see in Figure 6, the line for *D_GP* is not horizontal and varies across time, which confirms the results obtained in the zero-slope test. More information can be outlined thanks to this graph. First, the slope's line is negative, which means that the coefficient of the covariate decreases through time. Moreover, the regression line crosses the zero-line, which means that the impact of the covariate changes over time. The effect of the variable is firstly positive but decreases until around month 120 and has a negative effect on the independent variable from month 90 to the end of the period. Hence this trend invalids the proportional hazard hypothesis.

Taking this into account, it can be concluded that the *D_GP* variable does not respect the proportional hazard assumption and therefore cannot be included in the model without making some changes so that the assumption is verified.

4. Adjusting D_GP for proportional hazard assumption

There are several possibilities to adjust a variable that does not respect the proportional hazard assumption and allow a variable to be influenced by the time in the Cox Proportional Hazard model. The simplest one is to use a stratified Cox model where the covariate that does not fulfill the hypothesis is stratified and excluded from the model. I will not develop this option further because it would be impossible to study the impact of the covariate if it is excluded from the model.

Another simple method to adapt a Cox model for non-proportional covariate is to use step functions for the coefficient β in order to split the data into different time periods with different coefficients for the covariates (Therneau, Crowson and Atkinson, 2020). Once the different time periods are set, you can specify in the Cox regression which covariate will be allowed to change during the studied period of time. This method described by Therneau, Crowson and Atkinson (2020) will be used so that the variable *D_GP* can be handled by the Cox model.

The first step is to create the different time periods by defining a start time and a stop time for each period. Unfortunately, I wasn't able to find a systematic approach to define the different cutoff values for the sub-periods of time. Often, researchers analyze the scaled Schoenfeld residuals plot and arbitrarily cut the sample where they can see a shift in the line's trend (Therneau et al, 2020).

For greater clarity, the plot of the Schoenfeld residuals of *D_GP* in Figure 6 has been reproduced here on Figure 7. The regression line crosses the Y = 0 line around month 90. It means that it is around that time that the impact of the covariate on the hazard changes. I arbitrarily choose 90 as a cutoff value for dividing the sample in two different time periods. Dividing the sample into more than 2 sub-periods does not seem to be needed here as no trend other than the crossing of Y = 0 can be clearly identified in the graph.

Figure 7

Schoenfeld residuals for D_GP: Time-to-failure

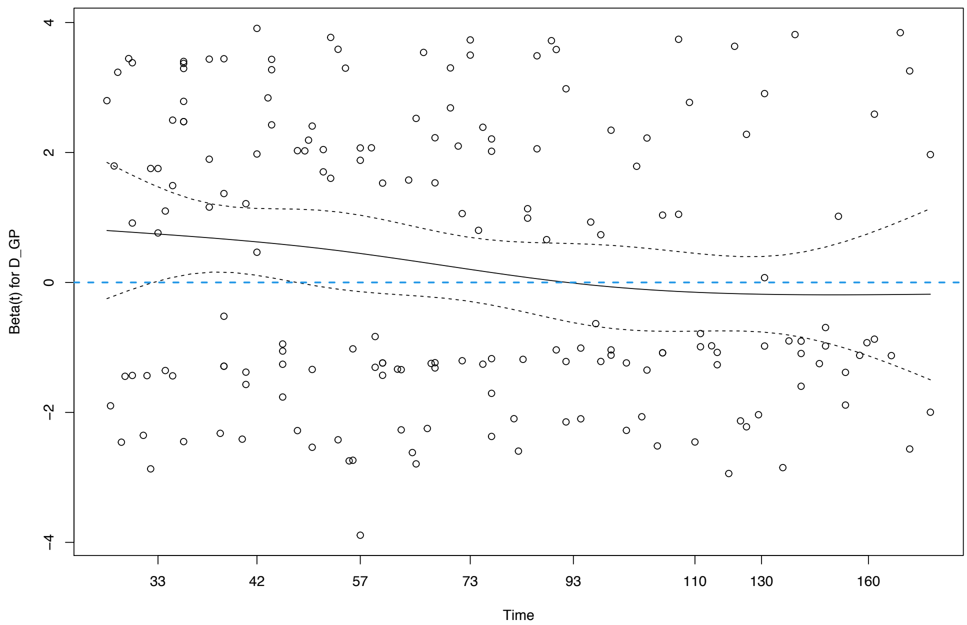


Figure 7 shows the Schoenfeld residuals for the *D_GP* variable. The time in the X-axis corresponds to the survival time, or in other words, the time between the introduction of a company in the sample and the event (failure in this case). The plots are obtained from R using the *cox.zph* function from the *survival* package (Therneau, 2020). The blue dotted line on the graph is the zero line to help the comparison and the study of the plot, the dark continuous line is the regression line which is the one that is studied for the hypothesis check, and the dark dotted lines are the 95% confidence interval.

After adjusting the *D_GP* variable, we have to fit one more time a Cox regression model and do the zero-slope test again. The old *D_GP* variable will be excluded from the model and the new *D_GP* variable is included in the model. From now, *D_GP* can take two coefficients depending if they belong to the first time interval [1; 90] or the second time interval [91; 184]. All the other variables in the model do not change and have still only one coefficient. As these variables fulfilled the proportional hazard assumption, their hazard ratios are constant through time which means that their influence on the probability of failure or success remains the same. The hazard ratios for these variables are therefore the same for the two sub-group of time.

Table 8

Zero slope test for the model with adjusted D_GP: Time-to-failure

Variables	Chi square	p-value
LIST1	1.1133	0.291
LIST2	2.6232	0.105
LIST3	1.6161	0.204
D_AGE	0.5035	0.478
D_AUDIT	0.9205	0.337
D_NOM	2.9862	0.084
D_VCB	0.1006	0.751
D_GP:tgroup	0.0699	0.966
GLOBAL	10.8631	0.285

Signifiance codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Table 8 shows the results from the zero-slope test conducted on the new Cox model including the adjusted *D_GP* variable. If the p-value for a variable is significant, the covariate does not respect the proportional hazard hypothesis. This table is directly obtained from R by using the cox.zph function in the *survival* package (Therneau, 2020).

As we can see in Table 8, with the new adjusted *D_GP* variable, none of the variables in the model have significant p-value for the zero-slope test. Therefore, it can be concluded that all the variables in the model fulfill the proportional hazard hypothesis. The final equation of the model that will be used for the analysis takes the form:

$$\lambda(Time, FAIL) = LIST1 + LIST2 + LIST3 + D_{AGE} + D_{GP}\!: tgroup + D_{AUDIT} + D_{NOM} + D_{VCB}$$

(Equation C)

Where $D_{GP}\!: tgroup$ is the *D_GP* variable that is allowed to change in time thanks to the two sub-periods that were chosen. The Cox regression will return two different rows for this variable: one for $tgroup = 1$ and one for $tgroup = 2$ with different coefficients and p-values.

5. Time-to-success model

Without going in details, the results of the hypothesis testing for the time-to-success model will be briefly described here. The time-to-success model is similar to the time-to-failure model, except for the definition of the event, which is now the success of the IPO instead of its failure. And the time now refers to the number of months between the IPO date and the success of the company.

First of all, the *D_GP* variable instead of *ln(GP)* was included in the model so that we have the same variables than for the time-to-failure model, and all the variables are categorical (dummy), which means that we do not have to test the linearity hypothesis.

Then, the presence of influential observations is checked on Figures 8 and 9. We can see that, unlike the time-to-failure model, it is revealed on these graphs that several observations have a significant influence on the coefficient for each covariate except *D_NOM*.

Figure 8

Dfbeta residuals for variables 1-4: Time-to-success

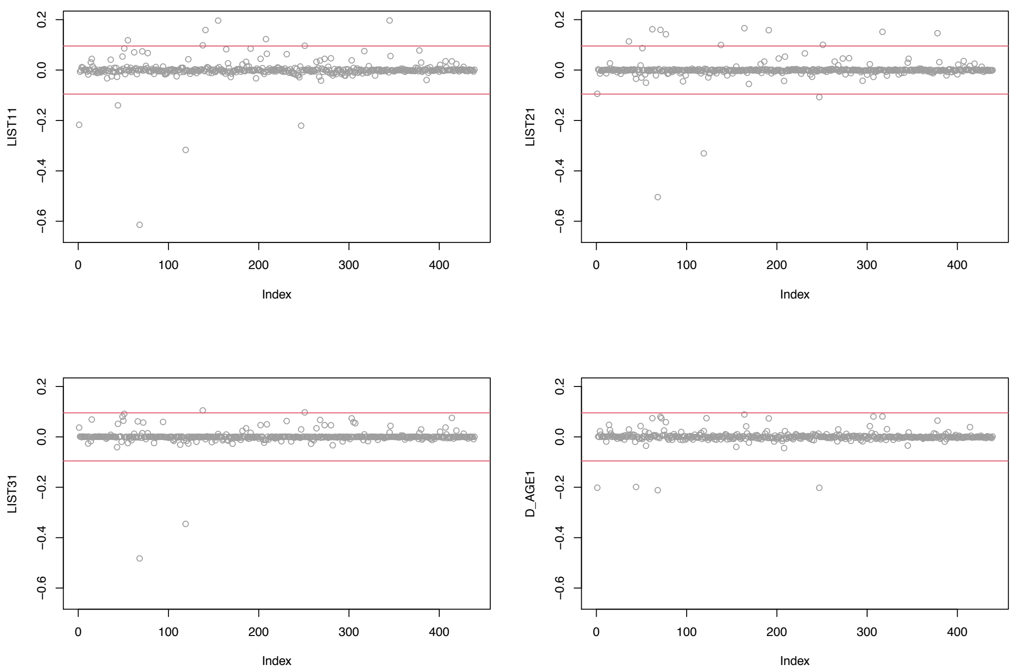


Figure 8 shows the dfbeta for each observation in the sample for the *LIST1*, *LIST2*, *LIST3* and *LIST4* variables in the time-to-success model. The number 1 after each variable is the reference (baseline) category for the dummy variable, which in this case is equal to 1. The Index on the X-axis corresponds to the index of the observation in the database. The dot at index 1 represents the coefficient of the variable if the first observation (the first company in the sample) is deleted.

These results are quite logical because of the really small number of events for the time-to-success model: there are only 29 success for 439 observations. Therefore, a single observation can have a strong influence on the coefficients. It is especially true for the *LIST* variables.

Figure 9

Dfbeta residuals for variables 5-8: Time-to-success

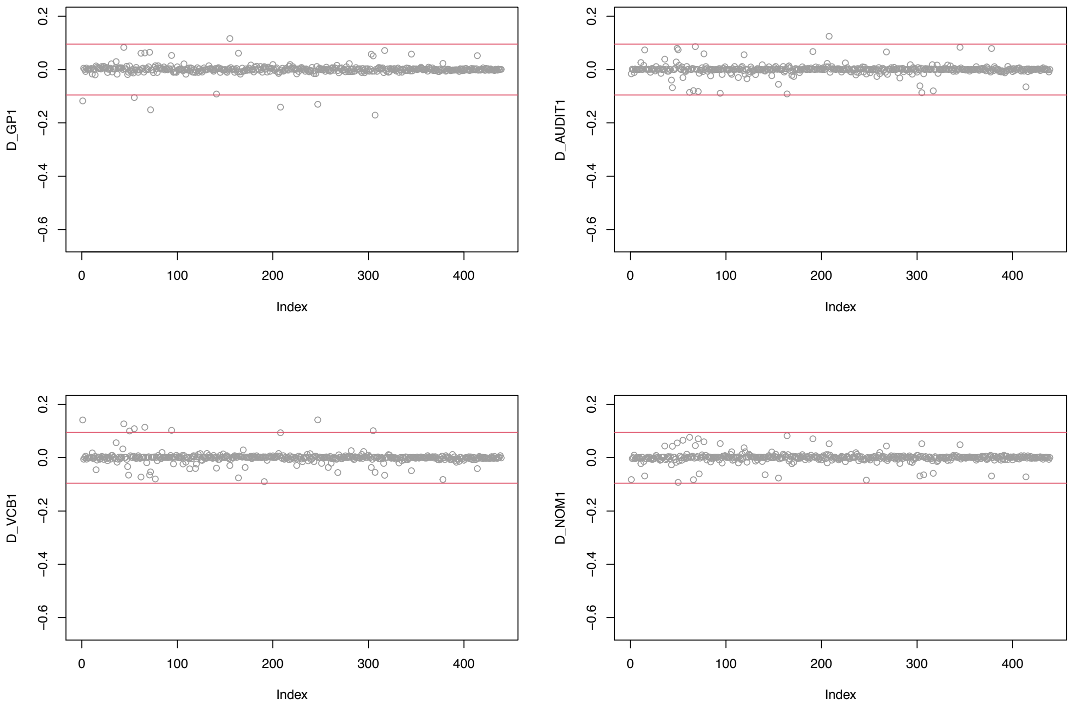


Figure 9 shows the dfbeta for each observation in the sample for the *D_GP*, *D_AUDIT*, *D_VCB* and *D_NOM* variables in the time-to-success model. The number 1 after each variable is the reference (baseline) category for the dummy variable, which in this case is equal to 1. The Index on the X-axis corresponds to the index of the observation in the database. The dot at index 1 represents the coefficient of the variable if the first observation (the first company in the sample) is deleted.

With that in mind, it is safe to say that the model for the time-to-success is not completely relevant. Nevertheless, this part will be kept in this work and checked using the regression table for information and to see what trends, if any, can be drawn from it. However, it is important to remember that these results should be considered with caution.

Finally, as we can see in Table 9, according to the zero-slope test conducted on the time-to-success model, none of the variables are significant. It can be concluded that all the covariates fulfill the proportional hazard hypothesis. Therefore, it is not needed to adjust the *D_GP* variable as for the time-to-failure model. The original *D_GP* dummy variable will be kept in this case.

Table 9

Zero-slope test for the time-to-success model

Variables	Chi square	p-value
LIST1	1.13005	0.29
LIST2	1.28775	0.26
LIST3	0.07057	0.79
D_AGE	0.49734	0.48
D_AUDIT	0.62749	0.43
D_NOM	0.13609	0.71
D_VCB	0.00191	0.97
D_GP	0.59509	0.44
GLOBAL	5.05039	0.75

Signifiance codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Table 9 shows the results for the zero-slope test conducted on the time-to-success model. If the p-value for a variable is significant, the covariate does not respect the proportional hazard hypothesis. This table is directly obtained from R by using the cox.zph function in the *survival* package (Therneau, 2020).

The model for the time-to-success takes this form after checking the hypotheses:

$$\lambda(Time, FAIL) = LIST1 + LIST2 + LIST3 + D_{AGE} + D_{GP} + D_{AUDIT} + D_{NOM} + D_{VCB} \quad \textit{(Equation D)}$$

6. Final models and global significance

The last step before analyzing the results given by the two models is to analyze the global significance of the models and see if they fit well the data using different statistical tests.

The Concordance statistic is one of the most used goodness-of-fit measures for the Cox regression model and is defined as the proportion of random pairs of individuals that are correctly ordered by the model based on their survival times compared to what is observed (Raykar, Steck, Krishnapuram, Dehing-Oberije and Lambin, 2007). Therneau and Atkinson (2020) defined it as the probability that the prediction x goes in the same direction than the observed data y, or:

$$\mathrm{P}\left(x_i > x_j \middle| y_i > y_j\right)$$

A concordance of 0.50 is obtained when a random guess is used for each subject, a concordance of less than 0.55 is considered as not good and a concordance of 1 is obtained when the model ranked perfectly all the possible pairs in the model (Therneau and Atkinson, 2020).

Complementarily to the Concordance test defined above, a score test, the Wald test, and a partial likelihood test (maximum likelihood test adjusted for the Cox's partial likelihood) will be used to assess the global significance of the models.

These four tests will be applied to all four equations that were presented earlier. Equation A is the full time-to-failure model with the *ln(GP)* variable, in Equation B, *ln(GP)* is replaced by the *D_GP* variable, and Equation C is the final Cox model accounting for the variation in time of the *D_GP* variable. Finally, Equation D is the time-to-success model.

Table 10

Concordance and global tests for the different models

Model	Concordance	Partial Likelihood Ratio Test	Wald Test	Score Test
Equation A	0.612	36.34 *(<0.001)*	36.74 *(<0.001)*	37.42 *(<0.001)*
Equation B	0.613	37.18 *(<0.001)*	37.5 *(<0.001)*	38.18 *(<0.001)*
Equation C	0.622	43.1 *(<0.001)*	43.02 *(<0.001)*	43.68 *(<0.001)*
Equation D	0.731	17.97 *(0.02)*	16.45 *(0.04)*	18.62 *(0.02)*

Table 10 shows the concordance and the results from the partial likelihood test, the Wald test, and the Score test. The p-values for each test are reported in (). Equation A corresponds to the time-to-failure model with the *ln(GP)* variable. Equation B corresponds to the time-to-failure model with *D_GP* in it. Equation C corresponds to the time-to-failure model with the *D_GP* adjusted variable (*D_GP:tgroup*) and Equation D corresponds to the time-to-success model. The value for the three tests used is directly obtain in R by using the *survival* package developed by Pr. Therneau (Therneau, 2020).

