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Determinants of stock prices : Evidence from the Automotive Industry

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TABLE OF CONTENTS

Abstract :

Contrary to previous academic inquiries of stock price determination assessing the explanatory power of a distinct category of variables, this paper explores a comprehensive array of potential determinants of four automotive manufacturers' (Ford, Honda, Toyota and Tesla) share price. Using OLS regressions on daily panel data, spanning from January 2007 to December 2017, we investigate the effect of three macroeconomic variables : interest rates, inflation and the U.S. Dollar/Euro exchange rate and three microeconomic factors namely, firms' P/E ratio, Tobin's Q and Board size, on stock prices. Our ultimate contribution is the investigation of 13 major vehicle recall announcements on Ford Motor' stock price using a dummy variable approach which contrasts with the event study methodology mostly followed in the literature. Results point toward a high significance of these factors to explain variations in share price, except for the OLS investigation of major recall announcements which proves to be not significant. Notwithstanding low external validity, we deem the analysis to provide valuable insights to actors in the automotive industry, shareholders and prospective investors.

I/ INTRODUCTION

For CEOs, shareholders and prospective investors of publicly listed corporations, it is primordial to utilize econometric models to understand the origins of stock price variations in order to sharpen their decision-making and enhance their investment performance. For this reason, relying on OLS regression of the Carhart Four-Factor Model depicting stock prices movements as a function of four risk factors, we test the impact of three macroeconomic variables, then consider the impact of three microeconomic variables and ultimately, we investigate the effect of 13 major vehicle recall announcements on share prices, for four prominent automobile manufacturers from January 2007 to December 2017. Thus, this paper answers the following question :

What are the determinants of share prices in the automotive industry ?

Through the analysis briefly described above, we aim to provide CEOs of the four manufacturers scrutinized, shareholders and prospective investors in the automotive industry with supplemental

insights of the factors at the origin of stock price shifts in order to enhance their overall decision-making skills, and raise their awareness of the intricacy of stock price dynamics as an increasing number of factors appears to explain price fluctuations. The paper bridges the gaps in the existing literature by combining the investigation of the impact of macroeconomic, microeconomic variables and recall announcements on the firms' stock price using the most recent daily panel data available. In this respect, we believe that the joint investigation provides a broader picture of potential determinants and the high frequency of the observations raises the degree of accuracy of the research outcome in contrast to earlier works.

In the remaining of this thesis, we synthesize the existing literature addressing stock price determination. We pursue with a description of the empirical strategy that we employ further in the paper and continue with the presentation of the results. The ultimate section discusses the fundamental results as well as limitations of the research strategy. Ultimately, we conclude the thesis with suggestions for further research.

II/ The Evolution of Asset-Pricing Models

The unpredictable character inherent to financial markets and their underlying instruments has historically puzzled many economists which has led to extensive theoretical and empirical research intended to shed some light on the factors driving fluctuations in stock prices. In this section, we synthesize the academic literature relevant to our research question and examine how stock price determination has evolved over the course of time.

2.1. Macroeconomic, Institutional Variables and Stock Prices

As Ho and Iyke (2017) identify, financial literature addressing the evaluation of stock prices determinants can be decomposed into two main approaches : on the one hand, a comprehensive body of academic literature investigates the contribution of *macroeconomic* factors to fluctuation of stock prices.

In this vein, Asprem (1989) explores the significance of key macroeconomic instruments to explain stock prices in ten European countries. Using quarterly data spanning from 1968 to 1984, the author

establishes a joint negative relationship between unemployment, imports, inflation and interest rates on the one hand, and stock prices on the other hand. Despite the significance of the findings, Asprem acknowledges that raising the frequency of the observations composing his dataset may enhance the strength of this relationship. Other researchers, such as Muckherjee *et al.* (1995) share Asprem's findings in contrasting environments. The former, using 240 monthly observations between 1971 and 1990, extracted from the International Monetary Fund database, examines the effect of six macroeconomic variables. Muckherjee conducts a Vector Error Correction Model which enables the investigation of the cointegration degree for a set of variables, with contrasting time perspectives (short-run and long-run) and concludes that the Japanese stock market is negatively cointegrated with exchange rates, inflation and money supply. Along similar lines, Homa and Jaffee (1971) argue that a systematic pattern of determination of stock prices occur through the money supply and interest rates in five open countries between 2004 and 2014. The main results, derived using a Random Effects model for panel regression, allowing to illustrate heterogeneity between the variables, combined with panel Vector Error Correction to determine cointegration between the variables once transformed into stationary processes, concur with the previous papers. The findings put forth a negative relationship between the variables scrutinized and an index of share prices. Thus far, it appears that there exists a general consensus that macroeconomic indicators influence stock prices, nevertheless, Ho and Iyke (2017) question macroeconomic factors as the only drivers of fluctuations and detail another source.

The second approach outlined by Ho and Iyke (2017) postulates that share prices respond to the effect of *institutional* variables. The researchers posit that the integration of stock markets, legal framework and corporate governance constitute explanatory strands of stock prices. Along these lines, Pástor and Veronesi (2012) contend that political uncertainty, operationalized using as proxy the Policy Uncertainty Index (Baker, Bloom and Davis, 2012), raises the risk premium inherent to security price shifts, and that the phenomenon is amplified in the context of economic downturns. Their research applies a general equilibrium model which corroborates this hypothesis, using daily returns derived from the S&P 500 index, and monthly measures of economic state. Despite insightful implications, general equilibrium models rest on a set of assumptions such as perfect knowledge which hinders the external validity of the results. In the same vein, the researchers explore the joint impact of economic

and politic shocks assuming that the two occurences are independent. However, it is legitimate to question this assumption by testing the independence of the two events which the paper omits. In the seminal paper *Legal Determinants of External Finance*, La Porta *et al.* (1997) prompt further evidence of the impact of institutional variables on stock prices. The authors point out that the legal framework surrounding investor protection, acts as a determinant of capital markets. Employing a sample of 49 countries, the authors identify that the development of a state's legal environment is directly linked to the volume of its capital market. Thus far, we have argued that macroeconomic and institutional variables enable some explanations of stock prices movements. Though, economists have challenged the belief that macroeconomic and institutional factors form the exhaustive list of determinants of stock prices. In this vein, many have attempted to unravel asset-pricing puzzles by contemplating extra plausible facets.

2.2. News and Stock Prices

A third body of academic literature is consistent with the extrapolation of Normative Pricing Models whereby securities are priced according to the discounted value of expected future dividend streams (Bierman and Hass, 1971).

Thus, some economists have introduced the effects of heterogenous types of news on firm's market price such as McQueen and Roley (1993). Together, they explain stock price swings to originate from adjustments in the dividend discount rate in the light of various types of news. In conformity with this view, a seminal paper from Fama *et al.* (1969) reaches an analogous conclusion. The analysis led by Fama and his fellow researchers scrutinizes 940 stock splits that occurred on the NYSE between 1927 and 1959. The outcome of the log-log regression on stock returns highlights that, in the context of stock splits, stock prices react to information that alter the prospects of future dividend streams. In a related vein, Cutler *et al.* (1988) have determined that macroeconomic news explain approximately one third of the variance experienced by share prices. Nonetheless, in an attempt to explain the remaining component of the variance of stock returns, Cutler *et al.* have considered the role of major political and world events. However, the findings reveal that this category of events appears to explain only to a modest extent the fraction of the variance unexplained by macroeconomic news.

