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Abstract
Energy consumption in the transport sector is expected to increase substantially over the coming decades. The uncertainty in the forecasts are relatively high regarding the size of the increase but reports from the US Energy Information Administration (EIA) points to an increase of 56 percent between 2010 and 2040 (IEO2013, 2013, p. 9). World Energy Council forecasts an increase between 30 and 85 percent, depending on the impact of various factors such as market regulation, population growth, urbanization, and the availability of fossil energy (Global Transportation Scenarios 2050 (TSG 2050), 2011, p. 4-5).

Some of this energy could come from advanced renewable fuels such as advanced renewable biodiesel. The commercialization of advanced renewable biofuels has however been slow even though the technology has long been considered mature for large scale production. External market factors that are frequently blamed for the lack of commercialization are lack of political support, low crude oil prices, high raw material prices, and notable profitability for producers of first generation biofuels. Previous studies further suggest that advanced biofuels are expensive to produce (Demirbas, 2010; Milbrandt et al., 2013) and that the companies operating in the industry hold high financial risks (Miller et al., 2013).

This study examines the systemic financial risks as well as the estimated returns that the market places on companies active in the emerging advanced biodiesel industry. The results from the study indicate, contrary to previous studies and current external market factors that the systematic risks are not considerable higher for the advanced biodiesel industry than the market average or the established biofuel industry. This is despite the fact that oil prices have been low, raw materials prices high and that the uncertainty surrounding the political forms of support for the industry during the studied period have increased. This should have resulted in increasing rather than decreasing financial risk in relation to the previous studies of the advanced biofuel sector.

Important factors that contribute to the results obtained in this study are circumstances that previous studies have completely disregarded, factors that may be beneficial for the studied companies. The studied firms are showing noteworthy profitability, access to substantial working capital, relatively low ratios between stock prices and cash flows. Furthermore, the analyzed companies have a business structure that other studies so far have completely ignored, e.g. they are structured as "biorefineries". This means the studied firms, similarly to conventional petroleum refineries, are producing and trading various products produced from the same raw material. The difference being that the analyzed firms use renewable raw materials rather than crude oil to produce the commodities. The firms thus possess an "option-based" diversification strategy which may be perceived by the market as a future real option. In contrast to focused firms these firms may simply change their business focus based on changes in prevailing external market factors or decreasing profitability in any part of the company.

In accordance with the theories of the effective market hypothesis theory and random walk the market has access to all this available knowledge regarding these firms’ specific factors, pricing the risks on this knowledge these as well as prevailing external market factors. The results of the study suggest that the firm-specific factors in the studied companies may be more important than some of the considered external market factors in the pricing of financial systemic risks.
Sammanfattning

Energiavanvändningen i transportsektorn beräknas öka kraftigt de kommande decennierna. Osäkerheten i prognoserna är relativt höga om hur stor denna ökning kommer att bli men rapporter ifrån U.S. Energy Information Administration (EIA) pekar på en ökning på 56 procent mellan 2010 och 2040 (IEO2013, 2013, p. 9). World Energy Councils prognos pekar på en ökning mellan 30 och 85 procent beroende på genomslaget av olika faktorer såsom marknadsregleringar, befolkningsökning, urbanisering, samt tillgången på fossil energi (Global Transportation Scenarios 2050 (GTS 2050), 2011, p. 4-5).

En del av denna energianvändning bör kunna komma ifrån avancerade förnyelsebara bränslen såsom ”grön diesel”. Kommersialiseringen av avancerade förnyelsebara biobränslen har dock varit långsam trots att tekniken länge ansetts vara mogen för storskalig produktion. Externa marknadsfaktorer som vanligtvis ges skulden är bristen på politiskt stöd, låga oljepriser, höga råmaterialpriser, samt en god lönsamhet för producenter av första generationens biobränslen. Tidigare studier tyder dessutom på att avancerade biobränslen är dyra att tillverka i förhållande till den avancerade biodieselindustrin. Resultaten ifrån studien pekar tvärt emot tidigare studier och rådande externa marknadsfaktorer att marknaden inte prissätter risken högre för den avancerade biodieselindustrin än marknaden i genomsnitt eller den etablerade biobränsle industri. Detta trots att oljepriset varit lågt, råmaterialpriset varit högt samt att osäkerheten kring de politiska stödförmed som finns för industrin under den studerade tidsperioden ökat. Vilka faktiska borde ha resulterat i ökande snarare än minskande finansiella risker i förhållande till tidigare studerade tidsperioder.

Viktiga faktorer som bidrar till de uppnådda resultaten är omständigheter som tidigare studier helt har bortsett ifrån men som faktiskt varit fördelaktiga i de undersökt bolagen. Företagen uppvisar god lönsamhet, god tillgång på rörelsekapital, relativt låga förhållanden mellan aktiepris och kassaflöden. Dessutom har de analyserade företagen en annorlunda affärsidé som andra studier helt bortser ifrån; de är strukturerade som ”bioraffinaderier”. Det innebär att de i likhet med konventionella oljeraffinaderier producerar och säljer flera olika produkter som produceras ifrån samma råvara. Med skillnaden att de analyserade företagen använder en förnyelsebar råvara istället för råolja för att producera specialkemikalier, biobränslen och diverse biomaterial. Detta gör att de besitter en s.k ”option-based” diversifieringsstrategi som uppfattas av marknaden som en framtida konkurrensfördel. Tillskillnad från specialiserade företag så kan de undersökt företagen snabbt och enkelt byta verksamhetsfokus beroende på förändringar i rådande externa marknadsfaktorer eller minskande lönsamhet i någon del av företaget.