As we can see in Table 10, for the three time-to-failure models, all the transformations and adaptations that have been applied to the model improved its significance and allowed it to better match the data, with Equation C having the greatest value for the three statistical tests. All the p-values reported by the tests are highly significant at all levels, except for the time-to-success model that is not significant at the 1% level. Higher p-values for the time-to-success model's statistical tests were indeed expected with the small number of events.

Regarding the Concordance, we can see that it improved from Equation A to Equation C with a final concordance of 0.622, which means that in 62.2% of the cases, the model ranked the random pairs correctly with respect to what was observed. Quite surprisingly, an even higher value is obtained for the time-to-success model, with a concordance of 0.731.

To conclude, it is safe to say that the final equation for the time-to-fail (Equation C) is globally significant and that it is the one that performs best in the various statistical tests conducted.

IX. Results and discussions

As the Equation C is the best amongst the time-to-failure equations, this is the one that will be used for the time-to-failure part of the analysis, and Equation D will be used for the time-to-success analysis as reference model.

A. Time-to-failure: results and discussion

In the following table, one can find the results of the Cox Proportional Hazard Model for the survival analysis conducted on the sample of 439 companies listed on the Alternative Investment Market. The dependent variable of the model is the hazard rate and the independent variables are listed and explained in the *Description of the Variables* part of this work. A positive coefficient means that the covariate has a positive impact on the hazard rate or, that the risk that the company delists from the AIM is increased. On the contrary, a negative coefficient means that the covariate has a negative impact on the hazard rate and thus impacts negatively (decreases) the risk of failure for the company.

In Table 11, the coefficients for each variable are reported together with their p-value and the Hazard Ratio. The Hazard Ratio, noted HR or [exp(Coef)] in Table 11 is the exponential of the coefficient and tells us the effect of size of the coefficient (Cox, 1972). It can also be computed by dividing the Hazard when the dummy variable is equal to one by the Hazard when the dummy variable is equal to zero. For example, in Table 11, the Hazard Ratio (HR) for the D_AGE variable is equal to 0.60 which means that a company that fulfilled the D_AGE requirement (operational history greater than 5 years at IPO) is 0.60 times as likely to die as a company that has less than 5 years of existence, with a confidence interval of 95%. The inverse Hazard Ratio, HR^{-1}, is also given in Table 11 and it is equal to the exponential of minus the coefficient.

As we can see in Table 11, only three variables of the model have a significant effect on the survival of companies present in the sample. The variables D_AGE, D_VCB and D_GP for $tgroup = 1$ (survival time between 1 and 90 months) are significant at the 0.01 level which means that, according to the model, the age of the company at IPO, the Venture Capitalists involvement and the gross proceeds have the greatest influence on the failure risk of a company after its IPO.

Table 11

Regression table for Time-to-failure: Model 1

Variables	Expected Relation	Coefficent	exp(Coef)	exp(-Coef)	p-value
LIST1	(+)	-0.23187	0.793049213	1.260955794	0.57049
LIST2	(+)	0.57222	1.772196965	0.564271365	0.13511
LIST3	(-)	-0.09787	0.906766776	1.102819409	0.80155
D_AGE	(-)	-0.50142	0.605669997	1.651064118	0.00527 **
D_AUDIT	(-)	-0.03992	0.960866305	1.040727513	0.82703
D_NOM	(-)	-0.0138	0.986294783	1.01389566	0.93052
D_VCB	(-)	-0.52733	0.590178645	1.69440221	0.00339 **
D_GP (tgroup=1)	(-)	0.52899	1.697217253	0.589199761	0.00729 **
D_GP (tgroup=2)	(-)	-0.25829	0.772371212	1.294714231	0.35609

Signifiance codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Table 11 shows the result for the Cox regression using the first model for the time-to-failure. The Cox regression is conducted on a sample composed of 439 companies with 181 number of event (failure). The table is obtained in R by using the *coxph* function from the *survival* package developed by Pr. Therneau (Therneau, 2020).

The first significant variable is D_GP for $tgroup = 1$ and corresponds to the fifth hypothesis which states that IPOs with a higher gross proceeds are more likely to survive than IPOs with smaller gross proceeds. The results obtained for the D_GP $tgroup = 1$ does not coincide with what was expected. D_GP $tgroup = 1$ has a positive coefficient of 0.52, which means that a greater gross proceeds size increases the failure risk of the company within 90 months of the IPO. Moreover, as the covariate is significant, the hypothesis saying that the size of the IPO impact positively the probability of survival can be rejected for the first time-group (month 1 to 90). According to the Hazard Ratios reported in the table, an IPO with gross proceeds superior to €7,604,627.869 is 1.69 times as likely to delist than a company with IPO's gross proceeds inferior to this amount.

However, the D_GP variable for $tgroup = 2$ is not significant and more importantly, the sign of the coefficient has changed compared to $tgroup = 1$, which means that for companies that survived more than 90 months, the *D_GP* variable had a negative impact on the failure risk and decreased it. Taking that into account, the hypothesis concerning the gross proceeds cannot be fully accepted. For companies that survived less than 90 months, the hypothesis can be rejected as the model shows that the gross proceeds have the opposite effect of what was expected at the beginning of this study. And for the second time period, beyond 90 months of survival, no conclusion can be made as the variable is not significant.

The second significant variable is *D_AGE*, that has a coefficient of -0.501 and corresponds to the fourth hypothesis of this work which states that older companies are more likely to survive than younger and less experienced companies. It indicates that companies having more than 5 years of existence at the time of the IPO have less risk to delist than younger companies. The Hazard Ratio is 0.605, hence the failure risk for an older company is equivalent to 60.5% of the failure risk for a younger company, or, if we take the result from another perspective using the inverse Hazard Ratio, a younger company is 65% more likely to delist than an older company. In light of these results, the hypothesis concerning the age of the company stated earlier in this study can be affirmed as the variable is significant and the coefficient of the variable is negative: companies with more than five years of operational history are more likely to survive than companies with less than five years of operational history.

Figure 10

Cumulative Hazard functions for the D_AGE variable: Time-to-failure

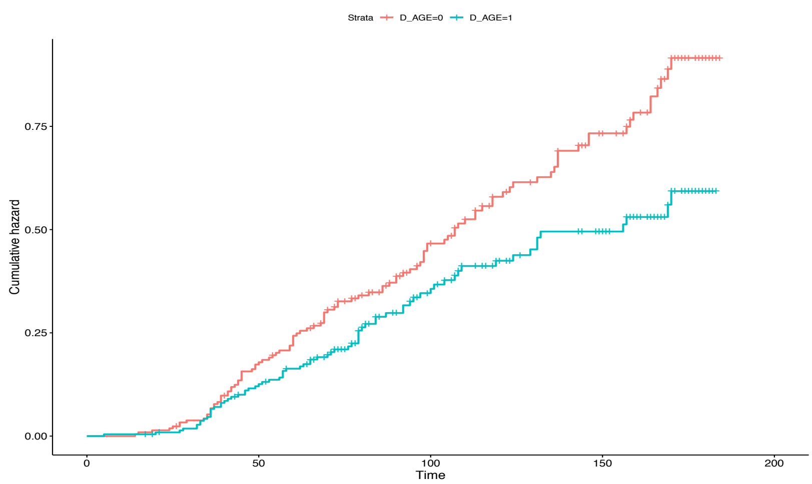


Figure 10 reports the cumulative hazard function for the *D_AGE* variable. A smaller cumulative hazard function indicates that the probability of failure is smaller across time. And inversely, a greater cumulative hazard function indicates that the probability of failure is greater across time. The hazard functions are obtained in R with the survival package developed by Pr. Therneau (Therneau, 2020).

Figure 10 gives a graphical representation of the probability of failure for the companies in the sample as a function of the time. As we can see, the cumulative hazard function for D_AGE equal to 1 is under the one for D_AGE equal to 0.

The third significant variable is the D_VCB dummy variable and it has a coefficient of -0.52. The variable D_VC corresponds to the sixth hypothesis which states that IPOs that are backed by a Venture Capitalist are more likely to survive than companies that do not. Given the coefficient obtained, the involvement of a Venture Capitalists in the IPO of a company decreases its failure risks quite significantly. The Hazard Ratio obtained for the covariate is 0.59. An IPO backed by a VC is 0.59 as likely to delist as a company that is not backed by a VC. From another perspective, a non-VC backed IPO is 69% more likely to fail. The hypothesis concerning Venture Capitalists backed IPO is therefore considered to be true because the variable is significant at the 1% level and has the expected effect on the failure risk of the companies.

Figure 11

Cumulative Hazard functions for the D_VCB variable: Time-to-failure

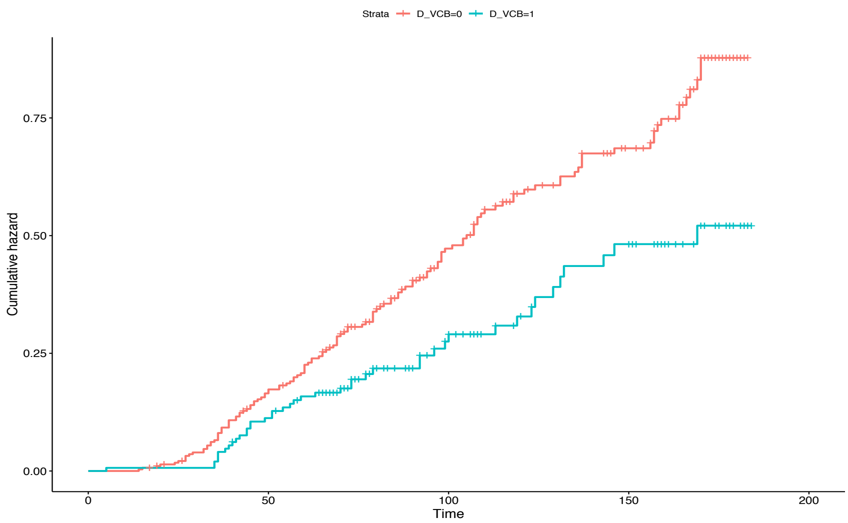


Figure 11 reports the cumulative hazard function for the D_VCB variable. A smaller cumulative hazard function indicates that the probability of failure is smaller across time. And inversely, a greater cumulative hazard function indicates that the probability of failure is greater across time. The hazard functions are obtained in R with the survival package developed by Pr. Therneau (Therneau, 2020).

Figure 11 gives a graphical representation for the probability of failure for the companies in the sample as a function of time. As we can see, the cumulative hazard function for D_VCB equal to 1 is under the one for D_VCB equal to 0.

If we take a look at the coefficients of the covariates in the model, we can see that most of them are negative, which means that the variables decrease the company's failure risk. The only two variables with positive coefficients are *LIST2* and *D_GP* for $tgroup = 1$ which are the only covariates that increase the company's failure risk.

As we can see in Table 11, the positive relationship for the *LIST2* variable was expected as it was assumed that companies with positive earnings at the time of IPO had a smaller risk to delist than companies with negative earnings. However, as the variable is not significant, the hypothesis concerning *LIST2* cannot be accepted.

The most surprising result is obtained for the variable *LIST1* (no revenues), with a negative coefficient of -0.23, which is the opposite of what was expected. This suggests that a company that reported no revenues at the time of IPO has a lower failure risk that a company that reported revenues. This can be explained by the large number of natural resources companies that went public on the AIM during the 2005-2006 period, when they were still in the development stage without revenues or activities. Moreover, if we look at the Descriptive statistics table (Table 6), we can see that the surviving rate is slightly bit higher for companies without revenues than for companies with revenues, which is consistent with the result obtained for the coefficient of the *LIST1* variable. Unfortunately, the variable is not significant, and therefore the hypothesis number one which states that companies that list with revenues are more likely to survive than companies that do not can neither be ejected or nor approved.

Afterwards, we tried to determine whether there was a link between the companies backed by Venture Capitalists at IPO and companies that reported no revenues at the time of the IPO. Indeed, if Venture Capitalists invested more in no-revenues companies, the involvement of the VC could explain the fact that the survival rate is higher for companies without revenues. However, it appears that over the 151 companies that were backed by Venture Capitalists at the time of IPO, only 36 reported no revenues. This proportion is quite small, hence the surviving rate cannot be explained by Venture Capitalists' involvement.

All other variables have the expected relationship with the hazard function: they have a negative relationship with the failure risk of the company. However, the hypotheses linked to these variables cannot be confirmed because the variables are not statistically significant. Consequently, hypotheses 1, 3, 7 and 8 can neither be approved nor rejected.

In order to test the hypotheses two and three of this work (influence of the profitability and of the shareholders' equity plus profitability), it will be needed to modify the main model used above. The three variables *LIST1, LIST2 and LIST3* will be replaced by the *PROFIT* variable or by the *LIST4* variable in models two and three respectively. The two variables could not be included in the original model because they can be expressed as a linear combination of other variables and would therefore not be treated by the statistical model.

The equations for the three versions of the model are the following:

$$\lambda(Time, FAIL) = LIST1 + LIST2 + LIST3 + D_{AGE} + D_{GP} + D_{AUDIT} + D_{NOM} + D_{VCB} \quad \text{(Model 1)}$$

$$\lambda(Time, FAIL) = PROFIT + D_{AGE} + D_{GP} + D_{AUDIT} + D_{NOM} + D_{VCB} \quad \text{(Model 2)}$$

$$\lambda(Time, FAIL) = LIST4 + D_{AGE} + D_{GP} + D_{AUDIT} + D_{NOM} + D_{VCB} \quad \text{(Model 3)}$$

Table 12

Regression table for Time-to-failure: Model 2

Variables	Expected Relation	Coefficent	exp(Coef)	exp(-Coef)	p-value
PROFIT	(-)	-0.41809	0.658302978	1.519057383	0.02401 *
D_AGE	(-)	-0.20322	0.81609868	1.225342014	0.24436
D_AUDIT	(-)	-0.02436	0.97593431	1.024659129	0.89309
D_NOM	(-)	-0.01752	0.982632583	1.017674375	0.9121
D_VCB	(-)	-0.46951	0.625308594	1.599210388	0.00929 **
D_GP (tgroup=1)	(-)	0.53515	1.707704379	0.585581446	0.00616 **
D_GP (tgroup=2)	(-)	-0.26781	0.765053127	1.307098768	0.33509

Signifiance codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Table 12 shows the result for the Cox regression using the second model for the time-to-failure where the three *LIST* variables are replaced by the *PROFIT* variable (eps > 0). The Cox regression is conducted on a sample composed of 439 companies with 181 number of event (failure). The table is obtained in R by using the *coxph* function from the *survival* package developed by Pr. Therneau (Therneau, 2020).

The *PROFIT* variable corresponds to the second hypothesis of this work which states that companies reporting profit at the IPO are more likely to survive than companies that do not. As one can see in Table 12, the *PROFIT* variable is significant at the 5% level with a coefficient of -0.41 which means that if the variable takes the value 1, the risk of failure will decrease. The Hazard Ratio is equal to 0.65, hence, a company reporting profits is 0.65 times as likely to fail as a company reporting negative earnings at the time of IPO. The coefficients for the other variables keep the same signs than in the previous model meaning that their relationships with the failure risk has not changed. It also appears in the model that the variable *D_AGE* has lost its significance. Given the results obtained, the second hypothesis which states that companies reporting positive earnings at the time of IPO have lower failure risk can be affirmed.

Figure 12

Cumulative Hazard functions for the PROFIT variable: Time-to-failure

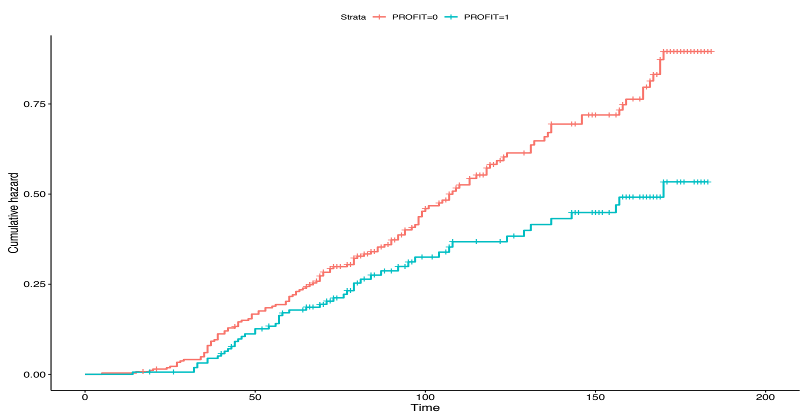


Figure 12 reports the cumulative hazard function for the PROFIT variable. A smaller cumulative hazard function indicates that the probability of failure is smaller across time. And inversely, a greater cumulative hazard function indicates that the probability of failure is greater across time. The hazard functions are obtained in R with the survival package developed by Pr. Therneau (Therneau, 2020).