In order to provide further support to the hypothesis that the disclosure of new information influences stock prices, Hite and Owers (1983) consider 123 spin-offs announcements between 1963 and 1981 communicated by 116 firms. Together, they uncover abnormal favourable returns over a 1-day window surrounding the corporate announcements ; nonetheless, they expose negative returns for corporations experiencing legal or regulatory difficulties, which contributes to demonstrating the linkage between news disclosure and stock prices variations. One branch of this literature segment has studied the financial consequences of automobile recall announcements on stock prices, which we explore in more detail in this paper for the corporation Ford Motor.

In this vein, Jarrell and Peltzman (1985) provide some evidence of a negative association between automobile recall announcements and the announcing manufacturer's market value. The researchers conduct an event study, using a dataset which comprises 116 major recalls from the three former biggest manufacturers according to market capitalisation : Ford, General Motors and Chrysler spanning from 1967 to 1981. The authors arbitrarily define major recalls as withdrawals involving, more than 50,000 automobiles for Ford, 20,000 vehicles for General Motors and 10,000 for Chrysler. The outcome of the event study points towards a negative cumulative excess return using a two-week event window. Nonetheless, Jarrel and Peltzamn (1985) constrain the analysis solely to safety recalls thereby omitting sources such as mechanical failures and manufacturing defects. In order to strengthen the outcomes set forth by the two authors, Hoffer *et al.* (1988) offer a reexamination of the inquiry. The central argument put forward motivating a second investigation draws on the reliability of the data collected by Jarrel and Peltzman (1985). Through their reexamination, the authors indicate that the former paper included 21 recalls which failed to meet the size criteria thereby weakening the internal validity of the research. Furthermore, the reexamination addresses a second limitation of the dataset used in the previous analysis insofar as 16 recalls which met the size criteria had been omitted. Thus, the reexamination proposes an updated version of the findings which contrasts with the outcome put forth by Jarrel and Peltzman (1895). In this vein, Hoffer *et al.* contend that stock prices are, for the most part, unaffected by automobile safety recalls between 1975 and 1981. The authors used the updated version of Jarrel and Peltzman dataset which solves the limitations they have posited and find that only Ford and the combined three manufacturers experience a decrease *circa* 2% in their stock price

following the announcement. We notice a decrease in the magnitude of the effects in comparison to the analysis led by Jarrel and Peltzman (1985) and Chrysler's stock price is unaffected by the announcements. Chu *et al.* (2005) share the hypothesis stating that recall announcements convey adverse information as proposed in Jarrell and Peltzman (1985) and highlight significant negative abnormal returns surrounding the recall announcement date. The former examines 269 non-automotive recall announcements spanning from January 1984 and December 2003. The paper follows a similar methodology as the foregoing papers and conducts an event study which identifies significant adverse abnormal returns on the date of the announcement.

Collectively, the evidence outlined thus far supports the hypothesis that financial asset prices respond to the release of diverse types of information – macroeconomic, financial, political. The foregoing literature has extended the scope of research in stock prices determination to qualitative factors such as news, elevating the complexity for researchers, corporations and institutions to pinpoint the array of factors at the origin of stock price variations. In recent years supplementary academic developments have further complexified the security-pricing debate with the emergence of behavioral finance.

2.3. The Advent of Behavioral Finance

As posited by Barberis and Thaler (2003) the new branch of finance (but also applicable to the field of economics) relaxes the key assumption of rationality and considers the existence of human biases leading to diverging views and representations of concepts in contrast with historical normative models. An undeniable number of academic inquiries comes within the scope of this area such as the work provided by the forerunners in the subject : Shiller *et al.* (1984). The three authors argue that social dynamics, that we may exemplify as investors' behaviors and sentiments may well be the primary origin of security prices oscillations. Through a time series model of aggregate real dividend return supported by US stock market data, the research highlights that collective beliefs may be a prevailing source of movements in the value of the financial markets' indexes. Likewise, Bondt and Thaler (1985) develop supplemental evidence in their paper *Does the stock market overreact ?* The purpose of the analysis is to gauge the extent of individuals' « overreaction » to news – violating Baye's rule – and its

effect on security prices. The empirical work formed using a dataset of monthly stock returns confirms Bondt and Thaler's hypothesis and accentuates the existence of abnormal returns surrounding the news release, in accordance with their expectations. Further academic research conducted by Bollen *et al.* (2011) has attempted to forecast the Dow Jones Industrial Average performance (DJIA) on the basis of « Twitter mood ». Bollen and his co-researchers, established a scale introducing six dimensions (Calm, Alert, Sure, Vital, Kind and Happy) that illustrates the aggregate « mood » of Twitter users at a given time. The authors collected 9.9 million tweets between February and December 2008 and ran Granger-Causality tests to examine the extent to which these dimensions constitute accurate predictors of the DJIA. Overall, the model specified in the paper explains 87.6% of the daily changes in DJIA index returns.

Thus, at the outset of this section, we have introduced two types of factors – *macroeconomic* and *institutional* variables – which have been deemed to influence stock prices. Nonetheless, such variables have failed to explain perfectly price shifts entailing a body of researchers to focus their efforts on inspecting the ability of *news* to justify price discrepancies. Eventually, we have contemplated the emergence of behavioral finance which relaxes key assumptions such as rationality and incorporates psychological biases into asset-pricing models in order to achieve more realistic results. Considering the foregoing evidence**,** asset-pricing is still puzzling numerous scholars as one central challenge unfolds : the trade-off between keeping unrealistic assumptions and drawing upon behavioral finance which meets resistance as some economists disparage the association of finance and psychology and advocate that the operationalization of behavioral concepts is intricate.

In this paper, we attempt to bridge the gap in the existing literature by inspecting conjointly the influence of three macroeconomic variables : the inflation rate, the US/€ exchange rate and the risk-free rate, and three microeconomic variables : the Price-to-Earnings ratio, Tobin's Q and eventually Board size, in the automotive industry. Furthermore, we also contribute to develop the literature on the effect of automobile recall announcements, by investigating the effect of 13 major recalls for Ford Motor from January 2007 to December 2017 which remains hitherto unexplored. This approach offers to the reader a broader picture of the conceivable determinants of stock prices for this specific industry by combining the variables that stem from these two branches of economics. In contrast to the papers that we have

introduced, we use daily panel data from four prominent automotive manufacturers namely Ford, Honda, Toyota and the recent automobile manufacturer Tesla.

III/ DATA

As mentioned in the foregoing paragraphs, we consider seven different factors with specific characteristics. The purpose of choosing this array is two-fold: initially we aim to bring new insights in the literature by combining macroeconomic factors, microeconomic factors, and vehicle recall announcements. Secondly, we believe that the joint investigation of these three categories proposes a more general analysis allowing readers grasp the complexity of stock market dynamics. As a result, the following subsection develops the hypotheses tested further in this paper. Last, we describe the dataset employed to perform our analyses.

3.1 Hypothesis Development

In this section we aim at motivating the hypotheses that we probe in the subsequent sections. The hypothesis development is subdivided into three sections to contrast the variables probed. We first formulate hypotheses that relate to our baseline specification, the Fama/Carhart Four-Factor Model. The next subsections explore the extension of the baseline model by means of macroeconomic and corporate-level variables. A comprehensive description of the variables follows in the data section.