Enligt teorierna om den effektiva marknadshypotesen och ”Random Walk” så besitter marknaden all denna tillgängliga kunskap om de interna bolagsfaktorerna och prissätter risken i bolaget utifrån dem snarare än de externa marknadsfaktorerna. Resultatet av studien tyder således på att de bolaggsspecifika faktorerna i de studerade bolagen eventuellt kan vara av betydande vikt för prissättningen av bolagens finansiella systematiska risker.
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<tr>
<td>ADM</td>
<td>Archer-Daniel Midland Company</td>
</tr>
<tr>
<td>BE</td>
<td>Book-to-Market Equity ratio</td>
</tr>
<tr>
<td>Bio-SG</td>
<td>Bio-Synthetic Gas</td>
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<tr>
<td>BtL</td>
<td>Biomass-to-Liquid</td>
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<tr>
<td>CAPM</td>
<td>Capital Asset Pricing Model</td>
</tr>
<tr>
<td>EBITDA</td>
<td>Earnings before Interest, Taxes, Depreciation, and Amortization</td>
</tr>
<tr>
<td>EMH</td>
<td>Effective Market Hypothesis Theory</td>
</tr>
<tr>
<td>EISA</td>
<td>Energy Independence and Security Act</td>
</tr>
<tr>
<td>EPA</td>
<td>Environmental Protection Agency</td>
</tr>
<tr>
<td>EPAact</td>
<td>Energy Policy Act</td>
</tr>
<tr>
<td>DCF</td>
<td>Discounted Cash Flow</td>
</tr>
<tr>
<td>E10</td>
<td>Gasoline with 10 percent ethanol blend</td>
</tr>
<tr>
<td>E85</td>
<td>Ethanol fuel with 15 percent gasoline blend</td>
</tr>
<tr>
<td>ED95</td>
<td>Diesel substitute of 95 percent ethanol</td>
</tr>
<tr>
<td>EIA</td>
<td>Energy Information Agency</td>
</tr>
<tr>
<td>E/P</td>
<td>Earnings-to-Price ratio</td>
</tr>
<tr>
<td>GHG</td>
<td>Green House Gas</td>
</tr>
<tr>
<td>GTS2050</td>
<td>Global Transportation Scenarios 2050</td>
</tr>
<tr>
<td>HML</td>
<td>High minus Low</td>
</tr>
<tr>
<td>HVO</td>
<td>Hydrotreated Vegetable Oil</td>
</tr>
<tr>
<td>IEA</td>
<td>International Energy Agency</td>
</tr>
<tr>
<td>ME</td>
<td>Market Equity</td>
</tr>
<tr>
<td>MUSD</td>
<td>Million United States dollar</td>
</tr>
<tr>
<td>NREL</td>
<td>National Renewable Energy Laboratory</td>
</tr>
<tr>
<td>OECD</td>
<td>Organization for Economic Cooperation and Development</td>
</tr>
<tr>
<td>P/CF</td>
<td>Price-to-Cash Flow ratio</td>
</tr>
<tr>
<td>R&amp;D</td>
<td>Research and Development</td>
</tr>
<tr>
<td>RFS2</td>
<td>Renewable Fuel Standard II</td>
</tr>
<tr>
<td>SMB</td>
<td>Small minus Big</td>
</tr>
<tr>
<td>S&amp;P 500</td>
<td>Standard and Poor’s 500 Index</td>
</tr>
<tr>
<td>TFM</td>
<td>Fama-French Three Factor Model</td>
</tr>
<tr>
<td>USD</td>
<td>United States dollar</td>
</tr>
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1. Introduction

'The Stone Age did not end for lack of stone, and the oil age will end long before the world runs out of oil.' - Sheik Ahmed Zaki Yamani.

1.1 A Brief History of Biofuels

The use of liquid biofuels within the transportation sector is not an entirely novel idea as it dates back to the very first combustion engines ever built. The first prototypes of internal combustion engines that were constructed in the 1820s by Samuel Morey were operated on a mix of turpentine and ethanol (Soni, 2007, p. 277). The commercial success of Morey’s new engines were however limited due to lack of funding and Morey’s greater interest in steam engines. The next historically significant application of liquid biofuels in engines did not come about until fifty years after the first use of liquid biofuels when inventor Nicholas Otto employed ethanol to power some of his four-stroke-piston-chamber engines, early prototypes of modern day spark-ignition engines (Soni, 2007, p. 277). Ethanol did enjoy some initial commercial success with the early Ford Model T’s build by Henry Ford I in 1908 (DiPardo, 2000, p. 2). The engines in these early T-Fords were constructed to run exclusively on ethanol, gasoline or a mixture of the two fuels. The potential of ethanol as a transportation fuel was however limited to the early history of transportation fuels as it was soon displaced by gasoline because gasoline was far cheaper and yielded superior performance in the early spark-ignition engines.