Figure 12 gives a graphical representation for the probability of failure for the companies in the sample as a function of the *PROFIT* variable. As we can see, the cumulative hazard function for *PROFIT* equal to 1 is under the one for *PROFIT* equal to 0.

Table 13 reports the results obtained with the third model. *LIST4* corresponds to the third hypothesis which states that companies reporting profit and a shareholders' equity greater than €18.09 million at the IPO are more likely to survive than companies that do not. The *LIST4* variable is not significant with a p-value of 0.68. Its coefficient is equal to -0.15, which means that it has a negative relationship with the failure probability of a company, as it was expected. However, as the test is not significant, it is impossible to affirm or deny the third hypothesis of the study. Once again, the coefficients of the remaining variables are similar to those in the first model, the only difference being that the significances of the variables *D_AGE* and *D_VCB* are lower.

Table 13

Regression table for Time-to-failure: Model 3

Variables	Expected Relation	Coefficent	exp(Coef)	exp(-Coef)	p-value
LIST4	(-)	-0.15252	0.858541723	1.164765757	0.6824
D_AGE	(-)	-0.35943	0.698074115	1.43251265	0.0259 *
D_AUDIT	(-)	-0.01441	0.985693327	1.014514325	0.9366
D_NOM	(-)	-0.04047	0.960337974	1.04130007	0.7984
D_VCB	(-)	-0.42496	0.653795936	1.529529237	0.0173 *
D_GP (tgroup=1)	(-)	0.50533	1.657532416	0.603306451	0.01 **
D_GP (tgroup=2)	(-)	-0.30958	0.733755069	1.362852596	0.2658

Signifiance codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Table 13 shows the result for the Cox regression using the third model for the time-to-failure where the three first *LIST* variables are replaced by the *LIST4* variable (eps > 0 and SE > €18.04m). The Cox regression is conducted on a sample composed of 439 companies with 181 number of event (failure). The table is obtained in R by using the *coxph* function from the *survival* package developed by Pr. Therneau (Therneau, 2020).

Compared to what Carpentier and Suret (2011) found in their study, the financial situation of the company at the time of IPO, denoted by the four *LIST* variables and the *PROFIT* variable, does not impact the survival of a company as much as the two authors found.

The only two intrinsic characteristics of a company that influence its survival are the operational history (*D_AGE*) and positive earnings before being listed (*PROFIT*). Regarding the variable *D_AGE* (*Hypothesis 4*), the argument of Audretsch (1995) which favors of the older companies by stating that older companies have more time to gather knowledge and understand the functioning of the industry in which they are competing, to recruit more competent people, gather financial resources, etc. seems to be valid for the AIM in view of what is found in this work. All similar researches that included the age of the companies in their model found similar results: the older the company, the lower probability of failure (see Audretsch, 1995; Bradley et al, 2006; Jain et al, 2008 and Carpentier and Suret, 2011).

The two other variables that have a significant effect on the survival of the company are the external factors that do not depend on the companies and their management: *D_VCB* (*Hypothesis 6*) and *D_GP* (*Hypothesis 5*).

The first external variable is the implication of Venture Capitalists in the ownership of companies at the time of IPO. For this work, it was found that Venture Capitalists decrease significantly the probability of failure of an IPO. Two arguments justifying the positive impact of Venture Capitalists were previously given in this work. Firstly, the involvement of third parties (prestigious auditors and nominated advisers included) in the IPO process reduces the asymmetries of information, the latter being quite pronounced in the penny stock market. Secondly, Venture Capitalists are highly qualified investors whose skills enables them to better analyze and value small growing companies that have high potential. As the variables *D_AUDIT (Hypothesis 7)* and *D_NOM (Hypothesis 8)* are not significant, it is not possible to determine if the involvement of prestigious third parties actually decreases the probability of failure for companies. However, given the results obtained, the fact that Venture Capitalists are able to decrease the information asymmetries and to select the best prospects seems to be a reasonable explanation for the rather high significance of *D_VCB*.

The second external variable that has a significant influence on companies' survival is the IPO's gross proceeds (*D_GP*). As the variable was modified so that it could be used in the model, the results obtained are more difficult to analyze. For the significant part of the variable $(tgroup = 1)$, the results are quite similar to what Jain et al, (2008) found: the size of the IPO has a positive significant relationship with the failure probability. However as mentioned several times before, for the second time group $(tgroup = 2, after\ 90\ months)$, the value of the coefficient became negative and insignificant. Unfortunately, in their paper, Jain et al, (2008) do not give any justifications or hypotheses that could explain the results they obtained for this variable. This positive coefficient of *D_GP* for the first time period is against what was expected, and I could not find any rational explanation for this result. Moreover, choosing a categorical variable instead of a continuous variable for the gross proceeds decreases the power of the variable. The different transformations used on the variable may have an impact on the results we get for the Cox regression and may lead to false conclusion especially because of the adjustment in order to fulfil the proportional hazard assumption of the model as the process is purely arbitrary as explained earlier.

Finally, if we compare the results obtained by the Cox regression in Table 11 – 12 - 13 to similar studies, we can see that the number of significant variables is much smaller here than in other researches with a small sample size. This can be explained by the fact that the sample is quite evenly distributed in terms of surviving rates for the different characteristics. For example, looking at companies with and without revenues at IPO, their surviving rate is 58.01% for companies with revenues and 60.63% for companies without revenues. The difference between the two surviving rates is very small and not statistically significant, which could explain the fact that the *LIST1 (Hypothesis 1)* variable is not significant. This is also the case for the other variables that are not statistically significant. The variables with the greatest difference in surviving rates are the ones that are significant in the regression model (i.e. *PROFIT*, *D_AGE*, and *D_VCB* or Hypotheses 2, 3 and 6 respectively) with the exception of the variable *D_GP* (*Hypothesis 5*) which is slightly different due to its adjusted form.

B. Time-to-success: results and discussion

In this section, one can find the results of the Cox Proportional Hazard Model for the survival analysis conducted on the sample of 439 listed companies on the Alternative Investment Market, along with the analysis of these results. The dependent variable of the model is the hazard rate and the independent variables are listed and described in the *Description of the Variables* part of this work. A positive coefficient means that the covariate has a positive impact on the hazard rate or in other words on the risk that the company succeeds during the studied period. On the contrary, a negative coefficient means that the covariate has a negative impact on the hazard rate and thus impact negatively (decreases) the risk of success for the company.

Before looking at the results, it is important to remember that some of the observations are highly influential on the coefficients obtained by the regression. This is mainly due to the fact that there are only 29 events (success) amongst the whole sample, which is hardly enough to obtain meaningful results.

As for the time-to-fail model, the coefficients for each variable are reported in the table alongside their p-value and Hazard Ratios.

As we can see in Table 14, two variables have a significant effect on the success of a company. The first one is *D_GP* and the second one is *D_NOM.*

Table 14

Regression table for Time-to-success: Model 1

Variables	Expected Relation	Coefficent	exp(Coef)	exp(-Coef)	p-value
LIST1	(-)	-0.02293	0.977330895	1.023194913	0.9803
LIST2	(-)	0.17452	1.190674556	0.839860057	0.8289
LIST3	(+)	0.45708	1.579455236	0.633129688	0.5471
D_AGE	(+)	0.30788	1.360537715	0.735003513	0.5385
D_AUDIT	(+)	0.36635	1.442460015	0.693260118	0.361
D_NOM	(+)	0.67433	1.962717515	0.50949767	0.0745 .
D_VCB	(+)	-0.08699	0.916686262	1.090885771	0.8294
D_GP	(+)	1.00219	2.724241389	0.367074667	0.0347 *

Signifiance codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Table 14 shows the results for the Cox regression using the first model for the time-to-success. The Cox regression is conducted on a sample composed of 439 companies with 29 events (success). The table is obtained in R by using the *coxph* function from the *survival* package developed by Pr. Therneau (Therneau, 2020).

The hypothesis linked to the *D_GP* variable is the fifth one which states that an IPO with a greater gross proceeds are more likely to succeed than a company with smaller gross proceeds. The *D_GP* variable is significant at the 5% level and has a positive coefficient of 1.00, which means that the gross proceeds of an IPO has a positive relationship with the probability to succeed of a company. The Hazard Ratio for the variable is equal to 2.72. Hence, an IPO with gross proceeds greater than €7,604,627.869 is 2.72 times as likely to succeed than an IPO with gross proceeds inferior to this cutoff value. The fifth hypothesis of this work for the time-to-success model can therefore be affirmed.

Figure 13

Cumulative Hazard functions for the D_GP variable: Time-to-success

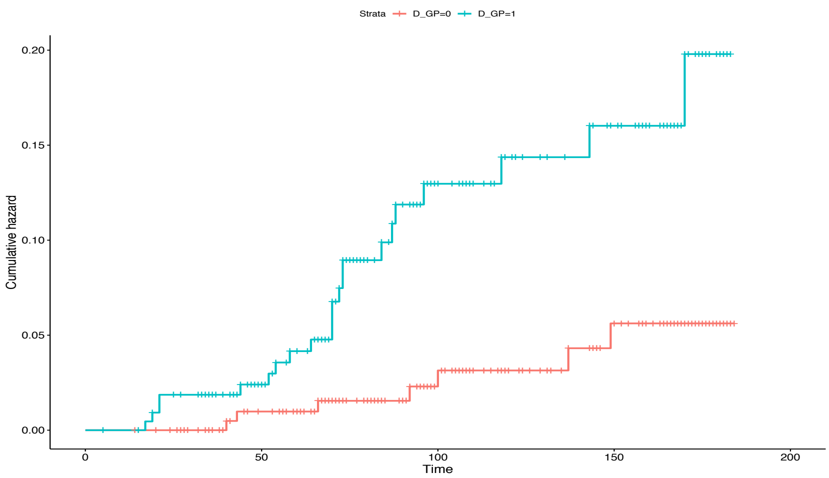


Figure 13 reports the cumulative hazard function for the *D_GP* variable. A greater cumulative hazard function indicates that the probability of success is greater across time. And inversely, a smaller cumulative hazard function indicates that the probability of success is smaller across time. The hazard functions are obtained in R with the survival package developed by Pr. Therneau (Therneau, 2020).

Figure 13 gives a graphical representation of the probability of success for the companies in the sample as a function of time. As we can see, the cumulative hazard function for *D_GP* equal to 1 is over the one for *D_GP* equal to 0.

The variable *D_NOM* corresponds to the eighth hypothesis of this work which states that an IPO with the involvement of a prestigious nominated adviser is more likely to succeed than an IPO without a prestigious nominated adviser. The *D_NOM* variable is significant only at the 10% level and has a positive coefficient of 0.67. It has therefore a positive impact on the probability of success of a company. The Hazard Ratio is equal to 1.96 which means that an IPO characterized by the involvement of a prestigious nominated adviser is 1.96 times as likely to succeed as an IPO without a prestigious nominated adviser. Once more, Hypothesis number 8 can be affirmed given the results obtained in this work.

Figure 14 gives a graphical representation of the probability of success for the companies in the sample as a function of time. As we can see, the cumulative hazard function for *D_NOM* equal to 1 is over the one for *D_NOM* equal to 0.

Figure 14

Cumulative Hazard functions for the D_NOM variable: Time-to-success

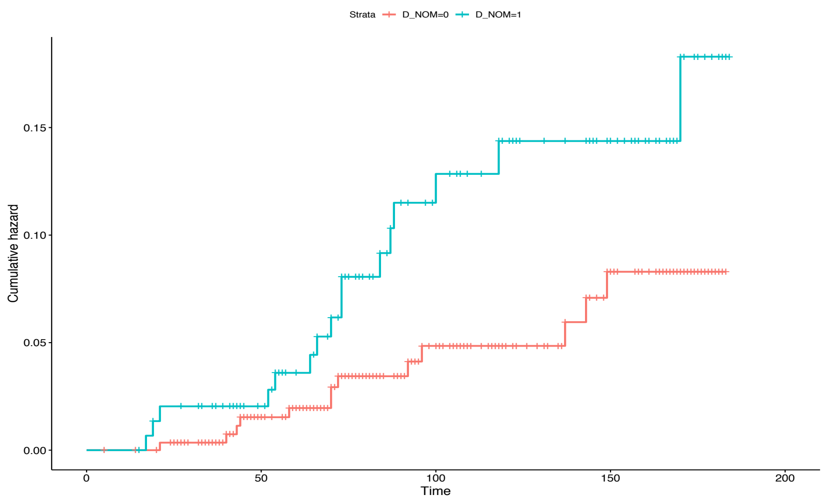


Figure 14 reports the cumulative hazard function for the *D_NOM* variable. A greater cumulative hazard function indicates that the probability of success is greater across time. And inversely, a smaller cumulative hazard function indicates that the probability of success is smaller across time. The hazard functions are obtained in R with the survival package developed by Pr. Therneau (Therneau, 2020).

All the other variables are insignificant with relatively high p-values. However, if we take a look at the sign of the coefficients, they are all positive except for the *LIST1 (Hypothesis 1)* and *D_VCB (Hypothesis 6)* variables that have a negative effect on the probability of success.

As for the time-to-failure model, the impact of the *PROFIT* and *LIST4* variables had to be tested separately because they can be expressed as a linear combination of other variables. In Model 2, the three *LIST* variables are replaced by the *PROFIT* variable and in Model 3, *LIST1-3* are replaced by *LIST4*. The two regression tables are given in Appendix 6 and 7. The two variables *PROFIT* (*Hypothesis 2*) and LIST4 (*Hypothesis 3*) are insignificant and have a low impact on the success probability. As expected, the *PROFIT* variable is positive, which means that it has a positive relationship with the success probability of a company. However, the *LIST4* variable has a negative coefficient of -0.33, it therefore negatively impacts the probability of success. The remaining coefficients for the Models 2 and 3 have the exact same signs as in Model 1, and the *D_GP* and *D_NOM* variables are also still significant and at the same level as in the first model.

As we can see in Table 14, although most of the variables are not statistically significant, the expected relationships between them and the probability to succeed for a company are respected for almost all of them. The only two variables that do not have the expected sign for their coefficient sign are the *LIST2* and *D_VCB (Hypothesis 6)* variables. The coefficient for *LIST2* is positive which means that it has a positive relationship with the probability of success even though the variable is not significant. The *D_VCB* variable has a very small negative coefficient (-0.086) which indicates that the involvement of a Venture Capitalist in the IPO has a negative relationship with the success probability. It is similar to what Jain et al (2008) found for their research: the involvement of a Venture Capitalist decreases the probability of success of an IPO. As mentioned in the *Junior Markets* part of this work, the Alternative Investment Market is designed to provide an exit way for Venture Capitalists. Sometimes, they are encouraged to introduce their investments on a public market before the companies are truly ready to bear all the costs and requirements that come with it (Jain et al, 2008). This theory holds true in our case, even if we cannot be sure of it, as the variable is not significant, and its p-value is extremely high (0.82).

If we compare the results obtained for the variable *D_GP (Hypothesis 5)* in the time-to-failure and time-to-success models, we can see that in both cases the variable is significant with a positive coefficient, which means that the variable increases both the probability of failure and the probability of success. However, these two effects may appear contradictory because they seem to be opposite to each other. This counter-intuitive result is nevertheless possible because the failure is not defined as the absence of success. Therefore, a variable can have an opposite effect on the two studied objects. However, as mentioned several times before, the time-to-success model is not fully reliable as the number of events is very low so the results of the time-to-failure model should prevail over the results obtained in the time-to-success model.

X. Conclusion

The objective of this thesis was to study the survival of penny stock IPO and to determine whether certain characteristics can significantly influence the survival and success of a company on the stock market. If such factors can be found, they could serve as a basis for retail investors to select safer investments amongst penny stock securities.

In order to try to give an answer to the research question, the first step of this work was to determine the hypotheses that will be tested and to create different variables that will be used in the model to see if these hypotheses can be affirmed/rejected or not. At the end of the day, I ended up with eight hypotheses. Hypothesis one to three are related to the financial situation of the companies, the fourth hypothesis is about the age of the company, the fifth hypothesis concerns the gross proceeds of the IPOs and finally, the three last hypotheses are linked to the involvement of prestigious third parties and Venture Capitalists in the IPO process. After the hypotheses, different success and failure criteria had to be defined to conduct a survival analysis. As a reminder, the success factors are mostly based on the graduation principle, which is when a company succeed to list on a better/bigger stock exchange. On the other side, failure criteria are mostly based on the bankruptcy and suspension of the companies present in the sample.

The second step was to create the sample by using the fact sheets provided by the London Stock Exchange each month and different web-based sources to complete the sample used for the remaining of the study. The sample is made up of 439 companies quoted on the Alternative Investment Market between January 2005 and December 2014.

Once the sample is completed, the Cox Proportional Hazard model (Cox, 1972) is used to conduct the survival analysis. Afterwards, the assumptions of the model are tested using the *survival* package developed by Pr. Therneau (Therneau, 2020) on R and some adjustments are made on the model, especially on the *D_GP* variable that will be stratified to allow its hazard ratio to move during the studied period of time. Finally, the time-to-failure and the time-to-success models fulfilled all the assumptions of the Cox regression even though the time-to-success model is less relevant due to some observations that may influence the results obtained.