3.1.1. Fama/Carhart Four-Factor Model

The first hypothesis that we formulate is therefore as follows :

H_1 : Carhart's specification significantly explain stock prices

Prior to extending Carhart Four-Factor Model we assess the explanatory power of the model specification on the sample of automotive manufacturers that we have selected. The model contains four independent variables namely, the stock the *Market Excess Return*, and the *Small-Minus-Big*, *High-Minus-Low*, *Up-Minus-Down* factors. The motivation that underlies stock price movements

according to these four variables is as follows : Fama formed and tested three central beliefs about stock markets namely, that the market excess return (average return of all securities minus the risk-free rate of return) offers some explanatory power for stock prices. His second beliefs originates from the observation that stocks with low capitalisations tend to outperform (in terms of superior rates of return) stocks having upper capitalisations. Ultimately, he believed that stocks with high book-to-market ratios (ratio of the book value to market value of a firm) are also characterized by superior returns in comparison to stocks characterised by low book-to-market ratios. Carhart has refined the former model by appending the last factor, Up-Minus-Down. The last variable translates stocks' momentum behavior, that is, the tendency to behave as they have during the 12 previous months. Our purpose is to assess the internal validity of the model on a sample of four automobile manufacturers during the period January 2007 to December 2017.

3.1.2. Macroeconomic determinants of Stock Prices

We formulate our second hypothesis :

H_2 : Interest Rates correlate negatively with Stock Prices

Our second hypothesis describes the relationship between the four automobile manufacturers' stock price and the risk-free rate, defined as the return an investor would expect on an investment with no underlying risk. The risk-free rate is virtually inexistant in real financial markets because the safest financial instrument bears a minimum degree of risk to safeguard the lender against potential adverse events such as a risk of default. Nonetheless, we are able to determine a proxy for the risk-free rate namely, the return associated with One-Month Treasury Bills which is unanimously considered to be the safest financial asset in which one can invest. A Treasury bill is a variety of bonds having a duration inferior to one year, issued by the federal government, thereby having no default risk – conditional on the assumption that governments cannot enter bankruptcy – in contrast to other groups of financial assets (stocks…). Nonetheless, T-bills still carry interest rate risk – the risk affiliated with variations in interest rates – which entails a small but positive return stemming from the intrument. We motivate this

hypothesis by observing the impact of the choice of capital structure on the firm's stock price. Firms that decide to be levered (choose a capital structure consisting of both debt and equity) are subject to interest payment towards their lenders. The magnitude of the interest payments in turn depends on the interest rate assigned by the lender. Fluctuations in this rate to confront the conjecture therefore alter interest payments of a firm which can cause stock price to change due to a boosted or depleted confidence with regards to future streams of cash flow. Typically, institutions also resort to interest rates to signal to the economy and actors in the financial industry their confidence or uncertainty for the foresseable future, thereby stabilizing or increasing share price's volatility. Therefore, we expect a negative relationship between interest rates and stock price.

The third hypothesis that we investigate is the following :

H_3 : Inflation Rate and Stock Prices are negatively correlated

The third hypothesis explores the degree to which automotive manufacturers' share price and inflation correlate with one another or fluctuate in an independent manner. Inflation rates ratchet up the level of prices for consumers and thereby diminishes the quantity of goods that they can afford. During periods where inflation is above historic rates – when a country's debt burden is too heavy for instance – prospective customers may refrain from purchasing a vehicle given that the outlay has increased compared to periods of regular inflation. That is, either customers can no longer afford the vehicle or, knowing that inflation rates will return to lower levels in the next periods, they decide to wait for a stabilisation or reduction of inflation in order to save the difference when they proceed to the purchase. This reasoning may entail lower vehicles sold from the manufacturers for the foregoing reasons or, due to the increase in the upfront cost to afford a car. Given that a reduction in the quantity of vehicles sold may jeopardize future streams of cash, we expect a negative correlation between the inflation rate and the manufacturers share prices.

The fourth hypothesis we consider is :

H_4 : Exchange Rates and Stock prices are negatively correlated.

The four automotive manufacturers selected own business units in diverse locations worldwide and mostly in Western Europe which occupies a substantial fraction of their respective market shares. As a consequence, oscillations in the value of the dollar are likely to affect the prices at which consumers in foreign countries purchase their vehicles. To exemplify this mechanism, a depreciation of the US dollar versus the Euro portends that it becomes cheaper for European customers to purchase a new vehicle. This mechanism entails an increase in vehicles sold for the manufacturers which enable them to extract more profit from the depreciation of the US dollar, or greater earnings that can affect subsequently their stock price. Conversely, an appreciation of the US dollar relative to Euro ratchets up the price of a vehicle from the European customers' standpoint which incentivize them to wait until an adjustment of the exchange rates occurs, or a more favourable period to realize a purchase, lowering current sales thereby impacting negatively earnings. Likewise, a slack period characterised by a weak financial performance may influence stock prices in a similar manner.

3.1.3. Microeconomic Determinants of Stock Prices

Our fifth hypothesis is as follows :

H_5 : Price-to-Earnings ratio and Stock Prices correlate positively

Contrary to the four foregoing hypotheses, the examination of the P/E ratio enables us to evaluate the explanatory power of a financial ratio to explain stock price. Accordingly, the fifth hypothesis brings a new viewpoint to assess the source of share price fluctuations for the automotive manufacturers chosen. The P/E ratio is computed according the following formula :

$$\frac{P}{E} = \frac{Price\ Per\ Share}{Earnings\ Per\ Share}$$

Earnings-Per-Share is calculated using the following formula :

$$Earnings\ per\ Share = \frac{Net\ Income\ -\ Preferred\ Dividends}{Weighted - Average\ number\ of\ shares\ outstanding}$$

The P/E ratio forms a company's financial metric which is frequently utilized by investors to predict future stock prices and gauge current performance. The indicator boils down to the amount an investor can expect to invest in a company in order to receive one dollar from the company's earnings. Since the P/E ratio varies according to valuations and growth rates among other factors, it is not fruitful to compare the price multiple across industries given that some sectors are characterised by higher valuations and growth rates than other industry segments (Technology, FinTech versus Energy and Utilities). Notwithstanding, the scope of this research allows us to sweep aside the foregoing concern given that we scrutinize the automotive industry alone. We expect a positive relationship between the P/E ratio and share prices given that the P/E increases in the Price Per Share. An alternative path to increase a firm's P/E is to diminish EPS – by issuing new shares for example – or decreasing net income. The latter is unlikely as the net income forms one of the key profitability measures of a firm, therefore a decline in Net Income could trigger a chain reaction and negatively affect multiple financial ratios, endangering the firms' financial prospects.

The sixth hypothesis that we scrutinize is :

H_6 : Tobin's Q significantly explains Stock Prices and the two variables are ambiguously correlated.