Diesel engines were developed in the 1890s by the German inventor and mechanical engineer Rudolph Diesel, who in 1893 published a paper describing the design and function of a new type of high pressure heat engine (Demirbas, 2008, p. 112-113). The advantage of the novel heat engine was the radically different principle of operation that allowed a far greater fuel flexibility than the spark-ignition engines built by Otto. Early experiments and demonstrations were made with vegetable oils, the most famous demonstration was a diesel engine running on peanut oil at the Paris World’s Fair in 1900 (Demirbas, 2008, p. 74). These experiments were performed on the request and funding by the French government that was tempted by the idea of using locally sourced vegetable oils to power diesel engines in remote colonies where no petroleum was available (Shrinivasa, 2012, p. 370-371). Eventually, the developers of the diesel engines settled for the more readily available mineral oils, residual byproducts from refining of crude oil for gasoline production. These residual mineral oils would later simply be known as “diesel fuel”.

Liquid biofuels have since the first and second oil crises gained augmented importance and significant attention has been directed towards the liquid biofuels sector. Responsiveness has mainly been through technical research and development as well as governmental mandates and programs directed towards further promoting the commercialization of biofuels (Schubert, 2006, p. 777). Commercialization has however been slow within the biofuels sector and much of the liability has been placed on the financial risks associated with the biofuels industries (Miller et al., 2013).
1.2 Problem Background
The International Energy Outlook 2013 (IEO2013) published by U.S. Energy Information Administration (EIA) projects that the total worldwide energy consumption will increase by 56 percent between 2010 and 2040 (IEO2013, 2013, p. 9). The transportation sector is projected to increase its energy consumption with around 38 percent during the same period (IEO2013, 2013, p. 141-142). A similar projection is made by the World Energy Council that projects an overall increase in demand for transportation fuels by 2050 by 30 percent if free market forces are allowed to prevail or as high as 82 percent if governments attempt to regulate markets (Global Transportation Scenarios 2050 (GTS 2050), 2011, p. 4-5). The increase is mainly projected to take place outside of the Organization for Economic Cooperation and Development (OECD) or the non-OECD countries (IEO2013, 2013, p. 141; GTS 2050, 2011, p. 12). Expansive economic growth, population growth, urbanization and the creation of mega-cities in the non-OECD countries are anticipated as driving forces behind the strong increase in energy demand in these developing countries (GTS 2050, 2011, p. 12-15).

Projecting the future supply of fossil crude oil is currently extremely difficult. In spite of the peak-oil theories of the past decade, it seems that the energy resources of the world are significant. The crude oil deposits have however become increasingly difficult and expensive to access, extract, convert and distribute in a cost-effective, secure, and environmentally friendly manner. The increasing demand for world energy is pushing the attention towards far more unconventional and riskier sources such as the tar sands in Canada and Venezuela, the deep waters of Brazil and the shale oil deposits in the US (GTS 2050, 2011, p. 18-19). The combination of the new and unconventional sources of crude oil together with the rapidly aging and diminishing oil fields make the Brent crude oil price very difficult to project. The reference case presented by EIA projects an increase of the Brent crude oil price from 81 USD per barrel in 2010, to 117 USD per barrel in 2025 and 163 USD per barrel in 2040 (IEO2013, 2013, p. 25). Prices could however be as low as 75 USD per barrel or as high as 206 USD per barrel in 2040, depending on factors such as the rate of economic growth in the non-OECD countries, geopolitical instability, technological development and discoveries or lack discoveries of new unconventional oil fields.

The strong increase in world energy consumption is also expected to impact the energy-related carbon dioxide emissions that are expected to rise from 31.2 billion metric tons in 2010 to 36.4 billion metric tons in 2020 and 45.5 billion metric tons in 2040 in the IEO2013 Reference case (IEO2013, 2013, p. 7). The increase in carbon dioxide emissions corresponds to an increase of 46 percent over a period of 30 years. As with crude oil prices, the projections contain significant uncertainties as the supply and demand and utilization of fossil energy may be lower or higher than the references case presented by EIA.

Although the uncertainties are significant in terms of projected demands for transportation fuels, fuel prices, crude oil supplies as well as carbon dioxide emissions, the reference case presented by EIA offers an insight into the challenges that the world is facing in terms of energy demand, including in the transportation sector. With an expected increased demand for transportation fuels that may be as high as 82 percent until 2050 the potential to at least partly replace the fossil fuels with renewable and sustainable transportation fuels such as bioethanol and biodiesel is an intriguing opportunity. The high energy and transportation fuels prices in the last decade have
sparked a renewed interest in alternative liquid biofuels (Cherubini, 2010, p. 1412-1413; FitzPatrick, 2010, p. 8915-8916). Conventional biofuels produced from corn, grain, sugar cane, soybean, sunflowers, and rapeseeds will be able to offset some of the increasing demands for transportation fuels but they are nearing their maximum potential (Schubert, 2006, p.779). The potential is however far greater for advanced biofuels produced from non-food lignocellulose feedstock such as wood, grasses, agricultural and forestry residues as these raw materials are expected to be far cheaper in the future than crude oil per energy unit contained in the raw material (Cavka, 2013, p. 4).