In Table 15, the significant relationships between the variables and the probabilities to success and failure are summarized with the signs indicating the effect of the variables on the probabilities.

Table 15

Summary of the results

Hypothesis	Variable	Significant relation with probability to	
		Fail	Succeed
1	LIST1	No	No
2	PROFIT	Yes	No
3	LIST4	No	No
4	D_AGE	Yes (-)	No
5	D_GP	Yes (+) for *tgroup=1* No for *tgroup=2*	Yes (+)
6	D_VCB	Yes (-)	No
7	D_AUDIT	No	No
8	D_NOM	No	Yes (+)

In Table 15, one can find the number of the hypotheses tested in this study with the variable associated to them. For the Fail and Succeed columns of the table, a Yes indicates that the variable is significant with the sign of the relationship in (). A No indicates that the variable is not significant and therefore no conclusion can be made regarding the corresponding hypothesis.

For the Time-to-Failure part, four different variables impact significantly the survival of an IPO on the Alternative Investment Market. The first one is the age of the issuer (*D_AGE*). This result show that retail investors should concentrate their researches on companies that have at least five years of operational history. Such companies have 40% less chance to fail than younger companies. The *D_AGE* variable corresponds to Hypothesis 4 and it can be affirmed than companies with more than 5 years of operational history are more likely to survive than companies that do not. The second variable is the involvement of a Venture Capitalist (*D_VCB*): a VC-backed company is 41% less likely to fail than a non-VC-backed firm. Taking that into account, we can affirm that IPOs that are backed by a Venture Capitalist are more likely to survive than companies that do not (*Hypothesis 6*). The third factor that influences the survival of a company is its profitability (*PROFIT*). Profitable companies have 35% less chance to fail than unprofitable companies, therefore, the second hypothesis can be affirmed: Companies reporting profits at the time of IPO have a greater probability to survive than companies that make loss. Investors should thus limit their investment possibilities to profitable penny stock companies. The last variable is *D_GP* for the first time group (before 90 months), IPOs with an offering size greater than

€7,604,627.869 are 1.69 times as likely to delist than a company with smaller offering size. Finally, in Table 15, we can see that for the time-to-failure model, the hypotheses number two, four and six can be confirmed and hypothesis five can be partially denied for $tgroup = 1$.

For the Time-to-Success model, the *D_NOM* variable is significant at the 10% level. IPOs characterized by the involvement of a prestigious nominated adviser are 1.96 times as likely to succeed than IPOs performed without prestigious Nomad. Hence, as shown in Table 15, the hypothesis number eight can be confirmed: IPOs with the involvement of a prestigious Nomad are more likely to succeed than IPOs without the involvement of a prestigious Nomad. Finally, the variable *D_GP* is also significant at the 5% level and IPOs with a gross proceeds greater than €7,604,627.869 are 2.72 times as likely to succeed for this study. The fifth hypothesis for the time-to-success part of the study can therefore be affirmed: a greater gross proceeds increases the probability of success of an IPO.

To summarize, taking all these results into account, people willing to invest in penny stocks should restrain their investment possibilities to profitable companies having more than five years of operational history at the time of IPO. Moreover, these companies should be backed by a Venture Capital fund and accompanied by a prestigious nominated adviser.

Unfortunately, for the time-to-failure model, the hypotheses 1, 3, 7 and 8 could not be affirmed or rejected. Hypothesis number one and three are related to the financial situation of the companies at the time of IPO. The first one concerns the revenues of the companies and the latter one concerns the shareholders' equity and the profitability of the companies. Hypothesis 7 and 8 are related to the third parties involved in the IPO. More specifically, Hypothesis 7 is related to the involvement of one of the Big 4 in the IPO and Hypothesis 8 concerns the involvement of a prestigious nominated adviser in the IPO process.

On another hand, it is important to point out that this work presents certain limitations, but also many possibilities for improvements and continuations. Firstly, the method used to create the sample could be reviewed as a very large number of companies were excluded from the sample. For instance, our sample is composed of 439 IPOs from 2005 to 2014. From 2005 to 2014, whereas the total number of IPOs on the Alternative Investment Market was greater than 1300 over the same period. Consequently, the sample used in this work is smaller than in most reference studies investigating the survival of IPO, for which the sample is composed of about 1000/2000 companies (see Carpentier and Suret, 2011). Another limitation of this study is the very small number of successes reported, for which the small size of the sample most likely plays a role. Consequently, the results obtained with the time-to-success model cannot be considered to be fully reliable. A possibility to overcome this problem, in addition to using a larger sample, would be to change the definition of success to make it more suitable for the penny stock market.

Another limitation of this work is the lack of rational explanations for the results of the variable *D_GP* in the time-to-failure model: namely, the change of sign and the positive effect on the probability of failure for tgroup = 1 cannot be justified. On the one hand, it could be due to the several approximations made so that *D_GP* could be used in the model. And on the other hand, it might be useful to search for new sources of information that could explain the negative effect on the IPO survival and why the gross proceeds' influence changes over time.

At last, it might be interesting to further develop the modeling part of this work, in order to find a model derived from Cox's proportional model that could better fit the data. For example, the Weibull model allows the use of time-dependent covariates, but it also relies on stronger assumptions for the underlying distribution of the sample, which makes it more complicated to use.

In terms of improvements, it would be really interesting to test additional risk factors such as Research & Development, intangible assets, number of patents, qualifications of the board and the management, etc. Indeed, some studies like the one conducted by Audretsch and Lehman (2005) suggest that the probability of success for a company is more influenced by intangible characteristics that can create a sustainable competitive advantage. The results obtained in this work are not inconsistent with this statement as we found that the financial situation does not have a significant influence on the probability of success. It would therefore be all the more relevant to investigate the influence of intangible assets, amongst others.

Finally, a continuation of this work would be to see if the significant characteristics cited in this study have a real influence on the returns of penny stocks, and if stocks fulfilling the criteria cited earlier can achieve better returns than stock that do not. For instance, this could be done by following the same methodology used by Konku, Bhargava and Malhotra (2012) in the second part of their study.

XI. Appendix

A. Appendix 1

List of the 30 nominated advisers registered for the Alternative Investment Market

Adviser Name	Location
Allenby Capital Limited	London
Arden Partners Plc	Birmingham
Beaumont Cornish Limited	London
Cairn Financial Advisers LLP	London
Canaccord Genuity Limited	London
Cantor Fitzgerald Europe	London
Cenkos Securities Plc	London
Davy Corporate Finance	Dublin
Deloitte Corporate Finance	London
finnCap Ltd	London
GCA Altium Limited	London
Grant Thornton UK LLP	London
Investec Bank Plc	London
J.P. Morgan Securities plc	London
Jefferies International Limited	London
Liberum Capital Limited	London
Macquarie Capital (Europe) Limited	London
Nplus1 Singer Advisory LLP	London
Numis Securities Limited	London
Panmure Gordon (UK) Limited	London
Peel Hunt LLP	London
PricewaterhouseCoopers LLP	London
RFC Ambrian Group Limited	Sydney
S P Angel Corporate Finance LLP	London
Shore Capital & Corporate Limited	London
SPARK Advisory Partners Limited	London
Stifel Nicolaus Europe Limited	London
Strand Hanson Limited	London
W H Ireland Limited	London
Zeus Capital Limited	Manchester

B. Appendix 2

List of the 439 companies composing my sample with their IPO date, the date of event and their status

ID	NAME	IPO DATE	DATE OF EVENT	EVENT
1	ZETAR	06/01/2005	01/10/2012	SUCCESS
2	TOWER RESOURCES	13/01/2005	01/06/2020	NEUTRAL
3	TRADING NEW HOMES	17/01/2005	25/02/2009	FAIL
4	BIOFUSION	02/02/2005	05/10/2018	FAIL
5	ADDWORTH	03/02/2005	04/04/2017	FAIL
6	BLACK RAVEN PROPERTIES	03/02/2005	19/11/2008	FAIL
7	CRYSTALBAND	04/02/2005	07/10/2009	FAIL
8	MCC ENERGY	04/02/2005	26/11/2008	FAIL
9	ZENITH HYGIENE GROUP	08/02/2005	26/11/2008	FAIL
10	EREDENE CAPITAL	10/02/2005	18/12/2014	FAIL
11	UKRPRODUCT GROUP	11/02/2005	01/06/2020	NEUTRAL
12	ZAREBA	14/02/2005	01/06/2020	NEUTRAL
13	LA TASCA GROUP	16/02/2005	06/03/2008	FAIL
14	UNITED CARPETS GROUP	17/02/2005	01/06/2020	NEUTRAL
15	ALTERNATIVE NETWORKS	18/02/2005	19/01/2017	SUCCESS
16	NEUTRAHEALTH	18/02/2005	19/01/2017	FAIL
17	URANIUM RESOURCES	18/02/2005	24/12/2018	FAIL
18	TV COMMERCE HLDGS	21/02/2005	01/06/2020	NEUTRAL
19	HERENCIA RESOURCES	22/02/2005	01/06/2020	NEUTRAL
20	MEDIAZEST	22/02/2005	01/06/2020	NEUTRAL
21	PANNAL	22/02/2005	28/03/2019	FAIL
22	LHP INVESTMENTS	23/02/2005	01/06/2020	NEUTRAL
23	QONNECTIS	24/02/2005	01/06/2020	NEUTRAL
24	CHIAN RESOURCES	28/02/2005	30/10/2013	FAIL
25	AZMAN	02/03/2005	01/06/2020	NEUTRAL
26	FREEPLAY ENERGY	02/03/2005	21/03/2016	FAIL
27	SARANTEL GROUP	02/03/2005	01/06/2020	NEUTRAL
28	ACCUMA GROUP	09/03/2005	23/03/2010	FAIL
29	IN CUP PLUS	09/03/2005	04/03/2014	FAIL
30	ALTONA RESOURCES	10/03/2005	01/06/2020	NEUTRAL
31	BROOKS MACDONALD GROUP	11/03/2005	01/06/2020	NEUTRAL
32	AFREN	14/03/2005	10/08/2015	FAIL
33	GASOL	16/03/2005	06/07/2018	FAIL
34	HARBINGER CAPITAL	17/03/2005	22/01/2015	FAIL
35	ROEFORD PROPERTIES	18/03/2005	01/06/2020	NEUTRAL

36	MECOM GROUP	23/03/2005	16/02/2015	SUCCESS
37	PLETHORA SOLUTIONS HLDGS	24/03/2005	01/06/2020	NEUTRAL
38	ZEST GROUP	24/03/2005	01/06/2020	NEUTRAL
39	RESMEX	29/03/2005	01/06/2020	NEUTRAL
40	ROTALA	29/03/2005	01/06/2020	NEUTRAL
41	INDIA STAR ENERGY	30/03/2005	19/06/2018	FAIL
42	ISIS RESOURCES	30/03/2005	01/06/2020	NEUTRAL
43	FONEBAK	31/03/2005	01/06/2020	NEUTRAL
44	PROXIMAGEN NEUROSCIENCE	31/03/2005	16/08/2012	SUCCESS
45	SWEET CHINA	31/03/2005	01/06/2020	NEUTRAL
46	ALBA MINERAL RESOURCES	04/04/2005	01/06/2020	NEUTRAL
47	HARDIDE	04/04/2005	01/06/2020	NEUTRAL
48	TELIT COMMUNICATIONS	04/04/2005	01/06/2020	NEUTRAL
49	OMEGA UNDERWRITING HLDGS	06/04/2005	09/11/2006	SUCCESS
50	FDM GROUP	07/04/2005	19/02/2010	SUCCESS
51	GULFSANDS PETROLEUM	08/04/2005	23/04/2018	FAIL
52	RAMBLER METALS & MINING	08/04/2005	01/06/2020	NEUTRAL
53	TABLE MOUNTAIN MINERALS	11/04/2005	17/03/2008	FAIL
54	CARDINAL RESOURCES	15/04/2005	23/05/2015	FAIL
55	SOUTH CHINA RESOURCES	18/04/2005	08/11/2010	SUCCESS
56	PLATINUM MINING CORP OF INDIA	19/04/2005	20/05/2008	FAIL
57	INTANDEM FILMS	22/04/2005	23/03/2015	FAIL
58	SPECTRUM INTERACTIVE	25/04/2005	11/05/2010	FAIL
59	YOUGOV	25/04/2005	01/06/2020	NEUTRAL
60	COAL INTERNATIONAL	28/04/2005	12/08/2008	FAIL
61	RDF MEDIA	04/05/2005	02/02/2009	FAIL
62	SERABI MINING	10/05/2005	30/03/2011	SUCCESS
63	MOTIVE TELEVISION	11/05/2005	20/08/2016	FAIL
64	INTERQUEST GROUP	20/05/2005	13/07/2018	FAIL
65	BORDERS & SOUTHERN PETROLEUM	24/05/2005	01/06/2020	NEUTRAL
66	TOLUNA	25/05/2005	21/04/2011	SUCCESS
67	INSPACE	26/05/2005	21/02/2008	FAIL
68	POWERLEAGUE GROUP	26/05/2005	30/11/2009	SUCCESS
69	PUNCH GRAPHIX	26/05/2005	27/02/2008	FAIL
70	TRISTEL	01/06/2005	01/06/2020	NEUTRAL
71	ADVENT CAPITAL HLDGS	03/06/2005	25/06/2012	SUCCESS
72	EG SOLUTIONS	06/06/2005	09/11/2017	SUCCESS
73	GRANBY OIL & GAS	15/06/2005	15/12/2008	FAIL
74	PROPERTY RECYCLING GROUP	16/06/2005	25/03/2011	FAIL
75	Z GROUP	21/06/2005	01/06/2020	NEUTRAL
76	MEDIA STEPS GROUP	24/06/2005	01/06/2020	NEUTRAL
77	SYSTEM C HEALTHCARE	28/06/2005	25/08/2011	SUCCESS

78	THOR MINING	29/06/2005	01/06/2020	NEUTRAL
79	BANGO	30/06/2005	01/06/2020	NEUTRAL
80	KIOTECH INTERNATIONAL	30/06/2005	01/06/2020	NEUTRAL
81	PERSIAN GOLD	30/06/2005	01/06/2020	NEUTRAL
82	ERUMA	01/07/2005	02/03/2019	FAIL
83	BYOTROL	06/07/2005	01/06/2020	NEUTRAL
84	STRATEGIC THOUGHT GROUP	07/07/2005	29/08/2013	FAIL
85	WATERLINE GROUP	13/07/2005	03/01/2011	FAIL
86	JARLWAY HLDGS	18/07/2005	03/01/2017	FAIL
87	OXONICA	20/07/2005	04/08/2009	FAIL
88	EMPYREAN ENERGY	27/07/2005	01/06/2020	NEUTRAL
89	ARIANA RESOURCES	28/07/2005	01/06/2020	NEUTRAL
90	INTERNATIONAL MOLYBDENUM	28/07/2005	06/11/2007	FAIL
91	KP RENEWABLES	29/07/2005	01/06/2020	NEUTRAL
92	RED ROCK RESOURCES	29/07/2005	01/06/2020	NEUTRAL
93	MESSAGING INTERNATIONAL	03/08/2005	01/06/2020	NEUTRAL
94	RESEARCH NOW	04/08/2005	16/12/2009	SUCCESS
95	ALPHA STRATEGIC	11/08/2005	06/11/2017	FAIL
96	RENEURON GROUP	12/08/2005	01/06/2020	NEUTRAL
97	ROCKHOPPER EXPLORATION	15/08/2005	01/06/2020	NEUTRAL
98	IPSA GROUP	20/09/2005	27/08/2019	FAIL
99	CELLCAST GROUP	21/09/2005	01/06/2020	NEUTRAL
100	GETECH GROUP	23/09/2005	01/06/2020	NEUTRAL
101	WHAM ENERGY	26/09/2005	12/11/2007	FAIL
102	CDS OIL & GAS GROUP	27/09/2005	16/05/2012	FAIL
103	PANTHEON LEISURE	27/09/2005	23/09/2010	FAIL
104	TRAVELZEST	03/10/2005	23/09/2014	FAIL
105	DATONG ELECTRONICS	07/10/2005	09/09/2013	FAIL
106	CARETECH HOLDINGS	12/10/2005	01/06/2020	NEUTRAL
107	DRIVER GROUP	13/10/2005	01/06/2020	NEUTRAL
108	SPI LASERS	26/10/2005	14/10/2008	FAIL
109	ACCSYS TECHNOLOGIES	26/10/2005	01/06/2020	NEUTRAL
110	CELOXICA HOLDINGS	27/10/2005	26/11/2008	FAIL
111	WOGEN	31/10/2005	05/10/2009	FAIL
112	SOFTWARE RADIO TECHNOLOGY	02/11/2005	01/06/2020	NEUTRAL
113	ABCAM	03/11/2005	01/06/2020	NEUTRAL
114	DOWLIS CORPORATE SOLUTIONS	07/11/2005	01/06/2020	NEUTRAL
115	ANGEL BIOTECHNOLOGY HLDGS	17/11/2005	22/04/2015	FAIL
116	HEALTHCARE LOCUMS	17/11/2005	03/06/2013	FAIL
117	MATTIOLI WOODS	23/11/2005	01/06/2020	NEUTRAL
118	BNS TELECOM GROUP	25/11/2005	03/06/2009	FAIL
119	HANSTEEN HLDGS	29/11/2005	24/02/2020	SUCCESS