Tobin's Q is a renowned ratio in Finance devised by the Nobel laureate in Economics James Tobin. In the literature, scarce evidence exists of the use of Tobin's Q to explain stock prices movements relative to more common research detailing the effects of the P/E ratio or EPS for instance. Tobin's Q is computed using the formula given below:

$$Q = \frac{Total\ Market\ Value\ of\ Firm}{Total\ Asset\ Value}$$

The motivation underlying the ratio is that a firm's market value (number of shares outstanding multiplied by the price per share) should be similar to firm'sreplacement costs, embodied as its total

assets. Accordingly, a Q-value pertaining to the range $0 \leq Q < 1$ implies that a firm's total market value is smaller than the value of its assets, implying the firm's replacement costs are greater than the value of its market value. In layman's terms, this indicates that the stock price is undervalued. On the contrary, a Q-value superior to 1 points out that a corporation's market value outweighs the replacement costs of its assets hence that its stock price is overvalued. Given that the ratio tends to one, depending on the undervaluation or overvaluation of the firm's stock Q may have a positive or negative effect on the stock price. The undervaluation of firm's stock convey the opportunity for investors to realize some profits by purchasing the stock at time *t* and closing its position (selling) at time *t+1* when the stock has reached its appropriate price. The reverse mechanism communicates a forseeable downward adjustment of the firm's stock price indicating that it is strategic to (short) sell the stock in order to not to realize a loss, or achieve a gain. That is why, we expect an ambiguous relationship between Tobin's Q and stock prices.

The penultimate hypothesis explored in this paper is developped as follows :

H_7 : Board Size and Stock Prices are negatively correlated

Through the penultimate hypothesis, we explore the impact of a corporate governance measure on firms' stock price. We assume that a profuse board increases the likelihood of malfunctions and inefficiencies in management's decision-making. Relative to boards composed of lesser members, we reckon that boards composed of numerous members face more difficulty to reach consensus and are prone to exhibit management inefficiencies compared to smaller boards. Empirical evidence tends to support an negative relationship between board size and key performance indicators in small, midsized and large firms (Eisenberg et al., 1998 ; Cheng, 2008). Such pattern has not yet been displayed for the automotive industry, that is why we aim at bridging the gap by scrutinizing this effect on stock prices for firms pertaining to the automotive industry.

Ultimately we test a last hypothesis :

H_8 : Vehicle recall announcements have a significant negative effect on Ford stock price

The ultimate hypothesis sheds some light on a qualitative variable which is intricate to measure, the effect of 13 major public releases of vehicle recall statements, involving at least 400,000 vehicles, on Ford stock price. The company is able to provide a reliable estimate of the direct cost it incurs when recalls are released. Nonetheless, the impact on stock price is more complex than the direct financial outlays necessary to fix the defective component. We have proposed some insights in the literature review suggesting a negative impact of recall announcements on manufacturers' market value. However such effect remains uninvestigated for Ford Motor Corporation over the period 2007 to 2017. Therefore, through this hypothesis we explore this effect considering a more recent timespan than the one used in previous research.

3.2. Data

To establish whether the macroeconomic and microeconomic factors that I have selected explain variations in stock prices for the automotive industry, I have assembled a comprehensive dataset comprising the daily stock prices (panel data) of the four automotive manufacturers scrutinized namely, Ford Motor Company, Honda Motor Company, Toyota Motor Corporation and Tesla Incorporated, between January 2007 and December 2017. I have also collected time series data for three macroeconomic variables and panel data for the three microeconomic (corporate) variables. The first three corporations are listed on the New-York Stock Exchange, while the last one is listed on the NASDAQ. The dataset gathers 2769 observations for each manufacturer, except Tesla which entered the NASDAQ in 2010. Therefore our dataset comprises 10,197 price observations, a number therefore inferior to the number of observations in an ideal setting. In that respect, I acknowledge some limitations inherent to the data collection insofar as stock price data for Tesla Inc. is unavailable before 2010. Other variables contain missing data which will be specified further in this section. At the outset of the data

collection process, I have downloaded daily security prices from the Center for Research in Security Prices accessed via Wharton Data Research Services.

Table 1 reports daily stock prices summary statistics displayed by corporation between January 3rd, 2007 and December 29th, 2017.

Variable	Obs	Mean	Std. Dev.	Min	Max
Stock Price (Ford)	2769	11.5209	3.8693	1.26	18.79
Stock Price (Honda)	2769	32.7723	4.3730	18.19	44.79
Stock Price (Toyota)	2769	100.826	21.9477	57.68	145.32
Stock Price (Tesla)	1890	153.2154	108.3021	15.3021	385

Table 1 : Descriptive statistics of the daily stock price by automotive manufacturer (2007-2017)
Source : Center for Research in Security Prices

The sum of all observations is consistent with the timespan contemplated. However, we notice some discrepancies with Tesla's data which gathers less observation than its three competitors. Tesla filed for an Initial Public Offering (procedure to list a firm on stock markets) on January 29th, 2010. As a result, stock market data for this company is unavailable before this date hence the inferior number of observations in comparison with the three long-established manufacturers. Notwithstanding its shorter presence on financial markets, Tesla has the highest mean stock price at a face value approximately equal to 153$ per share. However, it is visible, judging on the high standard deviation ($108.3), that the car-manufacturer has recently experienced a tremendous growth in its share price. Ford Motor has the lowest mean stock price in the sample equal to $11.5 per share. This inferior performance relative to the other corporations may reflect the aftermaths that stem from the subprime mortgage crisis which took a toll on the economy and had lasting adverse consequences on Ford finances in contrast to other firms in the sample, due to its strong presence in the United-States.

Once the daily security prices collected we have gathered data in order to construct our baseline model. We explore in more detail these variables in the next section.

3.2.1. Baseline Specification

Using WRDS, we have compiled daily data on the variables specified in the Carhart Four-Factor Model as outlined in the data section. The Four-Factor Model is expressed according the following formula :

$$Stock\ Price = \alpha + \beta 1 \cdot mkt + \beta 2 \cdot smb + \beta 3 \cdot hml + \beta 4 \cdot umd + \epsilon$$

We have chosen to access WRDS to download the variables listed above because of the convenience the database provides. Nonetheless, we could have also used the Kenneth French data repository where the economist, who was also one of the member who laid the foundations of the model, has compiled numerous datasets and prepared them for analyses. In the ensuing section we delineate the macroeconomic variables added to the model, then we outline the microeconomic factors joined to the framework.

- **Market Excess Return (MKT)** : the market excess return is the value-weighted return of all existing stocks on the New-York Stock Exchange, NASDAQ and American Stock Exchange from which is subtracted the risk-free rate. Therefore, the value describes the spread between the average market return relative to theoretically risk-free securities. One-month Treasury bills act as proxy for the idealized concept of risk-free rate. T-Bills from the treasury are classified as bonds with a duration inferior to 1 year, issued by the Federal Government. Conditional on the assumption that a government cannot enter bankruptcy, Treasury bills are exempted of default risk, thereby it is the safest financial instrument one can purchase.
- **Small-Minus-Big** : the factor describes the average return on three portfolios qualified as « small » minus the average return on three portfolios chracterised as « big » (Fama & French Three Factor Model, Investopedia). The variable depicts the size risk introduced by Fama & French and reflects the belief that small-capitalisation stocks frequently outperform stocks with higher capitalisations. The formula below depicts the calculation of the values using the parameters described further.

$$SMB = {}^{1}/_{3}\,(Small\ Value + Small\ Neutral + Small\ Growth) - {}^{1}/_{3}\,(Big\ Growth + Big\ Neutral + Big\ Growth)$$

The parameters « Small Value… » are obtained based on two portfolios built on the size criteria (Market Value of Equity) and on three portfolios built using Book-to-Market ratios. We have reproduced the classification as follows :

	Median ME	
70th Book/Market percentile	Small Value	Big Value
	Small Neutral	Big Neutral
30th Book/Market percentile	Small Growth	Big Growth