1.3 Problem Discussion
The total share of biofuels in the worldwide transport sector was in 2010 less than 2 percent of the total fuel consumption (GTS2050, 2011, p. 22). Significant regional differences in the use of biofuels do however exist. The share of biofuels in the transportation sector was in 2010, 21 percent in Brazil, four percent in the US and three percent in the EU, mainly bioethanol and biodiesel (Eisentraut et al., 2011, p. 11). In 2011, the International Energy Agency (IEA) projected in their Technology Roadmap that the consumption of biofuels could potentially increase from 2 percent in 2010 and account for 27% of total transport fuel consumption in 2050 (Eisentraut et al., 2011, p. 5). The biofuels industry is currently on the rise as is evident by the strong increase of liquid biofuel production in the first decade of the new millennia which saw an increased biofuels production from 16 billion liters in the year 2000 to 100 billion liters in 2010 (Eisentraut et al., 2011, p. 11). The advanced biofuels industries that produce biofuels from non-food raw materials, have so far had difficulties attracting enough capital to achieve significant world-wide large scale commercialization (Miller et al., 2013). This is despite the fact that the technology for production of these advanced alternative low-carbon biofuels, such as second generation bioethanol and advanced biodiesel are considered to be mature and ready for commercialization (Miller et al., 2013, p.2).

The IEA conclude in their report from 2011 that biofuel production is not considered to be competitive with fossil transportation fuels at contemporary market prices in 2010, i.e. 100 USD per barrel (Eisentraut et al., 2011, p. 39). The competitiveness was however strongly depending on the raw material that is used for production of the biofuels and the crude oil price at the time. Brazilian sugarcane ethanol and some other low-cost conventional biofuels are considered to be the exceptions in terms of lacking competitiveness with fossil transportation fuels. Demirbas (2010) performed an extensive review of economic feasibility studies performed on biodiesel production and concluded in the review of 12 studies that the projected production costs for biodiesel from oilseed or animal fats in the reviewed studies exceed the cost of fossil diesel fuels, thus rendering biodiesel production from these raw materials economically unfeasible (Demirbas, 2010, p. 1502). The key factor that renders biodiesel production economically unfeasible is the feedstock, which accounts for approximately 80% of the total operating cost (Demirbas, 2010, p. 1503).

An extensive technical report published by the National Renewable Energy Laboratory (NREL) in 2013 covered the investigation of the feasibility to produce advanced biodiesel and jet fuels in the United States from renewable raw materials (Milbrandt et al., 2013.) The study concluded in agreement with previous studies that the cost of producing advanced biodiesel with the technologies that are covered in this thesis were
higher than the market price of the end products. Production costs were strongly related to the technology and raw material used for production but the costs could be anywhere between 5-20.5 USD per gallon (Milbrandt et al., 2013, p 7-10). Average sale price of biodiesel in the US during the studied period was around 4.3 USD per gallon (Hofstrand 2014).

Much emphasis has also been placed on the economic feasibility evaluation of advanced cellulosic ethanol production from various raw materials. These studies either include the use of small scale laboratory experiments from which the results are used to model large scale production and subsequently perform discounted cash flow (DCF) analysis to evaluate the economic feasibility of the ethanol production (Aden and Foust, 2009, p. 537) or the use of present net value and real option analysis to model commercial size bioethanol plants (Schmit et al., 2009). Few studies have so far been focused on actual large scale commercial production units when the financial analysis is performed.

Miller et al., (2013) did as one of few studies perform financial analysis on publically traded biofuels companies. The study analyzed a selected number of second-generation biofuel companies, mainly second-generation bioethanol companies through the use of financial beta-analysis and arrived at the conclusion that these companies pose a significant risk for investors. It was thus concluded that the entire biofuels sector has difficulties to generating adequate returns in order to attract direct investment under current policy and market conditions. This is because the biofuels sectors is considered to be too risky to merit investment (Miller et al., 2013, p. 31). The suggested solution to overcoming this lack of investor confidence is further revision of existing incentives and implementation of further support from governments to drive investment more effectively. The study by Miller et al., (2013) does however not provide a comprehensive and conclusive analysis of the risks and opportunities that are present in the analyzed biofuels firms. Firstly, the analysis is performed solely on second-generation bioethanol companies and does not include any other publically traded advanced biofuel companies. Secondly, the financial beta analysis that was used is one potential tool that may provide some insight into the perceived risks of publically traded companies but it does not provide a comprehensive and conclusive analysis of the firm level risks and potential future performances of the companies. Thirdly, some of the selected and analyzed companies have yet in the autumn of 2014 to start real large scale production and sales of their commercial biofuels, i.e. to start generating actual revenues from their biofuels operations.