120	HARGREAVES SERVICES	30/11/2005	01/06/2020	NEUTRAL
121	MISSION CAPITAL	05/12/2005	01/06/2020	NEUTRAL
122	AUTOCLENZ HLDGS	07/12/2005	12/02/2020	FAIL
123	INDEPENDENT RESOURCES	12/12/2005	01/06/2020	NEUTRAL
124	SERICA ENERGY	13/12/2005	01/06/2020	NEUTRAL
125	LOMBARD MEDICAL TECHNOLOGIES	13/12/2005	30/04/2014	FAIL
126	@UK	14/12/2005	07/02/2020	FAIL
127	CARLUCCIO'S	14/12/2005	05/11/2010	FAIL
128	PAN PACIFIC AGGREGATES	16/12/2005	01/06/2020	NEUTRAL
129	ZIRAX	16/12/2005	23/02/2010	FAIL
130	GAS TURBINE EFFICIENCY	21/12/2005	18/04/2011	FAIL
131	MWB BUSINESS EXCHANGE	21/12/2005	27/03/2013	FAIL
132	VENUE SOLUTIONS HLDGS	23/12/2005	30/08/2011	FAIL
133	NASSTAR	29/12/2005	10/03/2020	FAIL
134	STRATEX INTERNATIONAL	04/01/2006	01/06/2020	NEUTRAL
135	EKAY	05/01/2006	09/10/2012	FAIL
136	AMTEUS	18/01/2006	15/06/2011	FAIL
137	CLAIMAR CARE GROUP	31/01/2006	27/10/2009	FAIL
138	B.P.MARSH & PARTNERS	02/02/2006	01/06/2020	NEUTRAL
139	CHARIOT(UK)	06/02/2006	10/02/2009	FAIL
140	CHINA GOLDMINES	07/02/2006	14/04/2015	FAIL
141	SOLOMON GOLD	10/02/2006	13/07/2017	SUCCESS
142	CAGNEY	13/02/2006	19/07/2017	FAIL
143	MICROFUZE INTERNATIONAL	13/02/2006	01/06/2020	NEUTRAL
144	ADEPT TELECOM	15/02/2006	01/06/2020	NEUTRAL
145	MOBILE STREAMS	15/02/2006	01/06/2020	NEUTRAL
146	CLARKSON HILL GROUP	17/02/2006	11/08/2015	FAIL
147	PHYNOVA GROUP	27/02/2006	21/08/2009	FAIL
148	WORK GROUP	01/03/2006	01/06/2020	NEUTRAL
149	BETEX GROUP	03/03/2006	18/10/2007	FAIL
150	KIMCOR DIAMONDS	06/03/2006	14/12/2009	FAIL
151	NETSERVICES	08/03/2006	01/05/2015	FAIL
152	COHORT	08/03/2006	01/06/2020	NEUTRAL
153	INVOCAS GROUP	17/03/2006	01/06/2010	FAIL
154	KLEENAIR SYSTEMS INTERNATIONAL	20/03/2006	01/06/2020	NEUTRAL
155	KALAHARI MINERALS	21/03/2006	04/04/2012	SUCCESS
156	SYNTOPIX GROUP	23/03/2006	01/06/2020	NEUTRAL
157	LITCOMP	24/03/2006	09/02/2010	FAIL
158	VENTECO	24/03/2006	30/06/2009	FAIL
159	WESTERN & ORIENTAL	27/03/2006	15/04/2011	FAIL
160	NORTHBRIDGE INDUSTRIAL SERVICES	28/03/2006	01/06/2020	NEUTRAL
161	MORSON GROUP	30/03/2006	08/08/2012	FAIL

162	LUDORUM	03/04/2006	15/01/2015	FAIL
163	PANTHEON RESOURCES	05/04/2006	01/06/2020	NEUTRAL
164	IX EUROPE	07/04/2006	14/09/2007	SUCCESS
165	CITY OF LONDON INVESTMENT GROUP	12/04/2006	01/06/2020	NEUTRAL
166	MISSION MARKETING GROUP(THE)	13/04/2006	01/06/2020	NEUTRAL
167	BOW LANE CAPITAL	21/04/2006	02/07/2013	FAIL
168	LANSDOWNE OIL & GAS	21/04/2006	01/06/2020	NEUTRAL
169	OXFORD CATALYSTS GROUP	26/04/2006	01/06/2020	NEUTRAL
170	BALTIC OIL TERMINALS	27/04/2006	16/07/2014	FAIL
171	H & T GROUP	08/05/2006	01/06/2020	NEUTRAL
172	HORIZONTE MINERALS	08/05/2006	01/06/2020	NEUTRAL
173	INTERACTIVE WORLD	08/05/2006	17/04/2012	FAIL
174	ACERTEC	16/05/2006	30/06/2009	FAIL
175	ST JAMES'S ENERGY	19/05/2006	01/06/2020	NEUTRAL
176	DEBTS.CO.UK	24/05/2006	24/12/2009	FAIL
177	PROACTIS HLDGS	01/06/2006	01/06/2020	NEUTRAL
178	INSPIRED GAMING GROUP	02/06/2006	02/07/2010	FAIL
179	SUMMIT RESOURCES PLC	08/06/2006	21/01/2016	FAIL
180	WORTHINGTON NICHOLLS GROUP	12/06/2006	01/06/2020	NEUTRAL
181	DILLISTONE GROUP	15/06/2006	01/06/2020	NEUTRAL
182	MAY GURNEY INTEGRATED SERVICES	21/06/2006	08/07/2013	FAIL
183	INFOSERVE GROUP PLC	23/06/2006	01/06/2020	NEUTRAL
184	AFRICAN CONSOLIDATED RESOURCES	30/06/2006	01/06/2020	NEUTRAL
185	GREATLAND GOLD PLC	03/07/2006	01/06/2020	NEUTRAL
186	NATIONWIDE ACCIDENT REPAIR SERVICES	04/07/2006	05/06/2015	FAIL
187	TASTY PLC	04/07/2006	01/06/2020	NEUTRAL
188	TARGET RESOURCES PLC	12/07/2006	29/10/2009	FAIL
189	ARDEN PARTNERS PLC	19/07/2006	01/06/2020	NEUTRAL
190	GOLDPLAT PLC	26/07/2006	01/06/2020	NEUTRAL
191	HERITAGE UNDERWRITING AGENCY PLC	01/08/2006	14/05/2008	SUCCESS
192	1PM PLC	02/08/2006	01/06/2020	NEUTRAL
193	CUE ENERGY PLC	03/08/2006	11/07/2017	FAIL
194	CARECAPITAL GROUP PLC	04/08/2006	01/06/2020	NEUTRAL
195	BEST OF THE BEST PLC	14/08/2006	01/06/2020	NEUTRAL
196	ENERGETIX GROUP PLC	15/08/2006	08/10/2019	FAIL
197	AURELIAN OIL & GAS PLC	22/08/2006	24/01/2013	FAIL
198	PROBABILITY PLC	24/08/2006	30/04/2014	FAIL
199	HIGHTEX GROUP PLC	06/09/2006	27/02/2015	FAIL
200	RUBICON SOFTWARE GROUP PLC	06/09/2006	01/06/2020	NEUTRAL
201	NETWORK DATA HLDGS PLC	21/09/2006	29/05/2009	FAIL
202	HYDROGEN GROUP PLC	29/09/2006	01/06/2020	NEUTRAL
203	KANYON PLC	10/10/2006	01/06/2020	NEUTRAL

204	PLANT IMPACT PLC	16/10/2006	28/03/2018	FAIL
205	BRULINES (HLDGS) PLC	26/10/2006	01/06/2020	NEUTRAL
206	DIGITAL MARKETING GROUP PLC	26/10/2006	01/06/2020	NEUTRAL
207	MATCHTECH GROUP PLC	27/10/2006	01/06/2020	NEUTRAL
208	DRURY LANE CAPITAL PLC	30/10/2006	20/03/2015	SUCCESS
209	CENKOS SECURITIES PLC	31/10/2006	01/06/2020	NEUTRAL
210	PROTON POWER SYSTEMS	31/10/2006	01/06/2020	NEUTRAL
211	HASGROVE PLC	14/11/2006	12/07/2013	FAIL
212	EATONFIELD GROUP PLC	17/11/2006	31/05/2011	FAIL
213	WREN HOMES GROUP	30/11/2006	05/10/2010	FAIL
214	BRAINJUICER GROUP PLC	05/12/2006	01/06/2020	NEUTRAL
215	MONEY DEBT & CREDIT GROUP PLC	13/12/2006	29/10/2009	FAIL
216	RENEWABLE POWER & LIGHT PLC	14/12/2006	20/08/2010	FAIL
217	TAIHUA PLC	14/12/2006	08/05/2017	FAIL
218	IMAGINATIK PLC	15/12/2006	01/06/2020	NEUTRAL
219	KEFI MINERALS PLC	18/12/2006	01/06/2020	NEUTRAL
220	ALL POINTS NORTH PLC	19/12/2006	16/03/2012	FAIL
221	NORTHERN BEAR PLC	19/12/2006	01/06/2020	NEUTRAL
222	SABIEN TECHNOLOGY GROUP PLC	20/12/2006	01/06/2020	NEUTRAL
223	TIMAN OIL & GAS PLC	28/12/2006	15/12/2009	FAIL
224	BRIGHTSIDE GROUP PLC	09/01/2007	25/07/2014	FAIL
225	ASHLEY HOUSE PLC	15/01/2007	01/06/2020	NEUTRAL
226	MOBILE CREDIT BALTIC PLC	16/01/2007	09/02/2015	FAIL
227	CAMPER & NICHOLSONS MARINA INV LTD	29/01/2007	10/01/2018	FAIL
228	HELIUS ENERGY PLC	31/01/2007	22/04/2015	FAIL
229	BAOBAB RESOURCES PLC	01/02/2007	20/05/2015	FAIL
230	DIAMONDCORP PLC	01/02/2007	15/05/2017	FAIL
231	POLAR CAPITAL HLDGS PLC	06/02/2007	01/06/2020	NEUTRAL
232	NEUROPHARM GROUP PLC	06/03/2007	18/05/2010	FAIL
233	IPSO VENTURES PLC	07/03/2007	01/06/2020	NEUTRAL
234	NIGHTHAWK ENERGY PLC	12/03/2007	30/07/2018	FAIL
235	TRUST PROPERTY MANAGEMENT GROUP PLC	14/03/2007	04/02/2015	FAIL
236	STM GROUP PLC	28/03/2007	01/06/2020	NEUTRAL
237	BRAVEHEART INVESTMENT GROUP	30/03/2007	01/06/2020	NEUTRAL
238	INLAND PLC	03/04/2007	01/06/2020	NEUTRAL
239	EXPANSYS PLC	11/04/2007	14/04/2014	FAIL
240	ORA CAPITAL PARTNERS PLC	17/04/2007	07/06/2013	FAIL
241	AFC ENERGY PLC	24/04/2007	01/06/2020	NEUTRAL
242	BGLOBAL PLC	25/04/2007	09/09/2014	FAIL
243	VOLGA GAS PLC	25/04/2007	01/06/2020	NEUTRAL
244	TAU CAPITAL PLC	09/05/2007	23/07/2014	FAIL
245	ROXI PETROLEUM PLC	22/05/2007	01/06/2020	NEUTRAL

246	SDI GROUP PLC	02/07/2007	01/06/2020	NEUTRAL
247	MOUNT ENGINEERING PLC	06/07/2007	03/12/2010	SUCCESS
248	FRESHWATER UK PLC	16/07/2007	22/11/2010	FAIL
249	NOSTRA TERRA OIL&GAS CO PLC	20/07/2007	01/06/2020	NEUTRAL
250	CAPREGEN PLC	24/07/2007	24/07/2009	FAIL
251	TAWA PLC	26/07/2007	04/07/2018	FAIL
252	ENERGYBUILD GROUP PLC	06/08/2007	10/08/2010	FAIL
253	IDATECH PLC	06/08/2007	09/11/2011	FAIL
254	STRATEGIC NATURAL RESOURCES PLC	07/08/2007	01/07/2014	FAIL
255	LEED PETROLEUM PLC	15/08/2007	16/08/2016	FAIL
256	HAMPDEN UNDERWRITING PLC	04/09/2007	01/06/2020	NEUTRAL
257	REAL OFFICE GROUP PLC	07/09/2007	17/10/2011	FAIL
258	CRANEWARE PLC	13/09/2007	01/06/2020	NEUTRAL
259	KURAWOOD PLC	18/09/2007	18/12/2009	FAIL
260	ALL LEISURE GROUP PLC	01/10/2007	16/06/2016	FAIL
261	CVS GROUP PLC	10/10/2007	01/06/2020	NEUTRAL
262	ECO CITY VEHICLES PLC	11/10/2007	21/01/2016	FAIL
263	NINETY PLC	24/10/2007	17/07/2015	FAIL
264	CYRIL SWEETT GROUP PLC	31/10/2007	07/11/2016	FAIL
265	BOOMERANG PLUS PLC	05/11/2007	28/08/2012	FAIL
266	TRACSIS PLC	27/11/2007	01/06/2020	NEUTRAL
267	E-THERAPEUTICS PLC	28/11/2007	01/06/2020	NEUTRAL
268	ABBEY PROTECTION PLC	29/11/2007	20/01/2014	SUCCESS
269	LONZIM PLC	11/12/2007	01/06/2020	NEUTRAL
270	BAQUS GROUP PLC	14/12/2007	20/01/2016	FAIL
271	GLOBO PLC	14/12/2007	23/10/2015	FAIL
272	SNACKTIME PLC	19/12/2007	01/10/2018	FAIL
273	RANDALL & QUILTER INVTMNT HLDGS PLC	20/12/2007	01/06/2020	NEUTRAL
274	HERTFORD INTL GROUP PLC	24/12/2007	13/06/2011	FAIL
275	EVOLVE CAPITAL PLC	28/12/2007	28/02/2013	FAIL
276	ANIMALCARE GROUP PLC	15/01/2008	01/06/2020	NEUTRAL
277	LONGSHIPS PLC	21/04/2008	01/06/2020	NEUTRAL
278	OBTALA RESOURCES PLC	24/04/2008	29/09/2010	FAIL
279	IOFINA PLC	09/05/2008	01/06/2020	NEUTRAL
280	SHARE PLC	15/05/2008	01/06/2020	NEUTRAL
281	CHARIOT OIL & GAS LTD	19/05/2008	01/06/2020	NEUTRAL
282	OPG POWER VENTURE PLC	30/05/2008	01/06/2020	NEUTRAL
283	INDUS GAS LTD	06/06/2008	01/06/2020	NEUTRAL
284	RETHINK GROUP PLC(THE)	17/06/2008	09/12/2014	FAIL
285	SUNKAR RESOURCES PLC	30/06/2008	07/08/2014	FAIL
286	NEWRIVER RETAIL LTD	01/09/2009	01/06/2020	NEUTRAL
287	M WINKWORTH PLC	12/11/2009	01/06/2020	NEUTRAL