Figure 1 : Classification of the variables used to calculate Fama/Carhart four risk factors
Source : Kenneth French Data Library

- **High-Minus-Low** : Prior to explaining the function of this variable we must define two concepts. The measure distinguishes value stocks defined a stocks associated with a high book-to-market ratio and growth stocks which are characterized by low book-to-market ratios. The book-to-market ratio is the ratio of common stockholders' equity to the firm market capitalization, it indicates the value of a company. Therefore, the High-Minus-Low factor indicates the tendency of « value stocks » to outperform « growth stocks ». The daily values are computed using the following formula :

$$HML = {}^{1}/_{2}\,(Small\ Value + Big\ Value) - {}^{1}/_{2}\,(Small\ Growth + Big\ Growth)$$

- **Up-Minus-Down** : The ultimate parameter specified in the model embodies Carhart's contribution to Fama & French Three-Factor Model and highlights the momentum pattern of stocks. Carhart posits that stocks that have historically performed well tend to continue to achieve abnormal returns whereas stocks having poor performances tend to perform identically in the future. The variable is formed using returns of six weighted portfolios based on prior returns monitored over the past 12 months. The UMD factor can be calculated using the following formula :

$$UMD = {}^{1}/_{2}\,(Small\ High + Big\ High) - {}^{1}/_{2}\,(Small\ Low + Big\ Low)$$

Small and Big refer to the capitalisation of the stocks selected in their portfolio, whereas High and Low relate to their growth over the past 12 months.

3.2.2. Model extension using macroeconomic determinants

As we have posited in the hypothesis development, we broaden the baseline model (Carhart Four-Factor Model) with three macroeconomic variables that we believe could explain stock prices variations. Foremost, we contemplate the risk-free rate. We have retrieved the corresponding data from the Federal Reserve of Saint-Louis data repository where the risk-free rate chosen is the rate associated with One-Month Treasury Bills. Rates are measured in absolute values.

Subsequently, we append the inflation rate to the baseline framework as we have indicated in the third hypothesis. Likewise, we have obtained inflation rates figures from the Federal Reserve dataset. 10-year breakeven inflation rates embody inflation derived from 10-year treasury constant maturity securities and are expressed in percentages (FED).

The ultimate macroeconomic factor added to the model is the exchange rate for the European Monetary Union ($/€) that we have collected in an analogous manner.

Table 2 reports the descriptive statistics of the risk-free rate, inflation rate and exchange rate.

Variable	Obs	Mean	Std. Dev.	Min	Max
Risk-Free Rate	2769	.000027	.0001	0	.0002
Inflation Rate	2643	1.9983	.4197	.04	2.64
Exchange Rate ($/€)	2666	1.3000	.1318	1.0375	1.601

Table 2 : Descriptive statistics of the macroeconomic determinants (2007-2017)
Source : Federal Reserve of Saint-Louis

The number of observations conforms with the period examined. Slight discrepancies are apparent due to missing observations from the databases. We assign missing values to such observations hence negligible deviations. We operationalize the risk-free rate using a proxy namely the rate associated to one-month treasury bills. The rate of return of One-Month T-bills is virtually equal to 0 with a maximum value approaching 0.02%. Such descriptive statistics highlight the modest rate of return an investor may expect from treasury bills for reasons that we have outlined in the hypothesis development.

The inflation rate is coherent with the long-term trends with a mean value *circa* 2%. The values converge with the objectives set by the Federal Reserve namely to enforce a disinflation policy which

aims at maintaining inflation at a rate close to 2%. The maximum value equal to 2.64% over the period January 2007 – December 2017 confirms the stability of the indicator over the 11 year period. The inflation time series data also reports few missing observations due to the lack of data. We have assigned missing values to such cells in the dataset. The US Dollar/Euro parity remains rather stable with an exchange rate corresponding to 1.3$ per Euro from January 2007 to December 2017. The weak standard deviation (.1318$/€) corroborates the slight variations of the two currencies between 2007 and 2017. The extremum values however suggest that the two currencies almost reached perfect parity at an exchange rate of $1.04 per Euro. In contrast, the maximum exchange rate is 54.3% higher than the minimum rate with a parity of $1.6 per Euro.

This group of variables forms the macroeconomic determinants that will be utilized further in this research to establish the link between macroeconomic variables and stock prices.

3.2.3. Model extension using microeconomic determinants

The three microeconomic variables that will be tested in the statistical analyses have been collected from Bloomberg Terminals which supply comprehensive financial data solutions, live stock market news and tools destined at financial analysis. As motivated in the hypothesis development, we have compiled three distinct metrics, the corporations' Price-to-Earnings ratio, Tobin's Q and the Board Size.

Readers can refer to the hypothesis development to get acquainted with the formulas employed to estimate the P/E valuation multiple and Tobin's Q. It is worth reminding that P/E ratios provide unreliable comparisons when contrasted across industries. Given that the scope of our research encompasses firms operating within the automotive industry, it is safe to ignore this warning when drawing comparisons within P/Es. On the contrary, Tobin's Q is comparable across industries which facilitates juxtapositions with other Q-values from dissimilar firms. Together, the P/E multiple and Tobin's Q are unitless and must be interpreted relative to their denominators.

The last microeconomic determinant that we consider relates to Corporate Governance. For purposes of analyzing whether corporate governance influences stock prices we will take a close look at the firms' board size for each automotive manufacturer.

Analogously to the two preceding subsection, we comment descriptive statistics reported in Table 3. We begin by the P/E ratio, then pursue with Tobin's Q and eventually Board size.

Variable	Obs	Mean	Std. Dev.	Min	Max
P/E					
Ford	2013	7.1279	1.7937	3.7584	14.9193
Honda	2641	13.1583	9.8794	5.7171	72.5368
Toyota	2453	15.0642	11.5880	5.0893	86.4581
Tesla	723	1735.513	11169.2	67.9203	135550
Tobin's Q					
Ford	2763	1.1527	.0909	1.0391	1.3871
Honda	2764	1.0588	.0899	.9338	1.3778
Toyota	2763	1.0920	.1562	.9905	7.0100
Tesla	1764	4.7229	1.8677	2.3132	8.3851
Board Size					
Ford	2769	14.7707	1.8185	11	18
Honda	2769	9.8350	1.5569	7	16
Toyota	2763	8.60112	1.1212	4	12
Tesla	1764	7.2205	.5385	6	9

Table 3 : Descriptive statistics of the microeconomic determinants (2007-2017)
Source : Bloomberg Terminals

Again, we notice slight discrepancies in the number of observations of the corporate measures. This is due to missing data that has not been communicated by the firms. We assign missing values to the observations lacking data. The main limit of this segment of the data is the low number of observations for Tesla's P/E ratio relative to the three incumbents firms present in the sample. The identical justification applies, namely that the late stock listing constrains the quantity of data publicly released by the company.