Extensive governmental support programs for the biofuels industries as suggested by Miller et al., (2013) do exist today in the US and EU through the Department of Energy’s Biomass Program, the Department of Agriculture’s program for second-generation biofuels, the European Union’s Seventh Framework Program, and the European Industrial Bioenergy Initiative (Miller et al., 2013, p. 30; Eisentraut et al., 2011, p. 39-41). These programs are implemented and aimed at providing financial support for commercialization of large scale biofuel production plants. The grants and loans provided by the programs have been implemented to provide guarantees, reduce investment risks and to promote direct investments into the biofuels industries to further promote commercialization within the biofuels industries. Creating and providing stable, long-term frameworks and programs to create incentives through political measures for biofuel deployment is important but have proven insufficient to promote further investment and commercialization within the emerging biofuel industries if
these industries are considered risky or economically unfeasible (Miller et al., 2013, p. 31). In order to achieve and maintain investor confidence in the long term and drive the future expansion of biofuel production it is thus important that the biofuels sector can generate healthy returns and stable finances.

In order to appropriately scrutinize and comprehend the financial risks and returns within commercial biofuels industries it is important to analyze the sector as a whole, including producers of both advanced biodiesel as well as advanced bioethanol companies. Particularly as the former have had a strong development in recent years with several companies that produce and trade the advanced biodiesel fuels being listed on the NASDAQ and New York stock exchange. Many of the companies that produce advanced biofuels are also involved in other related businesses such as providing technology for the biofuel sector, producing high performance industrial oils and lubricants, ingredients and oils for health foods and hygiene industries. These companies were not included in previous analysis of the biofuel sector. The possibility to diversify risk by producing several different products should also be considered when valuating and assessing financial risk in the biofuel sector as this may help tip the confidence in the favor of the advanced biofuels industries. Product diversification may be of particular importance if biofuels themselves are deemed unprofitable at current market prices as previously discussed in this section.

Furthermore, the analysis of the publically traded advanced biofuel companies must also include many other tools available for financial analysis of firm valuation and assessment of firm level risks. These tools may be used to determine if the analyzed firms are worth investing in and if they actually pose a significantly higher risk than companies in other fields of business. Possible tools that may be used besides beta analysis is multiple analysis and factor models such as the Capital Asset Pricing Model (CAPM) and the Fama-French Three Factor model. These factor models may be valuable tools in terms of assessing systematic risks and required or estimated returns, offering a profound analysis of the studied firms. Multiple analysis such as the “price-to-cash flow ratio” is a type of relative valuation tool that quantitatively compares a company’s financial statements to either previous years, other companies, the industry, or even the economy in general (Berk and DeMarzo, 2007, p. 269-270). Multiple analysis may thus be a useful compliment to the understanding of relative valuations and risks in relation to similar companies or industries.

1.4 Potential Theoretical and Practical Contribution

The theoretical contribution of this study is mainly to contribute to the existing body of knowledge in the field of financial analysis of biofuel industries. In general, the research on the financial aspects of the emerging advanced biofuel industry is mainly focused on modeling of commercial production plants and their potential financial performance, such as Aden and Foust (2009) and Schmit et al., (2009). These studies are limited in their contribution of the valuations, risks and financial performance of already established and commercial advanced biofuel producers. There are a few studies, such as Miller et al., (2013), that do analyze some of the existing biofuel firms listed on the NASDAQ and New York stock exchange. These studies do however not include firms that may be strongly diversified in their product portfolio as many of the recently publically listed firms are. The companies that are analyzed in this thesis are all listed on the NASDAQ and New York stock exchange but they do also have a diversified product portfolio, in contrast to previous studies. As previously discussed in the
problem discussion section, many studies of financial feasibility of biofuel production deem these projects unprofitable at current market conditions. This study will contribute to the understanding of product diversified biofuel firms that similarly to producers of fossil gasoline and diesel produce a wide range of products other than fuels that may yield revenues. No such study has so far been performed to our knowledge.

The applied contribution of this work may provide a practical approach for investors and policy makers of how to comprehensively assess the valuations and firm level risks within advanced biofuels market. The results will thus show whether or not the emerging industry does merit further investment or not at current market conditions. If the results show that diversification of the product portfolios indeed does result in lower risk and higher valuations of the analyzed firms it may also provide an incentive and encouragement to those performing research and development within the advanced biofuels industries. Furthermore, the work may also result in restoring some of the lost confidence that the failure of many early biofuels projects has left behind.

1.4 Purpose

The emerging advanced biodiesel industry is an important part of the transition from a fossil based transportation sector to one based on renewable biofuels. The purpose of this thesis is to perform a comprehensive investigation of the financial systematic risks and to estimate the required returns of publically traded biodiesel firms that produce and trade advanced biofuels. The objective is to investigate if the perceived investment risks within the advanced biodiesel firms are significantly different from the general market and the established conventional biofuel sector. The intention is thus to provide an understanding of the investment risks within this emerging sector and to obtain knowledge about the confidence that the market has in the firms and industry as whole. The investigation should thus answer the question if the advanced biodiesel firms are able to attain investor’s confidence and to promote further investment into the emerging biofuels industries in order to stimulate further commercialization of the advanced biofuels sector or not.