288	AVIA HEALTH INFORMATICS PLC	16/11/2009	24/10/2014	FAIL
289	OXFORD NUTRASCIENCE GROUP PLC	12/02/2010	08/05/2018	FAIL
290	KEA PETROLEUM PLC	15/02/2010	27/11/2015	FAIL
291	EQUATORIAL PALM OIL PLC	26/02/2010	01/06/2020	NEUTRAL
292	DIGITAL BARRIERS LTD	04/03/2010	01/06/2020	NEUTRAL
293	EMIS GROUP PLC	29/03/2010	01/06/2020	NEUTRAL
294	ILIKA PLC	14/05/2010	01/06/2020	NEUTRAL
295	EASYDATE PLC	30/06/2010	01/06/2020	NEUTRAL
296	DP POLAND PLC	28/07/2010	01/06/2020	NEUTRAL
297	SURETRACK MONITORING PLC	03/08/2010	01/06/2020	NEUTRAL
298	NBNK INVESTMENTS PLC	20/08/2010	21/06/2016	FAIL
299	XCAP SECURITIES PLC	17/09/2010	17/04/2015	FAIL
300	CENTRAL ASIA METALS PLC	30/09/2010	01/06/2020	NEUTRAL
301	INSTEM LIFE SCIENCE SYSTEMS PLC	13/10/2010	01/06/2020	NEUTRAL
302	AFRICAN MINING & EXPLORATION PLC	01/11/2010	01/06/2020	NEUTRAL
303	PRODUCE INVESTMENTS PLC	18/11/2010	04/12/2018	SUCCESS
304	HUMMINGBIRD RESOURCES PLC	10/12/2010	01/06/2020	NEUTRAL
305	INTERNETQ PLC	10/12/2010	29/04/2016	SUCCESS
306	TMT INVESTMENTS PLC	10/12/2010	01/06/2020	NEUTRAL
307	MANROY PLC	22/12/2010	30/07/2014	SUCCESS
308	PEERTV PLC	30/12/2010	28/01/2016	FAIL
309	TRAP OIL GROUP PLC	17/03/2011	01/06/2020	NEUTRAL
310	WESSEX EXPLORATION PLC	23/03/2011	11/11/2017	FAIL
311	MICROSAIC SYSTEMS PLC	11/04/2011	01/06/2020	NEUTRAL
312	ORACLE COALFIELDS PLC	20/04/2011	01/06/2020	NEUTRAL
313	CHINA NEW ENERGY LTD	23/05/2011	01/06/2020	NEUTRAL
314	STRATEGIC MINERALS PLC	08/06/2011	01/06/2020	NEUTRAL
315	IN-DEED ONLINE PLC	15/06/2011	01/06/2020	NEUTRAL
316	UBISENSE GROUP PLC	22/06/2011	01/06/2020	NEUTRAL
317	CONTINENTAL FARMERS GROUP PLC	28/06/2011	02/04/2013	SUCCESS
318	MUSIC FESTIVALS PLC	28/06/2011	21/09/2012	FAIL
319	ENTEQ UPSTREAM PLC	01/07/2011	01/06/2020	NEUTRAL
320	BLUEBIRD ENERGY PLC	06/07/2011	11/12/2015	FAIL
321	SMART METERING SYSTEMS PLC	08/07/2011	01/06/2020	NEUTRAL
322	BAYFIELD ENERGY HLDGS PLC	18/07/2011	01/06/2020	NEUTRAL
323	FERREX PLC	18/07/2011	01/06/2020	NEUTRAL
324	SOVEREIGN MINES OF AFRICA PLC	28/07/2011	01/06/2020	NEUTRAL
325	ALLANFIELD GROUP PLC	18/08/2011	20/05/2017	FAIL
326	FLUORMIN PLC	15/09/2011	20/05/2013	FAIL
327	GALILEO RESOURCES PLC	28/09/2011	01/06/2020	NEUTRAL
328	NANDAN CLEANTEC PLC	09/11/2011	15/12/2014	FAIL
329	SPHERE MEDICAL HLDG PLC	17/11/2011	20/09/2017	FAIL

330	MAGNOLIA PETROLEUM PLC	25/11/2011	02/07/2018	FAIL
331	INSPIRED ENERGY PLC	28/11/2011	01/06/2020	NEUTRAL
332	BELVOIR LETTINGS PLC	21/02/2012	01/06/2020	NEUTRAL
333	ZATTIKKA PLC	16/04/2012	29/07/2013	FAIL
334	SNOOZEBOX HLDGS PLC	01/05/2012	08/11/2017	FAIL
335	RETROSCREEN VIROLOGY PLC	03/05/2012	20/01/2020	FAIL
336	CLUFF NATURAL RESOURCES PLC	22/05/2012	01/06/2020	NEUTRAL
337	MERCOM OIL SANDS PLC	29/05/2012	28/07/2017	FAIL
338	WANDISCO PLC	01/06/2012	01/06/2020	NEUTRAL
339	UTILITYWISE PLC	12/06/2012	01/02/2019	FAIL
340	NEW TREND LIFESTYLE GROUP PLC	28/06/2012	01/06/2020	NEUTRAL
341	REVOLYMER PLC	10/07/2012	01/06/2020	NEUTRAL
342	GOOD ENERGY GROUP PLC	30/07/2012	01/06/2020	NEUTRAL
343	LZYE GROUP PLC	17/08/2012	05/01/2015	FAIL
344	FOX MARBLE HOLDINGS PLC	31/08/2012	01/06/2020	NEUTRAL
345	ELAND OIL & GAS PLC	03/09/2012	18/12/2019	SUCCESS
346	CLINIGEN GROUP PLC	25/09/2012	01/06/2020	NEUTRAL
347	BLUR GROUP PLC	05/10/2012	28/06/2019	FAIL
348	SULA IRON & GOLD PLC	09/10/2012	01/06/2020	NEUTRAL
349	CENTURION RESOURCES PLC	12/11/2012	01/06/2020	NEUTRAL
350	VENN LIFE SCIENCES	14/12/2012	01/06/2020	NEUTRAL
351	RANGERS INTL FOOTBALL CLUB PLC	19/12/2012	07/04/2015	FAIL
352	HEALTHCARE INVESTMENT OPPS PLC	05/04/2013	01/06/2020	NEUTRAL
353	CAMBRIDGE COGNITION HLDGS PLC	18/04/2013	01/06/2020	NEUTRAL
354	ONE MEDIA IP GROUP PLC	18/04/2013	01/06/2020	NEUTRAL
355	QUIXANT PLC	21/05/2013	01/06/2020	NEUTRAL
356	AB DYNAMICS PLC	22/05/2013	01/06/2020	NEUTRAL
357	OUTSOURCERY PLC	24/05/2013	03/06/2016	FAIL
358	SUPERGLASS HLDGS PLC	04/06/2013	29/09/2016	FAIL
359	VERSARIEN PLC	12/06/2013	01/06/2020	NEUTRAL
360	IBEX GLOBAL SOLUTIONS PLC	28/06/2013	02/12/2016	FAIL
361	FRONTIER RESOURCES INTL PLC	05/07/2013	01/06/2020	NEUTRAL
362	KEYWORDS STUDIOS PLC	12/07/2013	01/06/2020	NEUTRAL
363	FRONTIER DEVELOPMENTS PLC	15/07/2013	01/06/2020	NEUTRAL
364	TRAFALGAR NEW HOMES	16/07/2013	01/06/2020	NEUTRAL
365	UNION JACK OIL PLC	30/07/2013	01/06/2020	NEUTRAL
366	CONVIVIALITY RETAIL PLC	31/07/2013	08/05/2018	FAIL
367	SCIENCE IN SPORT LTD	09/08/2013	01/06/2020	NEUTRAL
368	CENTRALNIC GROUP PLC	02/09/2013	01/06/2020	NEUTRAL
369	BlueRock Diamonds plc	04/09/2013	01/06/2020	NEUTRAL
370	NetScientific plc	16/09/2013	01/06/2020	NEUTRAL
371	Independent Oil & Gas plc	30/09/2013	01/06/2020	NEUTRAL

372	KROMEK GROUP PLC	16/10/2013	01/06/2020	NEUTRAL
373	EVERYMAN MEDIA GROUP PLC	07/11/2013	01/06/2020	NEUTRAL
374	RIGHTSTER GROUP PLC	12/11/2013	01/06/2020	NEUTRAL
375	EU SUPPLY PLC	13/11/2013	10/07/2019	FAIL
376	APPLIED GRAPHENE MATERIALS PLC	20/11/2013	01/06/2020	NEUTRAL
377	ECLECTIC BAR GRP PLC	28/11/2013	01/06/2020	NEUTRAL
378	KALIBRATE TECHNOLOGIES PLC	29/11/2013	11/08/2017	SUCCESS
379	SYQIC PLC	04/12/2013	29/12/2016	FAIL
380	SAFESTYLE UK PLC	11/12/2013	01/06/2020	NEUTRAL
381	BENCHMARK HLDGS PLC	18/12/2013	01/06/2020	NEUTRAL
382	MARTINCO PLC	18/12/2013	01/06/2020	NEUTRAL
383	MOPOWERED GROUP PLC	18/12/2013	23/12/2019	FAIL
384	KODAL MINERALS PLC	30/12/2013	01/06/2020	NEUTRAL
385	CITYFIBRE INFRASTRUCTURE HLDGS PLC	17/01/2014	22/06/2018	FAIL
386	HURRICANE ENERGY PLC	04/02/2014	01/06/2020	NEUTRAL
387	4D PHARMA PLC	18/02/2014	01/06/2020	NEUTRAL
388	SUMMIT GERMANY LTD	26/02/2014	17/03/2020	FAIL
389	DX PLC	27/02/2014	01/06/2020	NEUTRAL
390	KOOVS PLC	10/03/2014	10/12/2019	FAIL
391	BOOHOO.COM PLC	14/03/2014	01/06/2020	NEUTRAL
392	XLMEDIA PLC	21/03/2014	01/06/2020	NEUTRAL
393	XEROS TECHNOLOGY GROUP PLC	25/03/2014	01/06/2020	NEUTRAL
394	HORIZON DISCOVERY GROUP PLC	27/03/2014	01/06/2020	NEUTRAL
395	SCHOLIUM GROUP PLC	28/03/2014	01/06/2020	NEUTRAL
396	VENTURE LIFE GROUP PLC	28/03/2014	01/06/2020	NEUTRAL
397	TEKCAPITAL PLC	04/04/2014	01/06/2020	NEUTRAL
398	HAYDALE GRAPHENE INDUSTRIES PLC	14/04/2014	01/06/2020	NEUTRAL
399	EAGLE EYE SOLUTIONS LTD	16/04/2014	01/06/2020	NEUTRAL
400	ROSSLYN DATA TECHNOLOGIES PLC	29/04/2014	01/06/2020	NEUTRAL
401	SPRUE AEGIS	30/04/2014	01/06/2020	NEUTRAL
402	SAFESTAY PLC	02/05/2014	01/06/2020	NEUTRAL
403	REX BIONICS PLC	08/05/2014	30/05/2017	FAIL
404	LIMITLESS EARTH PLC	12/05/2014	01/06/2020	NEUTRAL
405	PATISSERIE HOLDINGS PLC	19/05/2014	25/02/2019	FAIL
406	FLOWTECH FLUIDPOWER PLC	21/05/2014	01/06/2020	NEUTRAL
407	SHOE ZONE PLC	23/05/2014	01/06/2020	NEUTRAL
408	NAHL GROUP PLC	29/05/2014	01/06/2020	NEUTRAL
409	MYSALE GROUP PLC	16/06/2014	01/06/2020	NEUTRAL
410	ZIBAO METALS RECYCLING HLDGS LTD	20/06/2014	01/06/2020	NEUTRAL
411	CDIALOGUES PLC	27/06/2014	01/06/2020	NEUTRAL
412	IMIMOBILE PLC	27/06/2014	01/06/2020	NEUTRAL
413	AFH FINANCIAL GROUP PLC	30/06/2014	01/06/2020	NEUTRAL

414	EASYHOTEL PLC	30/06/2014	19/05/2020	SUCCESS
415	ABZENA LTD	10/07/2014	11/10/2018	FAIL
416	ERGOMED PLC	15/07/2014	01/06/2020	NEUTRAL
417	AGGREGATED MICRO POWER HLDGS PLC	18/07/2014	17/01/2020	FAIL
418	DJI HLDGS PLC	24/07/2014	04/11/2017	FAIL
419	EPWIN GROUP PLC	24/07/2014	01/06/2020	NEUTRAL
420	ULS TECHNOLOGY PLC	28/07/2014	01/06/2020	NEUTRAL
421	PRESSFIT HLDGS PLC	01/08/2014	15/01/2015	FAIL
422	SAVANNAH PETROLEUM PLC	01/08/2014	01/06/2020	NEUTRAL
423	FAIRFX GROUP PLC	05/08/2014	01/06/2020	NEUTRAL
424	ATTRAQT GROUP PLC	19/08/2014	01/06/2020	NEUTRAL
425	MEDAPHOR GROUP PLC	27/08/2014	01/06/2020	NEUTRAL
426	CROSSRIDER LTD	30/09/2014	01/06/2020	NEUTRAL
427	GAMMA COMMUNICATIONS LTD	10/10/2014	01/06/2020	NEUTRAL
428	FULHAM SHORE PLC(THE)	20/10/2014	01/06/2020	NEUTRAL
429	C4X DISCOVERY HLDG PLC	23/10/2014	01/06/2020	NEUTRAL
430	ENTU (UK) LTD	30/10/2014	24/08/2017	FAIL
431	FEVERTREE DRINKS PLC	07/11/2014	01/06/2020	NEUTRAL
432	MORTGAGE ADVICE BUREAU (HLDGS) LTD	14/11/2014	01/06/2020	NEUTRAL
433	STRAT AERO PLC	17/11/2014	01/06/2020	NEUTRAL
434	PEOPLES OPERATOR PLC(THE)	04/12/2014	02/07/2018	FAIL
435	MIDATECH PHARMA PLC	08/12/2014	01/06/2020	NEUTRAL
436	MANAGEMENT RESOURCE SOLUTIONS PLC	11/12/2014	04/09/2019	FAIL
437	QUANTUM PHARMA PLC	11/12/2014	31/10/2017	FAIL
438	MERCIA TECHNOLOGIES PLC	18/12/2014	01/06/2020	NEUTRAL
439	GFINITY PLC	22/12/2014	01/06/2020	NEUTRAL

C. Appendix 3

Top 65 nominated advisers from 2005 to 2014

Nominated Advisers	Number of IPO
Collins Stewart Europe Limited	69
Seymour Pierce Limited	62
Grant Thornton UK LLP	54
W.H. Ireland Limited	51
Canaccord Genuity Ltd	48
Nabarro Wells & Co. Limited	48
KBC Peel Hunt Limited	46
Evolution Securities Limited	43
Numis Securities Limited	42
Cenkos Securities plc	37
Panmure Gordon & Co	36
City Financial Associates Limited	32
Daniel Stewart & Company plc	32
Beaumont Cornish Limited	27
Arbuthnot Securities Limited	24
Teather & Greenwood Limited	24
Corporate Synergy plc	23
Investec Bank plc	23
Charles Stanley Securities	21
Arden Partners	19
Brewin Dolphin Securities Limited	19
Noble & Company Limited	19
Smith & Williamson Corporate Finance Limited	19
Strand Partners Limited	19
Insinger de Beaufort	18
Libertas Capital Securities Li	18
Shore Capital Stockbrokers Lim	18
ARM Corporate Finance Limited	17
Westhouse Securities LLP	17
Zeus Capital Limited	17
John East & Partners Limited	16
Cairn Financial Advisers LLP	15
Davy Stockbrokers	14
finnCap Ltd	14
Oriel Securities Limited	14
Bridgewell Limited	13
Allenby Capital Limited	12
Durlacher Limited	12
Ruegg & Co Limited	12
Liberum Capital Limited	11
Nplus1 Singer Advisory LLP	11
Altium Capital Limited	10
RFC Corporate Finance Limited	10
Strand Hanson Limited	9
William de Broe Plc	9
ZAI Corporate Finance Limited	9
Zimmerman Adams International Ltd	9
HB Corporate	8
JPMorgan Cazenove Limited	8
Rowan Dartington & Co Limited	8
Dawnay, Day Corporate Finance Limited	7
Deloitte LLP	7
Matrix Corporate Capital Limited	7
Deutsche Bank AG London	6
Nomura International plc	6
Northland Capital Partners Ltd	6
Ambrian Partners Limited	5
Credit Suisse Securities (Europe) Limited	5
Ernst & Young LLP	5
Jeffries International Limited	5
KPMG LLP	5
BlueOar Securities Plc	4
Hanson Westhouse LLP	4