The most striking result with regards to the P/E ratio is the magnitude of the difference between Tesla's P/E and the three other manufacturers. Tesla's mean P/E ratio over the period 2010-2017 is respectively, 116 times, 133 times and 248 times greater than P/Es of Toyota, Honda and Ford. At first sight such an substantial figure could indicate that Tesla's stock price is either highly overvalued relative to Ford, Honda and Toyota or that investors express excessive high expectations for the company's future performance. Nonetheless, it would be an extrapolation to draw such conclusions without considering the business life cycle of the company. As we have previously stated, Tesla's IPO occurred on January 29th 2010 which is relatively recent compared to the date of the IPOs of the firms considered in the sample. Thus, Tesla has exited the « startup phase » of the business life and phased in the « Growth and Development » stage (Corporate Finance Institute). By supplying, attractive electric vehicles with a decent range of autonomy, Tesla disconcerted the incumbents such as Ford, Honda and

Toyota. As a result, the company has been put under the limelight and attracted continusous investments since its IPO. Therefore, it is important to bear in mind that the current business life cycle is prone to explain such a disproportionate P/E. Though, we may infer that the company's P/E will decrease in the long-run as its position in the market strengthens and its innovation capabilities diminish – if this proves to be the case. On the other hand, Ford, Honda and Toyota have reasonable P/Es ranging between 7 and 15. The latter indicates that Toyota's investors are, on average, willing to pay twice more for a dollar of the companies' earnings than Ford's investors.

The interpretation of Tobin's Q concurs with the foregoing explanation of Tesla's high P/E. To remind the reader, Tobin's Q indicates a stock overvaluation if its value exceeds one and conversely, undervaluation if Q is inferior to one. The summary statistics displayed in Table 3 point towards an overvaluation of Tesla's stock price with a mean Q equal to 4.7 meaning that the value of its stock price is nearly five times greater than the value of the firm's assets. In contrast, the three incumbents exhibit Qs in conformity with Tobin's hypothesis, that is close to 1. Respectively Q-values from Ford, Honda and Toyota, are equal to 1.15 ; 1.06 and 1.09 which according to James Tobin suggest that their stocks experience a negligible overvaluation.

Eventually we take a look at the number of board members within each corporation. Tesla has the fewest board members with on average 7 administrators sitting at the board. Ford has the largest board with on average twice the number of administrators as Tesla with 14 members and had a maximum of 18 officers in 2014.

IV/ IDENTIFICATION STRATEGY

Now that we are familiar with the dataset employed and the variables utilized, we use the Ordinary Least Squares method to construct regression models and answer the hypotheses introduced in the foregoing sections. We commence by testing the degree of exposure of stock prices to the four categories of risk outlined by Fama and Carhart. We formulate the regression as follows :

$$Stock\ Price = \alpha + \beta 1 \cdot mkt + \beta 2 \cdot smb + \beta 3 \cdot hml + \beta 4 \cdot umd + \epsilon \quad (1)$$

We pursue our analysis by testing the impact of the three macreconomic and microeconomic variables that we have selected. To that end, we construct two additional regressions :

$$Stock\ Price = \alpha + \beta 1 \cdot mkt + \beta 2 \cdot smb + \beta 3 \cdot hml + \beta 4 \cdot umd + \gamma 1 \cdot inflation + \gamma 2 \cdot interest + \gamma 3 \cdot exchange + \epsilon \quad (2)$$

$$Stock\ Price = \alpha + \beta 1 \cdot mkt + \beta 2 \cdot smb + \beta 3 \cdot hml + \beta 4 \cdot umd + \gamma 1 \cdot inflation + \gamma 2 \cdot interest + \gamma 3 \cdot exchange + \delta 1 \cdot \frac{P}{E} + \delta 2 \cdot Q + \delta 3 \cdot board + t \cdot D_t + \epsilon \quad (3)$$

With regards to the first regression we will focus the interpretation using the signs of the coefficients given that the magnitudes are not meaningful to interpret. The direction of the relationship between the risk factors of the Carhart Model and stock prices stipulates the tendency of the four manufacturers' stock price to respond to these four factors.

In adequacy with the hypotheses tested in the paper and their underlying motivations, we expect negative coefficients for regression (2). To remind the reader, periods where inflation reaches figures above average historic values, deplete consumers' purchasing power which tend to reduce the quantity of vehicles sold by the manufacturers. The reduction in revenues having a direct impact on manufacturers future streams of revenues, it stands to reason to infer that a weaker financial performance results in a diminution in the share price. Futhermore, interest rates may have an unfavourable effect on shares' value through changes in interest payments imposed by lenders on creditors which may increase the investors' uncertainty related to future streams of cash flows.

In contrast, in regression (3), we expect a positive coefficient for the P/E ratio, a negative coefficient associated with the board size, and an ambiguous relation with Tobin's Q. As stated in the hypothesis development, we expect the P/E to vary in tandem with stock prices. The motivation for a negative coefficient associated with the board size relates to potential inefficiency inherent to board composed of more members relative to smaller boards, where such inefficiencies may be more unlikely to arise. Last, we have motivated that the measure of Tobin's Q shall converge to 1 if a stock is correctly

priced. Thus its impact on stock price is ambiguous. We estimate this last regression to have the highest explanatory power, therefore we will use regression (3) to test the consequence of recall announcements on the corporations' share price. To conduct this inquiry we generate a dummy variable which takes value 1 on the dates where Ford published vehicle recalls in the United States. We have gathered 13 major recalls (involving more than 400,000 vechicles) using Ford press releases and articles from the Wall Street Journal. We expect the coefificient of the dummy variable to be negative which would indicate an adverse effect of the recalls on Ford's share price.

For the sake of this thesis, we have decided to focus on four prominent car manufacturers having market capitalisations in excess of 45 billion dollars however the sample is not exhaustive of all car manufacturers with market capitalisations exceeding 45 billion dollars. This research focuses exclusively on the automotive industry, hence we acknowledge potential divergences in the results if the research is repeated using a different sample or different stock exchanges than the NYSE and NASDAQ. Notwithstanding, the identification strategy that we have employed to test our hypotheses may be repeated to other companies to pursue the investigation.

We have commenced data collection by defining an appropriate timespan which would permit to examine variations in the value of stocks with more accuracy than past works. That is why we choose daily observations ending in December 2017 to provide new insights in accordance with our question. Historic data on firms' shares can be retrived from multiple sources, therefore we have not encountered difficulties to collect security prices. Therefore we have assembled a dataset comprising daily panel data over an 11-year time period that begins on January 3rd, 2007 until December 29th, 2017. A stretched period such as the one chosen in this paper creates more perspective and allows to test the accuracy of our models to explain historical stock price data. We have retrieved stock prices data from the Center for Research in Security Prices (CRSP) that we have accessed using Wharton Research Data Services portal (WRDS). The CRSP offers data on historic security prices that is frenquently utilized by scholars for academic research due to its high reliability and quality. Subsequently, we have retrieved macreconomic data for our independent variables (inflation, interest rates and exchange rates) from the Federal Reserve of Saint-Louis. Inflation rates are expressed in percentages, whereas interest rates are defined in absolute values ; Exchange rates are expressed in dollars per euros. Microeconomic data is

retrieved from Bloomberg Terminals which provides real time updates on firms' general information and financial performance.

V/ EMPIRICAL RESULTS AND ANALYSIS

5.1. Correlation tests

In order to obtain insights of the co-movements among the variables, we commence to perform correlation tests.