1.5 Problem Formulation and Research Question

The success of any type of emerging business depends significantly on their ability to secure necessary financing and to attain and maintain the investors’ confidence (Miller et al., 2013, p. 14). The existing body of knowledge suggests that the conventional biofuel sector is returning considerable returns on investment while the advanced biofuel sector on the contrary is considered to be too risky to even merit investment (Miller et al., 2013, p. 31, Hofstrand, 2014). This is mainly because of the higher production costs that are linked to the production of advanced biofuels (Demirbas, 2010; Milbrandt, 2013). As most previous financial studies of the advanced biofuels industry mainly focused on the advanced bioethanol sector there is little knowledge regarding the financial risks and returns in the advanced renewable biodiesel sector. The research questions is thus formulated to fill this existing knowledge gap and to realize the purpose previously discussed:

- What are the systematic risks and required returns on investment in publically traded advanced biodiesel companies with diversified product portfolios in relation to the general market and conventional biofuel companies?
1.6 Delimitations
The focus of this study is the advanced biofuels industry, the study will be limited to only include firms that are involved in renewable biodiesel production as most previous studies have omitted these in favor of advanced bioethanol. The study will focus on firms listed on the NASDAQ and New York stock exchange as most of the firm’s active within this field are listed there. This study will be limited to focus on companies that are in the early stages of commercial advanced biofuel production while having a diversified product portfolio to go along with the biofuel business.
2. Theoretical Methodology

2.1 Scientific Reasoning

Science, in its very precise definition is considered to be a cultural and social institution consisting of philosophical and academic achievement shaped by the groundwork of both individual reasoning and collaborative cognition (Feist, 2006, p. 7). Or in more general terms; “a body of knowledge and the activities that gave rise to that knowledge” (Zimmerman, 2005, p. 6). Scientific thinking or scientific reasoning is the knowledge seeking process that is the very groundwork of science, scientific research, knowledge development and intellectual thinking (Kuhn, 2004, p. 372). It is performed by any thinking human being and is not limited to only a selected few absorbed in scientific research. Scientific reasoning is considered to be “the practice of thinking with and about scientific knowledge” (Hogan and Fisherkeller, 2005, p. 95). It is thus considered to include both the scholarly and intellectual processing skills necessary for creating, testing and revising hypotheses or theories as well as the perceived reality around us. As well as including the process of reflecting on the advancement of knowledge that arises from utilization of already developed skills and methods of scientific reasoning (Morris et al., 2012, p. 61). Knowledge development and scientific reasoning includes both the discoveries and formulation of principles of basic scientific research such as the discovery of natural regularities, elementary scientific laws, or generalities but also the justification or verification of such formulated hypotheses. Meaning that there is a strong interest in employing both the inductive and deductive processes used in the formulation and testing of created hypotheses (Zimmerman, 2005, p. 6).

Scientific research based on the principles of scientific reasoning or thinking thus involves several different aspects of both theoretical and practical methods. These include among them theoretical and practical activities such as formulating research questions, hypothesizing, designing studies, choosing methods, evaluating evidence, reacting to contradictions or anomalous data, presenting and assessing arguments, etcetera (Zimmerman, 2005, p. 6). The foundation of scientific reasoning is thus the process of structuring theories as well as empirical evidence, and not only focusing on one aspect of scientific research but rather altering between and contemplating on both (Zeineddin and Abd-El-Khalick, 2010, p. 1065). In order to better reflect the decision of the authors on what aspects of the scientific reasoning to apply to this thesis it is important to present a short discourse on the available possibilities and methods that could be used.

2.2 Which research approach should be used?

Conducting scientific reasoning and thus attempting to perform a scientific research process will at some stage require the engagement of theoretical perspectives (Grey, 2013, p. 16). The enquiry of which theoretical perspectives to employ becomes thus the central question within the research process. Dewey (1933) outlined some 80 years ago in “How we think” a general standard about the logics behind scientific research approaches with the use of systematic inference. An enquiry that promoted a logical and systematic approach to scientific research. The approaches outlined and described by Dewey consisted of inductive discovery more known as induction and deductive proof also known as deduction (Dewey, 1933, p. 81). Induction starts from fragmentary facts or details and moves towards a connected or universal discovery of a binding principle or theory. Deduction on the contrary begins with the formulation of a hypothesis based
on pre-existing theories and works its way back towards facts and details thus testing, challenging, verifying, or if necessary modifying the basis of the binding principle or theory from which the hypothesis was derived (Dewey, 1933, p. 82). The choice of the scientific approach does however depend upon the nature of knowledge and how the researcher perceives knowledge, i.e. the epistemological consideration and what view of the reality the researcher has, i.e. the ontological consideration or if the researcher rather acknowledges the existence of paradigms (Godfrey-Smith, 2009, p. 5). Considering the purpose and the required quantitative approach that the research question necessitates, it is not implausible to suggest that the deductive approach towards scientific reasoning should be used in this thesis. This is further supported by the scientific point of departure which is based on existing previous knowledge regarding the research topic as well as well as established theories and tools associated with financial research.