D. Appendix 4

The code used in R for the empirical part of the thesis

```
#load the survival library
library(survival)

#import the database from my Excel sheet
library(readxl)
Data <- read_excel("Desktop/Model_me??moire.xlsx",
                   sheet = "Data")
View(Data)

# Modify these variables as factor - better readability
data$LIST1 <- as.factor(data$LIST1)
data$LIST2 <- as.factor(data$LIST2)
data$LIST3 <- as.factor(data$LIST3)
data$LIST4 <- as.factor(data$LIST4)
data$D_AGE <- as.factor(data$D_AGE)
data$D_AUDIT <- as.factor(data$D_AUDIT)
data$D_NOM <- as.factor(data$D_NOM)
data$D_VCB <- as.factor(data$D_VCB)
data$D_GP <- as.factor(data$D_GP)
data$PROFIT <- as.factor(data$PROFIT)


# Define a survival object depending on the survival times and the status
y <- Surv(time = data$Time, event = data$FAIL)

# fit the cox model
cox.model <- coxph(y ~ LIST1 + LIST2 + LIST3 + D_AGE + D_GP + D_AUDIT + D_
VCB + D_NOM, data = data)
summary(cox.model)


#CHECKING THE HYPOTHESES

### linearity for the GP variable

lin.check <- coxph(y ~ LIST1 + LIST2 + LIST3 + D_AGE + log(GP) + D_AUDIT +
D_VCB + D_NOM, data = data)
summary(lin.check)
# graph of the Martingal residuals without log(GP)
par(mfrow = c(1,1))
plot(log(data$GP), residuals(coxph(Surv(time = Time, event = FAIL) ~ LIST1
+ LIST2 + LIST3 + D_AGE + D_AUDIT + D_VCB
                              + D_NOM, data = data),
                        type = "martingale"),
     xlab = "Log Gross Proceeds",
     ylab = "Martingale Residuals (without log(GP)",
```

```
     col = 8)
lines(loess.smooth(log(data$GP), residuals(coxph(Surv(time = Time, event =
FAIL) ~ LIST1 + LIST2 + LIST3 + D_AGE
                                                            + D_AUDIT + D_VCB + D_NOM
, data = data),
                                                      type = "martingale")), col = 2,
lwd = 2)
abline(h=0, col = 4, lty = 2, lwd = 2)
#adding a zero line to compare

#graph with the log(GP)
plot(log(data$GP), residuals(lin.check, type = "martingale"),
     col = 8,
     xlab = "Log Gross Proceed",
     ylab = "Martingale Residuals (with log(GP))")

lines(loess.smooth(log(data$GP), residuals(lin.check, type = "martingal"))
, col = 2, lwd = 2)
abline(h=0, col = 4, lty = 2, lwd = 2)
# linearity assumption is not met so I decided to change the GP variable i
n a dummy variable D_GP

###Checking for influencial observations

# graph for variables 1 to 4
dfbeta <- residuals(cox.model, type = "dfbeta")
par(mfrow = c(2,2))
for (j in 1:4) {
  plot(dfbeta[,j], ylab = names(coef(cox.model))[j], ylim = c(-0.15,0.15),
col = 8)
  abline(h=0.0954, col = 2)
  abline(h=-0.0954, col = 2)
}
#graph for the variables 5 to 8
dfbeta <- residuals(cox.model, type = "dfbeta")
par(mfrow = c(2,2))
for (j in 5:8) {
  plot(dfbeta[,j], ylab = names(coef(cox.model))[j], ylim = c(-0.15, 0.15)
, col = 8)
  abline(h=0.0954, col = 2)
  abline(h=-0.0954, col = 2)
}


### Check Proportional hazard hypothesis

cox.model <- coxph(y ~ LIST1 + LIST2 + LIST3 + D_AGE + D_GP + D_AUDIT + D_
VCB + D_NOM, data = data)
summary(cox.model)

#use cox.zph to check the PH assumption and plot the results only for the
hypothesis that do
#not respect the assumption
```

```
cox.zph(cox.model)
par(mfrow = c(1,1))
plot(cox.zph(cox.model)[8])
abline(h=0, col = 4, lty = 2, lwd = 2)

plot(cox.zph(cox.model)[7])
abline(h=0, col = 4, lty = 2, lwd = 2)
# proportional assumption not met for the D_GP variable as we can see in t
he plot
#and in the cox.zph table

fit1 <- survSplit(Surv(Time, FAIL) ~ LIST1 + LIST2 + LIST3 + LIST4 + PROFI
T + D_AGE + D_GP + D_AUDIT + D_VCB + D_NOM, data = data, cut = c(90), epis
ode = "tgroup", id = "id")
fit1[c("LIST1", "LIST2", "id", "tgroup", "tstart", "Time")]
fit1
# create a new data set split in 2 for the time. I decided to take 90 as t
he cutoff as it is when D_GP cox.zph plot
# cross the h = 0 line, the data base is now split in two tgroup : 1 for 0
-90 and 2 for 91-184

fit1$D_GP <- relevel(fit1$D_GP, ref = 1)
#change the reference for the dummy variable

mod.fit1 <- coxph(Surv(tstart, Time, FAIL) ~  LIST1 + LIST2 + LIST3 + D_AG
E + D_GP:strata(tgroup) + D_AUDIT + D_VCB + D_NOM, data = fit1)
mod.fit1
#fit the model with the new version of D_GP variable

summary(mod.fit1)
cox.zph(mod.fit1)

plot(cox.zph(mod.fit1))

#stratify the D_GP variable.
#the PH assumption is now respected for the new variable

### compare the two models for the cox.zph and the global test

summary(cox.model)
summary(mod.fit1)

cox.zph(cox.model)
cox.zph(mod.fit1)

# the second model is globaly better than the first one given the global t
est

### Additional model for PROFIT and LIST4

#for profit --> testing H2
fit2 <- survSplit(Surv(Time, FAIL) ~ PROFIT + D_AGE + D_GP + D_AUDIT + D_V
CB + D_NOM, data = data, cut = c(90), episode = "tgroup", id = "id")
```

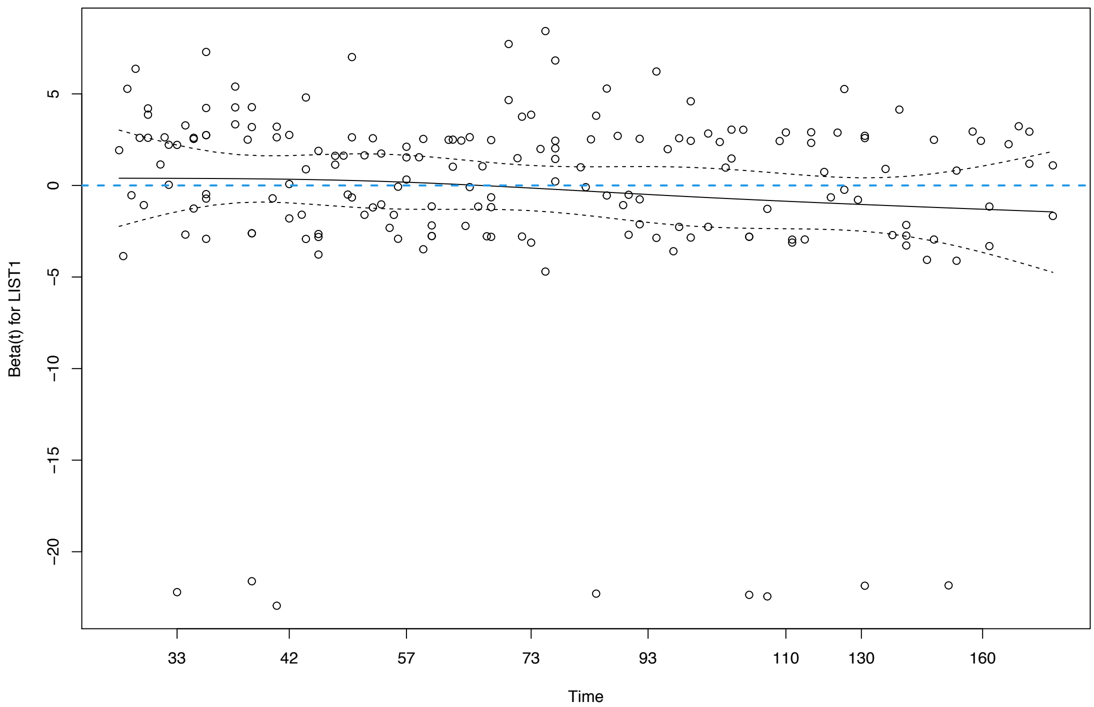
```r
fit2[c("LIST1", "LIST2", "id", "tgroup", "tstart", "Time")]
fit2
#create another database split in two with the PROFIT variable

mod.PROFIT <- coxph(Surv(tstart, Time, FAIL) ~  PROFIT + D_AGE + D_GP:stra
ta(tgroup) + D_AUDIT + D_VCB + D_NOM, data = fit2)
mod.PROFIT
summary(mod.PROFIT)
#fit the Cox model for the new data

#for LIST4 --> testing H3
fit3 <- survSplit(Surv(Time, FAIL) ~ LIST4 + D_AGE + D_GP + D_AUDIT + D_VC
B + D_NOM, data = data, cut = c(90), episode = "tgroup", id = "id")
fit3[c("LIST1", "LIST2", "id", "tgroup", "tstart", "Time")]
fit3
#new data base with LIST4

mod.LIST4 <- coxph(Surv(tstart, Time, FAIL) ~  LIST4 + D_AGE + D_GP:strata
(tgroup) + D_AUDIT + D_VCB + D_NOM, data = fit3)
mod.LIST4
summary(mod.LIST4)
#fit a cox model for fit3 including the LIST4 variable


### TIME TO SUCCESS
z <- Surv(time = data$Time, event = data$SUCCESS)

Smod <- coxph(z ~  LIST1 + LIST2 + LIST3 + D_AGE + D_GP + D_AUDIT + D_VCB
+ D_NOM, data = data)
summary(Smod)

#checking PH assumption
cox.zph(Smod)

par(mfrow = c(1,1))
plot(cox.zph(Smod)[8])
abline(h=0, col = 4, lty = 2, lwd = 2)
# ok for each variables

#checking for influencial observations
dfbeta_succ <- residuals(Smod, type = "dfbeta")
par(mfrow = c(2,2))
for (j in 1:4) {
  plot(dfbeta_succ[,j], ylab = names(coef(Smod))[j], ylim = c(-0.65, 0.2),
col = 8)
  abline(h=0.0954, col = 2)
  abline(h=-0.0954, col = 2)
}

dfbeta_succ <- residuals(Smod, type = "dfbeta")
par(mfrow = c(2,2))
for (j in 5:8) {
  plot(dfbeta_succ[,j], ylab = names(coef(Smod))[j], ylim = c(-0.65, 0.2),
```

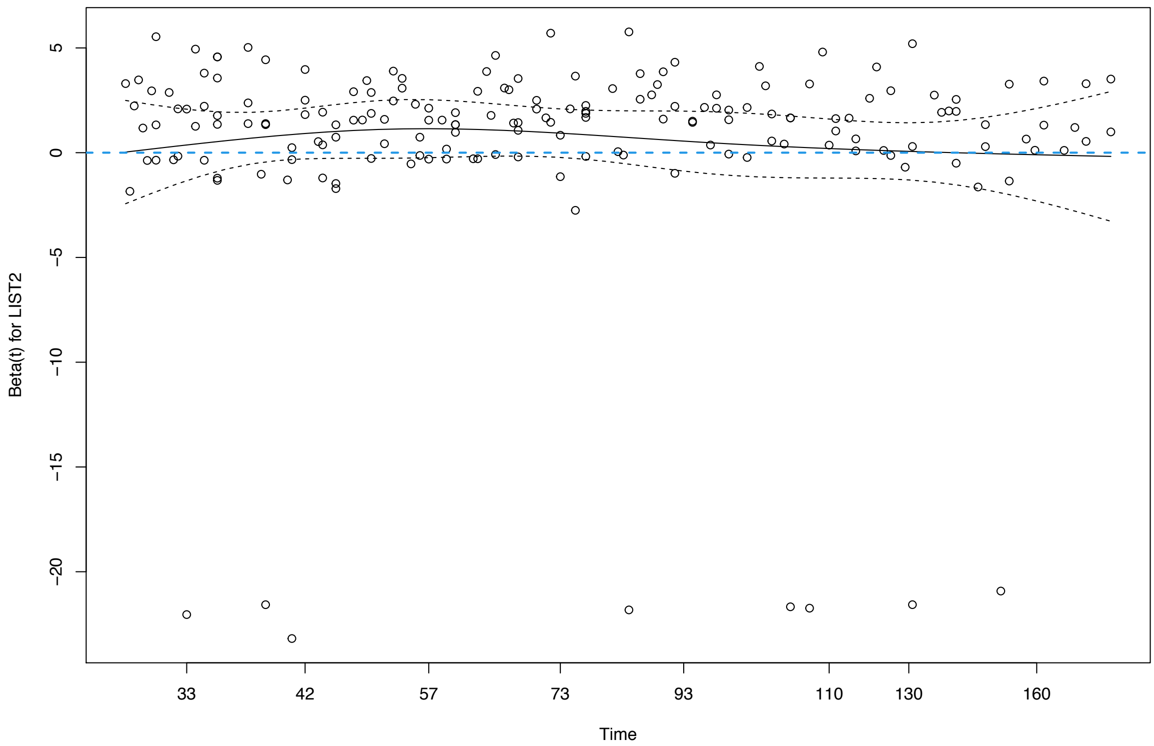
```
col = 8)
  abline(h=0.0954, col = 2)
  abline(h=-0.0954, col = 2)
}
#strong dependence on some observations in the sample

#Testing for Profitability --> H2
Smod.PROFIT <- coxph(z ~  PROFIT + D_AGE + D_GP + D_AUDIT + D_VCB + D_NOM,
data = data)
summary(Smod.PROFIT)

#Testing for LIST4 --> H3
Smod.LIST4 <- coxph(z ~  LIST4 + D_AGE + D_GP + D_AUDIT + D_VCB + D_NOM, d
ata = data)
summary(Smod.LIST4)


####Proportion test for descriptive statistics (Table 6)

FailureRevenue <- prop.test(x = c(131,50), n = c(312,127))
FailureRevenue
UnsuccRevenue <- prop.test(x = c(157,72), n = c(312,127))
UnsuccRevenue
SuccRevenue <- prop.test(x = c(24,5), n = c(312,127))
SuccRevenue
SurvRevenue <- prop.test(x = c(181,77), n = c(312,127))
SurvRevenue

FailureProf <- prop.test(x = c(51,130), n = c(162,276))
FailureProf
UnsuccProf <- prop.test(x = c(95,134), n = c(162,276))
UnsuccProf
SuccProf <- prop.test(x = c(16,13), n = c(162,276))
SuccProf
SurvProf <- prop.test(x = c(111,147), n = c(162,276))
SurvProf

FailureList4 <- prop.test(x = c(14,167), n = c(38,401))
FailureList4
UnsuccList4 <- prop.test(x = c(20,209), n = c(38,401))
UnsuccList4
SuccList4 <- prop.test(x = c(4,25), n = c(38,401))
SuccList4
SurvList4 <- prop.test(x = c(24,234), n = c(38,401))
SurvList4

FailureAge <- prop.test(x = c(108,73), n = c(215, 224))
FailureAge
UnsuccAge <- prop.test(x = c(98,131), n = c(215, 224))
UnsuccAge
SuccAge <- prop.test(x = c(9,20), n = c(215, 224))
SuccAge
SurvAge <- prop.test(x = c(107,151), n = c(215, 224))
```

```r
SurvAge

FailureSize <- prop.test(x = c(93,88), n = c(220, 219))
FailureSize
UnsuccSize <- prop.test(x = c(120,109), n = c(220,219))
UnsuccSize
SuccSize <- prop.test(x = c(7,22), n = c(220,219))
SuccSize
SurvSize <- prop.test(x = c(127,131), n = c(220,219))
SurvSize

FailureAud <- prop.test(x = c(43,138), n = c(111,328))
FailureAud
UnsuccAud <- prop.test(x = c(56,173), n = c(111,328))
UnsuccAud
SuccAud <- prop.test(x = c(12,17), n = c(111,328))
SuccAud
SurvAud <- prop.test(x = c(68,190), n = c(111,328))
SurvAud

FailureNom <- prop.test(x = c(62,119), n = c(150,289))
FailureNom
UnsuccNom <- prop.test(x = c(72,157), n = c(150,289))
UnsuccNom
SuccNom <- prop.test(x = c(16,13), n = c(150,289))
SuccNom
SurvNom <- prop.test(x = c(88,170), n = c(150,289))
SurvNom

FailureVC <- prop.test(x = c(43,138), n = c(151,288))
FailureVC
UnsuccVC <- prop.test(x = c(98,131), n = c(151,288))
UnsuccVC
SuccVC <- prop.test(x = c(10,19), n = c(151,288))
SuccVC
SurvVC <- prop.test(x = c(108,150), n = c(151,288))
SurvVC


#citation package survival
citation(package = "survival")
```