	Stock Price	MKT	SMB	HML	UMD
Stock Price	1				
MKT	.005	1			
SMB	.067	-.139	1		
HML	-.513	.039	-.245	1	
UMD	.189	-.275	.3519	-.2076	1

observation: 10,071

Table 4 : Correlation table including stock price, market excess return, small-minus-big average return, high-minus-low average return and the up-minus-down average return

	Stock Price	rf	inflation	exuseu
Stock Price	1			
rf	-.059	1		
inflation	-.119	.263	1	
exuseu	-.288	.221	.494	1

observation: 9,233

Table 5 : Correlation table including stock price, the risk-free rate, inflation and the USD/Euro exchange rate

Table 5 reports the correlation between stock price and the three corporate variables. In conformity with the expectations posited in the hypothesis development, we notice a small negative relationship between stock prices and the risk-free rate. In spite of the weak degree of correlation, this result tends to suggest that stock prices and interest rates move in the opposite direction. Likewise, the correlation tests in table 5 indicate a negative relationship between stock prices and inflation. This result corroborates the hypothesis of a negative relationship between stock prices and the inflation rate. Eventually, exchange rates appear to have a stronger negative correlation in comparison to the two previous macroeconomic variables that we scrutinize, with a value equal to -.29. The value points towards negative co-movements of the two variables. The outcome of the correlation is also in adequacy with our expectations as stated in the hypothesis development.

	Stock Price	P/E	Tobin's Q	Board Size
Stock Price	1			
P/E	.031	1		
Tobin's Q	.371	.181	1	
Board Size	-.613	-.053	-.320	1

observation: 7,822

Table 6 : Correlation table including stock price, the P/E ratio, Tobin's Q and Board size

Table 6 displays correlation tests between between the stock price of the four manufacturers inspected and three corporate metrics namely the P/E ratio, Tobin's Q and Board size. We notice a weak positive relationship between the P/E ratio and stock prices. The sign of the interrelation conforms with our expectations, that is, that co-movements of the P/E ratio and stock prices should point towards the same direction, nonetheless we are surprised by its low value. The P/E multiple is frequently used in regressions aiming at forecasting stock prices, therefore we expected a stronger correlation with stock price. Interestingly, Tobin's Q has a much more solid correlation with stock prices with a positive value equal to .371. This result supports a joint movement of stock prices and the metric of over/undervaluation of the stock price. Eventually, board size has a correlation much more pronounced than the degree we were expecting. The strong negative correlation with a value equal to -.61 supports our hypothesis which states that there exist opposite movements between board size and stock prices.

By means of the correlation tests performed, we have underlined the existence of co-movements between stock prices and our variables. Nonetheless, correlation provides a mere indication of co-movements, therefore we investigate in more detail, the explanatory power by running the four regressions developped in the identification strategy.

5.2. OLS Regressions

The outcome of the regression of the four factors on stock price yields the following results.

TABLE 7	OLS Estimates of the Effect of Macroeconomic and Microeconomic variables on Stock Prices Dependent variable: Log of Stock Prices 2007-2017			
	(1)	(2)	(3)	(4)
Constant	3.879***	6.656***	8.951***	3.766***
	.044	(.104)	(.079)	(.106)
Market Excess Return	-.232***	-.627***	.233***	.293***
	(.046)	(.045)	(.035)	(.024)
Small-Minus-Big Return	-.752***	-.876***	.598***	.238***
	(.021)	(.021)	(.029)	(.021)
High-Minus-Low Return	-.801***	-.887***	-.226***	-.032**
	(.015)	(.015)	(.015)	(.014)
Up-Minus-Down Return	.615***	.549***	.402***	.402***
	.026	(.021)	(.019)	(.012)
Inflation		.723***	.134***	.026*
		(.028)	(.019)	(.014)
Exchange Rate		-2.97***	-2.09***	-.264***
		(.075)	(.058)	(.044)
P/E ratio			0	.086***
			(0)	(.002)
Tobin's Q			-.228***	-1.132***
			(.008)	(.058)
Board Size			-.252***	-.030***
			(.002)	(.003)
Dummy Ford Recalls				-.026
				(.036)
No. Of Obs.	10,071	7,167	7,167	1842
Adj. R-squared	0.3047	0,4064	0.7162	0.6306

Notes to Table 7 : Standard Errors are in parentheses. Data include daily observations of Ford, Honda, Toyota and Tesla (2007-2017). « *** » indicates significance at the 1% confidence level. « ** » indicates statistical significance at the 5% confidence level. « * » indicates statistical significance at the 10% level. Regression (4) includes a dummy which takes value 1 on days when Ford announced an automobile recall of at least 400,000 vehicles between 2007 and 2017 and 0 otherwise. We have identified 13 major recalls between 2007 and 2017.

Table 7 reports the results from the four regressions that we have discussed in the identification strategy – with the ultimate adding a recall dummy variable – for the four automobile manufacturers between 2007 and 2017. In accordance with the expectations made, regression (1) indicates that the Fama/Carhart model provides some explanatory power for variations in share prices.

The findings support our first hypothesis : the coefficients on the factors defined by Fama and Carhart are significant to explain variations in stock prices. The interpretation of the magnitude of the coefficient is fruitless, nonetheless we are able to interpret the sign of the coefficients. Suprisingly, the market return in excess of the risk-free return appears to be negatively associated with stock price

variations. The latter conveys a tendency of stock prices, for our sample, to decrease as the average market return increases, holding the risk-free rate constant, or when the risk-free rate decreases, holding the market return constant. The Small-Minus-Big factor suggests that the size premium has an adverse impact on the stock price of the firms within our sample. In other words, an increase in the spread of the returns of the 30% smallest capitalisation stocks and the 30% highest capitalisation stocks (as defined by Fama and Carhart) implies a negative impact on the stock price of the four corporations. To remind the reader, Fama and Carhart calculate the SMB factor by computing the difference in average returns of the 30% smallest capitalisation stocks and the 30% highest capitalisation stocks. We notice that the stocks of the four manufacturers in our sample react significantly to the Fama/Carhart value premium. In other words, the difference in returns experienced by value stocks relative to growth stocks has a negative effect on stock prices. For example, an increase in the value premium between these two categories of stocks tends to decrease the price of the stocks in our sample. Eventually, the Up-Minus-Down factor which illustrates stocks momentum behavior affects positively stock prices. Therefore, the significant coefficient underpins Carhart's claim that stock prices experience momentum and tend to adopt an identical behavior to the one observed during the past 12 months. We notice that the R^2 is equal to 0.30. The latter conveys that the model is able to account for approximately 30% of the total variations in stock prices between January 2007 and December 2017 as measured by the R^2.

Regression 2 extends the Fama/Carhart and appends the effects of inflation and exchange rates to the model. We have omitted the risk-rate from the regression due to multicollinearity given that the interest rate is accounted for in the market excess return variable. After controlling for the factors specified in the Fama/Carhart model, we notice significant effects of inflation and the US/Euro exchange rates on stock price variations. Curiously, and in spite of the high significance of the effects, the magnitudes of the coefficients are substantial for the four automobile manufacturers. The amplitude of the effect seems unrealistic. Therefore, we will focus the analysis on the sign of the relationship between our independent variables and the dependent variable. Contrary to our expectations, regression (2) in Table 7 endorses a significant positive effect of inflation on the stock prices of the manufacturers in our sample. This result points out that raising inflation may increase stock prices for the manufacturers in our sample. However the apparent strong positive effect fades in the next regressions

where a positive relationship remains but the effect is substantially attenuated. Again, notwithstanding the high significant effect of exchange rates on stock prices, the direction of the relationship is opposed to our expectations. According the value displayed in regression (2), an increase in the US/Euro exchange rate, which implies a depreciation of the US dollar relative to the Euro – as one can own a greater quantity of US dollars for 1 euro – translates in a negative impact on stock prices.