2.3 Ontological Considerations
Ontology or metaphysics is a more controversial field of the philosophy of science than epistemology. It is concerned with the general questions about the nature of reality (Godfrey-Smith, 2009, p. 5). Ontology is thus the study of being, the nature of existence and what constitutes reality, thus representing the understanding of “what is”. Metaphysics attempts to answer the question of how individuals observe the reality, i.e. if there exists only one reality which is equal to all individuals or if every individual constructs their own reality based on their actions, perceptions and experiences (Gray, 2013, 19). This perception of reality is traditionally divided by two opposing traditions. The division is distinct between the Heraclitean ontology of becoming and the Parmenidean ontology of being (Gray, 2013, 20). Although both still exist, it is mainly the latter that is considered to be the dominant ontology in Western philosophy. Reality is perceived as the result of clearly shaped entities with identifiable properties rather than the contrasting Heraclitean ontology that places emphasis on formlessness, chaos, interpenetration and absence (Gray, 2013, 20).

Objectivism, which is derived from the Parmenidean ontology tells us that there is one existing objective reality and does not take into account how the individual’s perception is as they are within positivism able to observe reality independently of it. The contrasting constructionism rather suggests that the reality is dependent on a construction through which every individual choses to perceive reality (Bryman, 2011 p. 35-38). Objectivism does embrace reality as being independent of consciousness, i.e. that there exists an objective reality in which an objective discovery of the truth is possible. While it does perceive the seeking of truth possible independently of one’s own conscious it does not reject subjectivity, suggesting that we can study the reality and try to seek the truth but we must do so objectively (Gray, 2013, 20-21). The independent and separate nature of objectivism is by the authors of this thesis deemed as the most suitable ontological point of departure from which to perform assessments of financial risks and returns within the advanced biodiesel sector. It is considered so because of the independent state of the financial markets on which the studied objects exist, e.g. separate and autonomous from those that wishes to study them.

2.4 Epistemological Consideration
Epistemology is the side of philosophy that is concerned with questions of knowledge, justification of beliefs and rationality (Godfrey-Smith, 2009, p. 5). Individuals concerned with performing scientific research and thus scientific reasoning should carefully consider their stance on epistemology. There exist several diverse views of knowledge and rational of knowledge. Some are more contemporary than others and
thus more common in recent research but for the sake of discussion on the epistemological stance of the authors of this thesis it may be useful with a short discussion of different types of epistemologies. Objectivism, constructivism, and subjectivism are the three epistemologies from which the theoretical perspectives of positivism, interpretivism, feminism, critical enquiry and others have been derived (Grey, 2013, p. 19). Positivism which is closely related to objectivism argues that reality exists external to the researcher, that application of natural scientific methodology is applicable to describe the study of social reality and beyond (Bryman and Bell, 2011, p. 15-17; Grey, 2013, p. 20). Researchers acknowledging a positivist epistemology are depending on objective and unbiased data that are not influenced by subjective interpretation or imperfect methods to test hypotheses derived from existing theories. The aim of a positivist researcher is commonly to explain reality for a general population in terms of a generalized rule based on empirical inquiry.

Interpretivism on the contrary to positivism is based on the critical questioning of the applicability of natural science methods in a social world. The notion of challenge of the applicability natural science methods in social science is derived from the perception that natural and social science require different logics (Bryman and Bell 2011, p. 15-17; Grey, 2013, p. 23). Interpretivism respects the separation between researchers and the objects studied in the natural sciences but rejects that social scientists have the ability to grasp the subjective meaning of social action without being part of the studied entities. An interpretivist researcher aims to modify and create information in order to find out what is unexpected to the context (Bryman and Bell 2011, p. 18-19).

Gray (2013, p. 23) suggests that although some of the approaches to social scientific research that were developed under the era of positivism, such as empirical analysis, the use of experimental designs and inductive generalization are still evident, it is suggested that we now occupy a different positivist era. The emerging era has brought about alternative perspectives derived from positivism such as anti-positivism and post-positivism. Researchers of the new era that considered themselves as post-positivists acknowledge that there indeed exists an independent reality to be studied, but that the observation collected from such an reality are essentially imperfect (Ryan, 2006, p. 20). Post-positivism thus admit that the studied knowledge obtained with empirical inquiry can only be an approximation of the studied reality. Some probabilities may be assigned to the studied reality but the observed findings cannot be used seen as the truth. Post-positivism is by the authors of this thesis considered to be the most appropriate epistemological point of departure. Principally because of the selection of objectivism as the ontological starting point and the nature of the research that is performed. The recognition of available financial tools as imperfect reflections of the prevailing reality further promotes the post-positivistic as the most appropriate epistemological point of departure.

2.5 Paradigms
Perhaps the most important and influential piece of work regarding science and scientific thinking in the 20th century was published in 1962 by Thomas Kuhn (Godfrey-Smith, 2009, p. 75). The Structure of Scientific Revolutions as the work is called was Kuhn’s view that scientific thinking and behavior has little to do with traditional philosophical theories of knowledge and rationality (ibid.). Kuhn did not invent the word paradigm but he did redefine the word in such a sense that it would ever since be associated with him. The definitions of a paradigm is difficult to pin down in a simple and conclusive manner as it is so extensive, including many different aspects of
scientific reasoning and conducts. But in an attempt to put a simplified and summarized meaning to the word it may be interpreted as something encompassing a whole view of the world as well as the practice of scientific reasoning within that world, or actually in a particular field of science. A paradigm more or less encompasses all the knowledge, theories, claims, methods, habits, et cetera that are necessary for understanding scientific reasoning and action within a given field of science (Kuhn, 2012, 43-51).