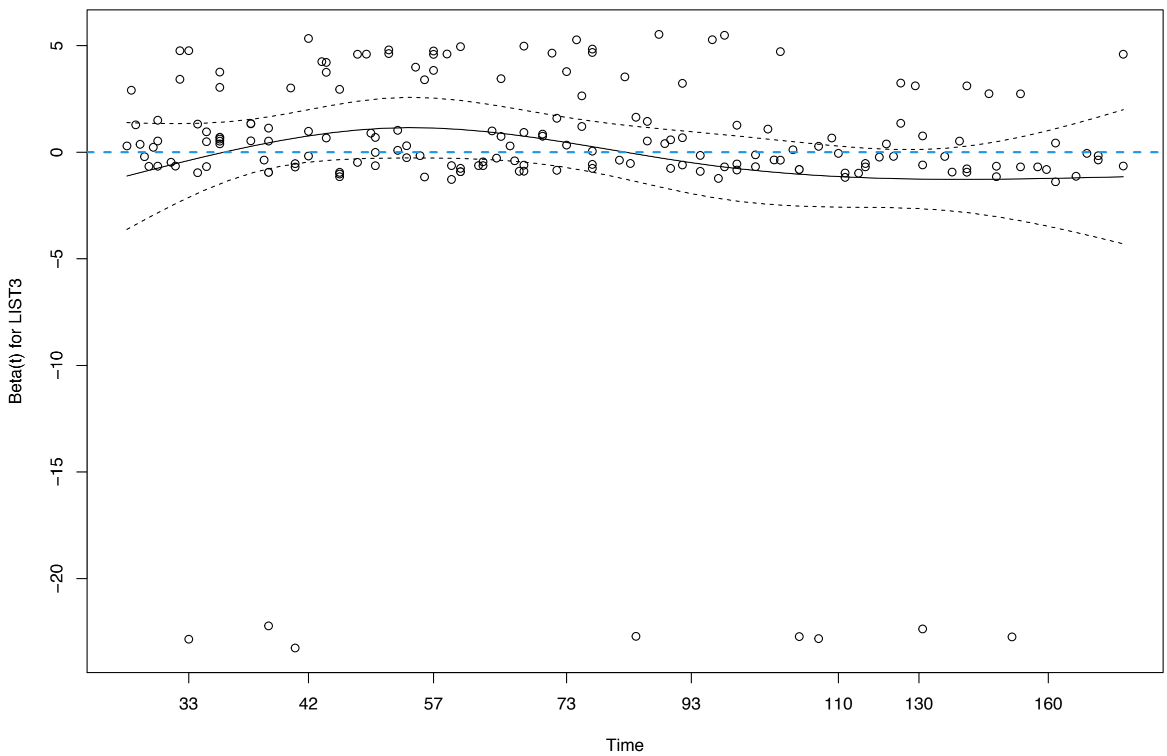
E. Appendix 5

Schoenfeld residuals plot for all the variables in the time-to-failure model

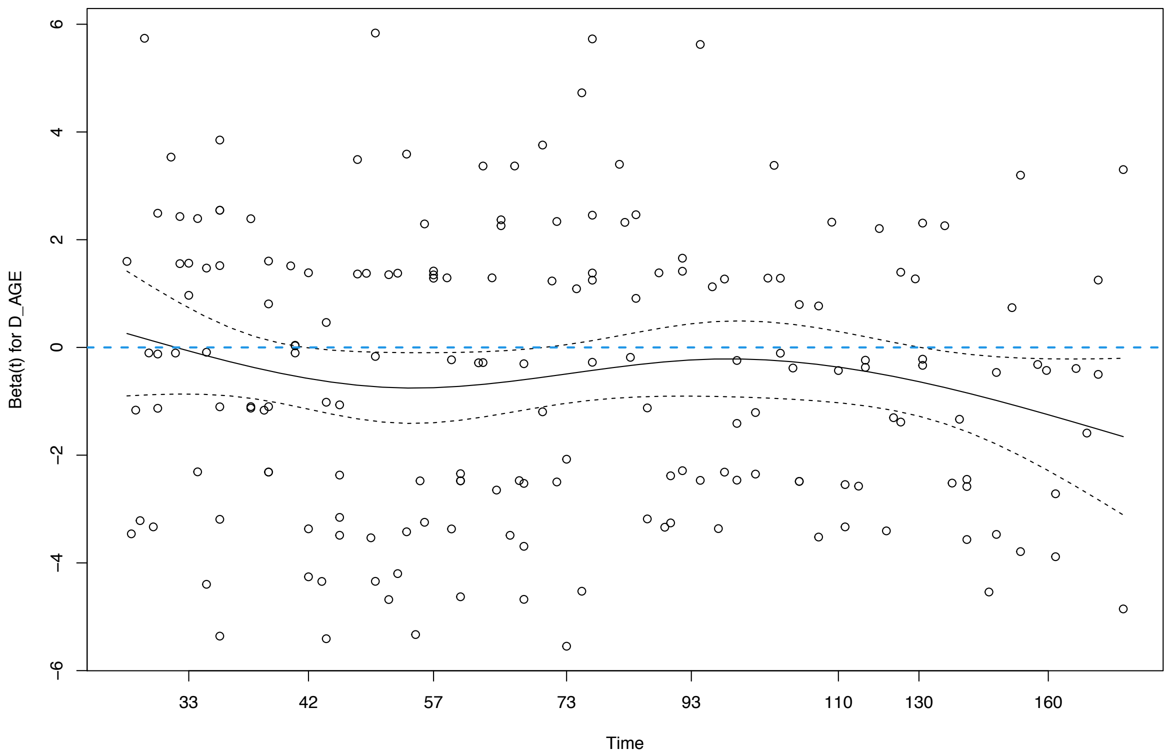


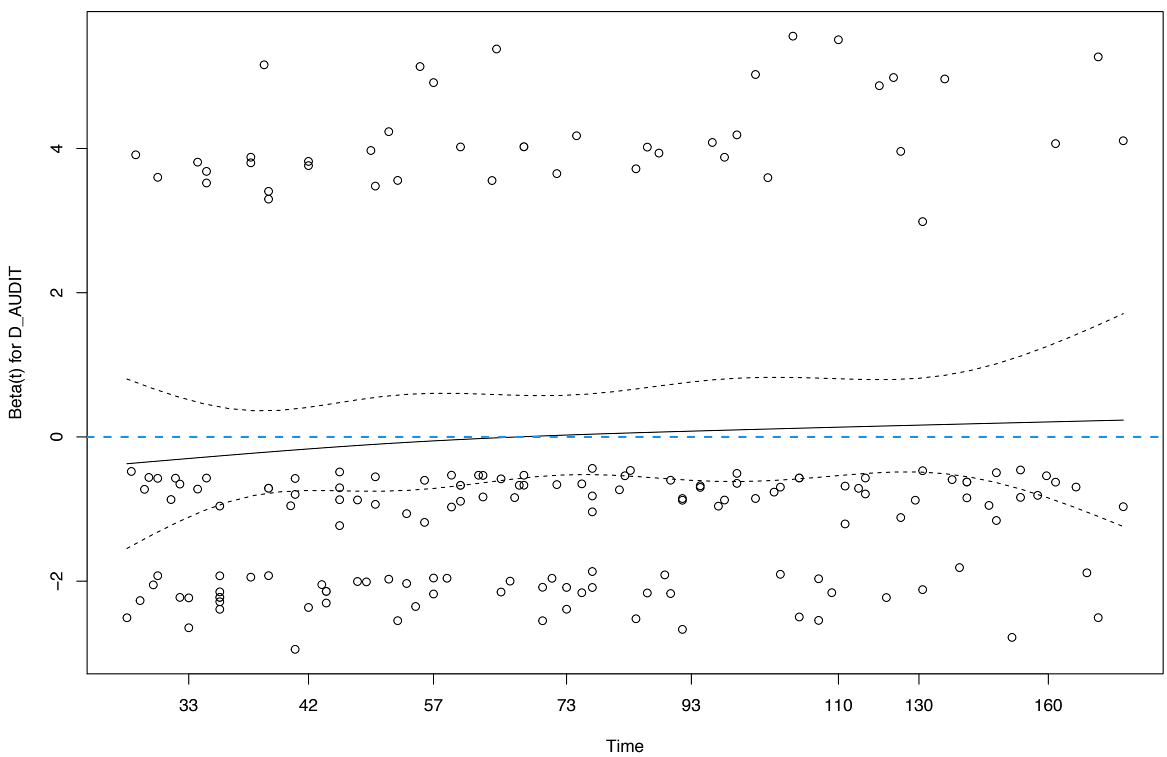


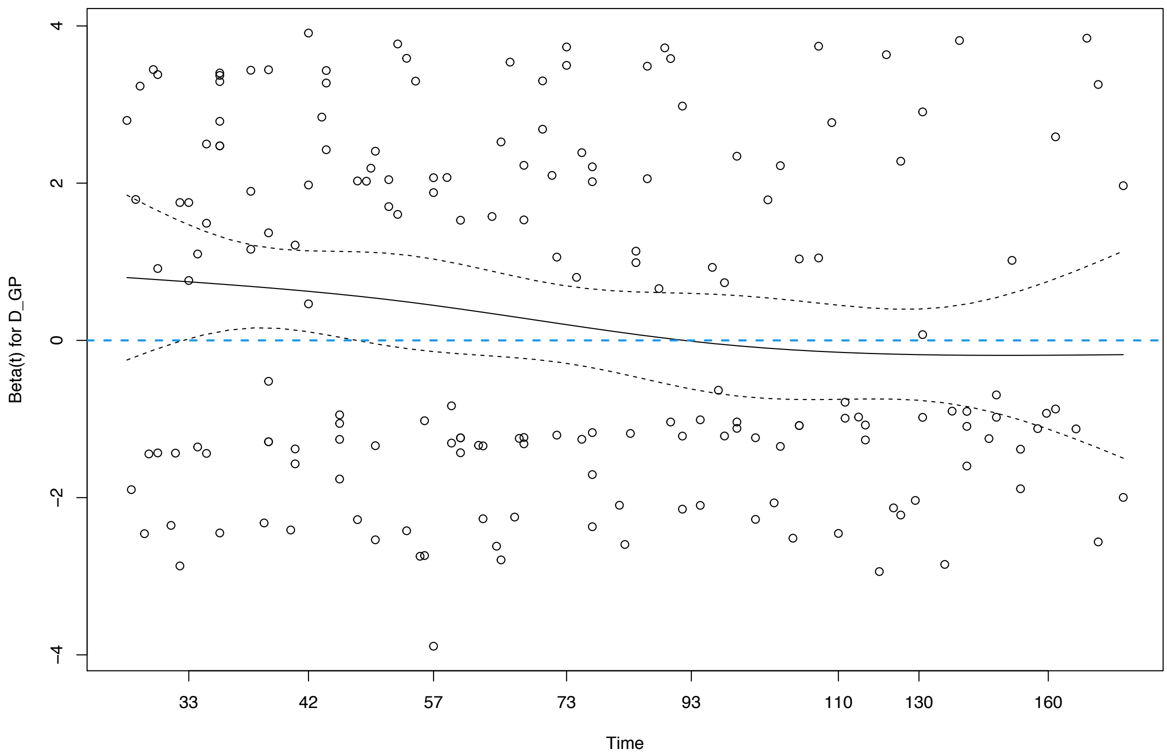
Beta(t) for LIST2
5
0
−5
−10
−15
−20
33
42
57
73
93
110
130
160
Time



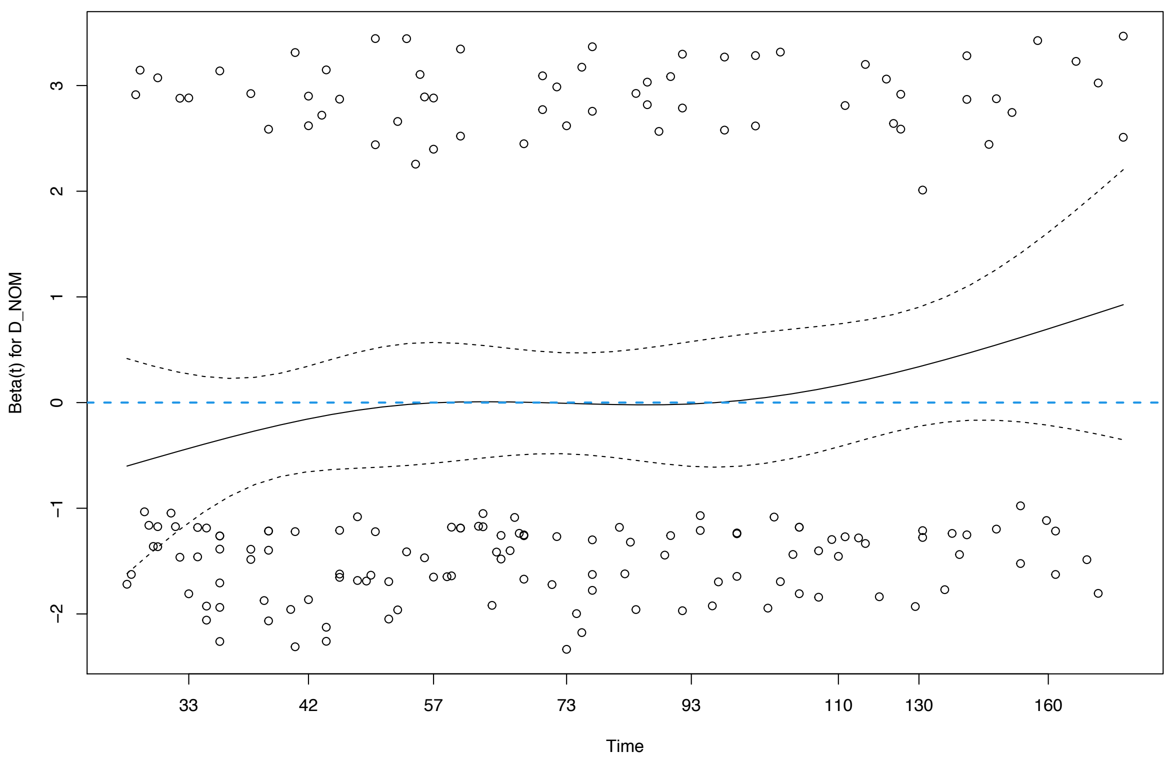
Beta(t) for LIST3
5
0
−5
−10
−15
−20
33
42
57
73
93
110
130
160
Time


Beta(t) for D_AGE
Time
33
42
57
73
93
110
130
160
-6
-4
-2
0
2
4
6

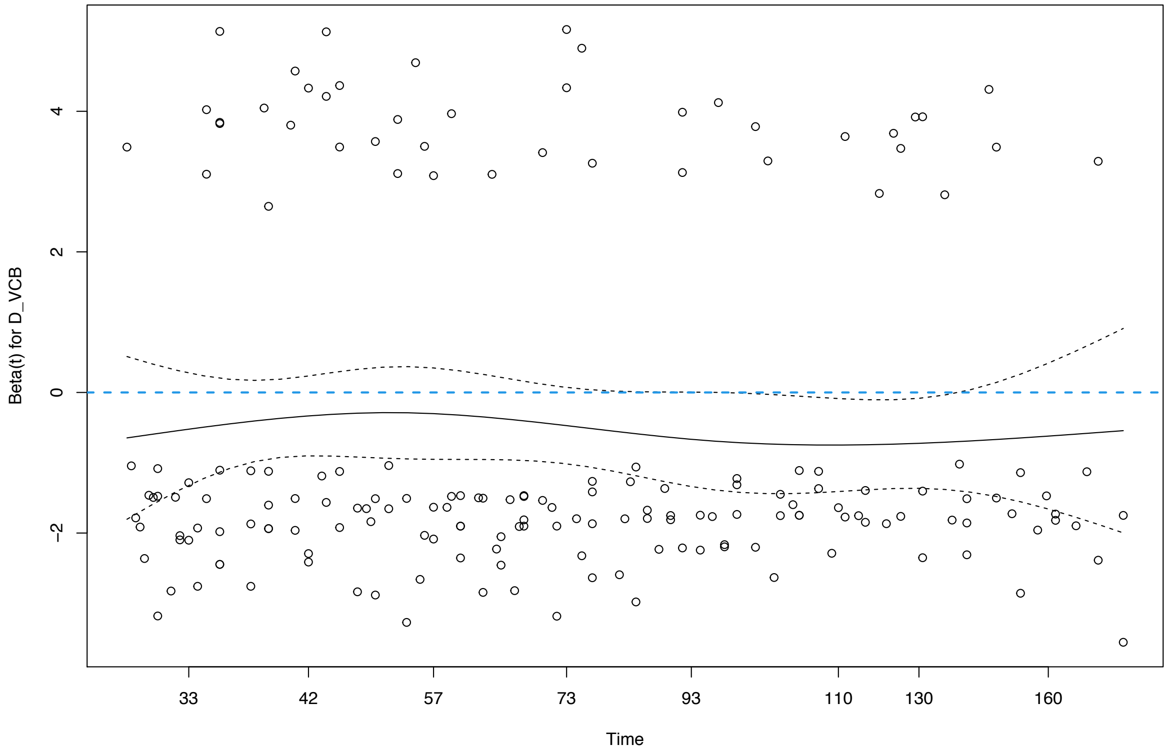

Beta(t) for D_AUDIT
Time
33
42
57
73
93
110
130
160
-2
0
2
4



Beta(t) for D_GP
Time
4
2
0
−2
−4
33
42
57
73
93
110
130
160



Beta(t) for D_NOM
Time
3
2
1
0
−1
−2
33
42
57
73
93
110
130
160



F. Appendix 6

Regression table for Time-to-success: Model 2 (PROFIT)

Variables	Expected Relation	Coefficent	exp(Coef)	exp(-Coef)	p-value
PROFIT	(+)	0.26849	1.307987897	0.764533068	0.5211
D_AGE	(+)	0.37181	1.450357387	0.689485232	0.4163
D_AUDIT	(+)	0.36548	1.441205621	0.693863516	0.3599
D_NOM	(+)	0.67113	1.956446857	0.511130674	0.0755 .
D_VCB	(+)	-0.07435	0.928346716	1.077183754	0.8539
D_GP	(+)	0.991	2.693927053	0.3712053	0.036 *

Signifiance codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

G. Appendix 7

Regression table for Time-to-success: Model 3 (LIST4)

Variables	Expected Relation	Coefficent	exp(Coef)	exp(-Coef)	p-value
LIST4	(+)	-0.3318	0.717630835	1.393474126	0.6561
D_AGE	(+)	0.508	1.661963941	0.601697772	0.2319
D_AUDIT	(+)	0.3528	1.423046506	0.702717723	0.3778
D_NOM	(+)	0.6942	2.002106748	0.499473867	0.0653 .
D_VCB	(+)	-0.1328	0.875640203	1.142021571	0.7402
D_GP	(+)	1.0545	2.870539525	0.348366567	0.0245 *

Signifiance codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

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