Regression (3) appends Tobin's Q, the corporations P/E ratios and Board Size as additional independent variables to regression (2). When adding these variables the Market Excess Return and the Small-Minus-Big factors appear to have positive impacts on stock prices. The change of direction of the relationship may indicate one potential issue with our dataset : the existence of confounders, that is, a variable that correlates with our dependent variable and one of the independent variables. In order to investigate this issue, we analyze correlations between the independent variables in regression (3). The results of the correlation are found in Table 8 (Appendix). We notice high degrees of correlation with the SMB, HML and UMD factors and Tobin's Q (correlation values superior to .56), however the exclusion of Tobin's Q from the regressions fails to correct the change of direction of the relationships. Therefore we conclude that potential confounders omitted from the regression may affect the change of direction of the relationship. Thus, conversely to regression (1) and (2), regressions (3) and (4) indicate a positive effect of the market excess return, which is more realistic than the interpretation from the former two regressions. The positive coefficient points out that as the spread between the average return of all the securities on the market relative to return on the risk-free rate increases, stock price of the four firms in our sample increases correspondingly, while the positive relationship between stock prices and the Small-Minus-Big factor illustrates a positive effect of the Size premium. Hence, the tendency that small capitalisation stocks surpass the performance of high capitalisation stocks provides some explanatory power for movements in the share price of the firms scrutinized. Surprisingly, the effect of the P/E ratio to explain fluctuations in stock prices is null and insignificant, nonetheless regression (4) provides some different insights. Tobin's Q reveals to have a significant negative effect on stock values. However, as we have explained in the hypothesis development, an interpretation of the magnitude of the coefficient is meaningless as one would need the actual value of Tobin's Q per firm to interpret whether the actual value is approaching 1, or above 1. Once we have the reference Tobin's Q an

interpetation is meaningful, however, given that we combine four distinct firms with distinct Qs only the sign is fruitful to interpret. Eventually the model's ultimate variable singles out a significant and negative effect of Board size on stock price supporting our hypothesis that inefficiencies may arise with boards composed of more rather than fewer members. Nonetheless it is not the scope of this paper to investigate the source of this relationship.

Regression (4) adds the vehicle recall dummy for the 13 major campaigns identified for Ford Motor, between 2007 and 2017. As a consequence, an inferior number of observation underpins the results. Nonetheless, the regression suggests that on the day of the recall announcements stock prices tend to decrease as a result of the announcements. Nonetheless the coefficient is not significant, therefore we reject the hypothesis that stock prices have a significant negative effect in stock prices at the 10% confidence level. Despite the unexpected outcome, several motivations may support this observation. Recently, vehicle recalls tend to be preventive which may not be viewed by stock markets as intrinsic adverse events. In this vein, the willingness of cooperation and the compliance of the manufacturer with governmental agencies or non-governmental organisations may communicate a non-negative information to investors leaving stock prices movements independent of such decision. Overall we notice that regression (4) provides the highest explanatory power as measured by the R^2 equal to 0.63 which tells us that our model explains approximately two thirds of stock prices variations for the four automobile manufacturers, therefore there must exist additional factors explaining variations of stock prices. With regards to the previous independant variables, we notice a much more mitigated effect in terms of the amplitude of the coefficients holding other variables constant, nonetheless, the major part of the independent variables significantly explain stock price movements at the 10% confidence level.

VI/ DISCUSSION & CONCLUSION

We have attempted to provide new insights on the share prices' potential determinants for four manufacturers operating within the automotive industry. Our central contribution resides in the joint investigation, using Ordinary-Least-Squares regressions, of the effect of three macroeconomic, three microeconomic variables and 13 major vehicle recall announcements using daily panel data spanning from January 2007 to December 2017. This contribution bridges the gap in the existing literature by offering a broader picture of stock price determination, and the intricacy of its dynamics.

Using the renowned Fama/Carhart Four-Factor Model as our baseline specification, we have challenged its predictions and highlighted that the four risk factors : the market premium, the size premium, the value premium and the momentum factor significantly explain the stock price of the firms forming our sample which leads us to accept our first hypothesis. Building on the model, we have accepted, based on the correlation tests that interest rates, inflation and exchange rates are together negatively correlated with stock prices, thus we do not reject hypotheses 2, 3 and 4. Nonetheless, our regression analysis has pointed some unexpected results as inflation tends to impact favourably stock prices and we have found that a depreciation of the US dollar relative to the Euro is detrimental to the stock price of the four manufacturers. Likewise, we cannot reject hypotheses 5, 6 and 7 which highlight respectively a positive correlation of the P/E ratio, the significance of Tobin's Q to explain stock price and a negative correlation of stock price and board size. For this group of variables, the outcome of the regression supports our expectations namely, the P/E ratio impacts positively stock price, Tobin's Q is deemed a significant factor to explain movements in stock price, and board size tends to decrease stock price. Last, the regression analysis vouches for a negative, although not significant effect, of vehicle recall announcements on the stock price which contrast with our expectations.

In addition to the findings that this paper underlines, we have to be aware of extant limitations with regards to the identification strategy followed. Foremost, we acknowledge a weak external validity as we have fundamentally scrutinized the internal validity of the variables selected. Furthermore, we have chosen a subset of prominent automotive manufacturers listed on American stock exchanges, thus our analysis does not account for the full-fledged automotive industry. Accordingly, the identification strategy employed may entail diverging conclusions if a different industry is analyzed or if a sample of

firms from stock exchanges other than the NYSE and NASDAQ are considered. Our paper contributes to provide further evidence on the rising interrelation of numerous variables acting as potential origins of movements in share values. This observation sheds some light on the intricacy of share price determination and the role played by each variable. The variables scrutinized in this paper do not form an exhaustive list of each source of asset prices fluctuations but rather provides the reader with a panel of factors which endorses fluctuations. As a result, one could hone the identification strategy in further inquiries by investigating additional factors or define macroeconomic and microeconomic variables using substitutes for variables that we have chosen. Another suggestion would be a comprehensive event study intended at exploring the effects of the recall announcements with more accuracy.

On a final note, the research presented in this paper has endavoured to contribute to drawing a broader picture of stock price determination by inspecting an array of variables with discrete attributes (macroeconomic variables, corporate variables, vehicle recall announcements) and underpins the complexity of share price determination on global financial markets. Notwithstanding, some limitations outlined in the foregoing paragraphs, we hope that this research will provide insightful pieces of information for actors in the automotive industry, shareholders and prospective investors.

Appendix

TABLE 8	Correlation Table								
	MKT	SMB	HML	UMD	Inflation	Exchange Rate	P/E	Tobin's Q	Board Size
MKT	1								
SMB	0.03	1							
HML	0.20	-0.31	1						
UMD	-0.33	0.51	-0.28	1					
Inflation	-0.10	0.20	0.16	0.16	1				
Exchange Rate	-0.21	-0.01	-0.09	0.20	0.56	1			
P/E	0.09	0.09	-0.09	0.01	0.01	-0.01	1		
Tobin's Q	0.03	**0.69**	**-0.64**	**0.56**	0.12	0.06	0.17	1	
Board	0.27	0.10	0.51	-0.12	-0.11	-0.29	-0.05	-0.31	1
No. Of Obs.	7,167								

Table 8 : Correlation of the independent variables of regression (3) and (4) between January 2007 and December 2017

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