Normal science is the phase of a paradigm when science involves extending the already existing body of knowledge and the facts that are fundamental to the particular paradigm (Kuhn, 2012, p. 23-24). It aims to explore the coherence between the established facts and fundamentals of the existing paradigm and the predications that the paradigm may offer (Gray, 2013, 22). Science becomes a type of jig-saw puzzle- or Sudoku puzzle-solving in which the solution is based on previous hints or pieces (Kuhn, 2012, p. 66-69). It is however very important to note that Kuhn does not suggest that every scientific problem does have a solution even if scientists may think that it may have, nor does every field of science have a paradigm (Godfrey-Smith, 2009, p. 81).

2.6 Research Approach
The interpretation of Kuhn’s work that paradigms have little to do with traditional philosophical theories of knowledge and rationality was to some extent exaggerated by those following his footsteps. Kuhn spent much of his later works distancing himself from many of the more radical views of science that completely rejected the need for philosophical method discussions (Godfrey-Smith, 2009, p. 75). The word paradigm has however on the contrary also been interpreted in a broader sense, to include traditional discourse of knowledge and rationality. Kavous Ardalan (2008) argues in his work “On the role of paradigm in finance”, that all theories in finance are based on different assumptions of the nature of social science and the nature of society, i.e. an epistemology and an ontology or as Ardalan describes it on “a philosophy of science and a theory of society” (Ardalan, 2008, p. 1).

One of the paradigms presented by Ardalan, the functionalist, views society as a concrete existence that is based on an objective and value free social science that can produce a truly predictive and explanatory knowledge of reality. The paradigm suggests that the researcher in a functionalist paradigm of finance may perform research in an objective manner by referencing of empirical evidence. Which in turn is collected by the scientists when he separates himself as observer from what he observes (Ardalan, 2008, p. 3). The functionalist paradigm is rooted in the traditions of positivism, suggesting that methods of natural science may be used in social science as well, because the structuring and ordering of the world in social science is deemed similar to that of natural science (Ardalan, 2008, p. 4-5).

This functionalist paradigm presented by Ardalan is considered to be the most suitable theoretical method and theoretical point of departure for this particular master thesis. As the purpose of this thesis is to objectively assess the market risks and required returns of early commercial biofuel companies, it is thus considered suitable to utilize a functionalist paradigm. This paradigm allows existing financial theories and models as well as prior research to be used to achieve the purpose formulated at the start of the thesis. Which in turn should be achieved by answering the research question formulated. The research question should be answered by using historical financial data obtained from public sources such as annual reports of the studied firms as well as historical data on returns and valuations of the studied firms obtained from public
financial portals. It is for that reason suitable to utilize a functionalist paradigm as the theoretical point of departure for this thesis rather than using a less objective and narrow paradigms of finance.

The choice of a functionalist paradigm is further underpinned by the objectivistic perspective of how the reality within social science is perceived by the authors. The authors perceive the research on financial markets as an independent object within social scientific existence that the authors cannot influence by performing a brief study. This becomes quite obvious because the authors wish to examine the valuations and risk of publically listed biofuel firms from data compiled in an independent database, i.e. Thompson Reuter DataStream. As the collected data is public, audited and validated by those who produce and publish it is considered to represent an objective view of the reality that exists externally of the authors who observe and utilize the data. The results obtained from the data collected is thus considered to explain a reality based on the empirical evidence which should enable the findings to be generalized to the population from which the sample is taken. The research will be performed with a strong emphasis on previous knowledge, practices, theories and methods that constitute a paradigm of normal science in financial research. Hence the authors thus chose a functionalist paradigm based on a post-positivistic epistemological view to perform the intended study.

2.7 Theoretical and Practical Pre-understanding

One part of the scientific reasoning within scientific research is as mentioned in the previous earlier sections the advancement of knowledge that arises from utilization of already possessed skills and experiences obtained through scientific training and knowledge development (Morris et al., 2012, p. 61). Such skills include both the theoretical and practical capabilities that the authors of this master thesis hold. Preconceptions and biases may however arise from the personal opinions, experiences, and values that researchers may hold (Bryman, 2011 p. 43). This may have an influence on the performed study and outcome of the research conducted. Therefore it is important to briefly cover the practical and theoretical pre-comprehension that the authors of this thesis hold and what importance these may have.

Both authors of this thesis have studied the Master program of Business and Economics at Umeå School of Business and Economics (USBE) for seven semesters with finance/accounting and management specialization respectively. Vahlström has spent two semesters abroad studying bachelor courses in business administration at the Euromed Management - School of Management and Business, Marseille, France and master courses at the Charles University, Prague, Czech Republic with a strong emphasis on financial tools and theories.

Cavka holds a PhD degree in technical chemistry from the Faculty of Science and Technology at Umeå University. He has at this point in time written and published numerous peer-reviewed scientific articles as well as a doctoral thesis on the topic of biofuel production. Cavka is furthermore also recognized as co-inventor of patented technologies for advanced biofuel production. His employment within the Industrial Graduate School for Research and Innovation (IGS) at Umeå University and as post-doctoral researcher at the Department of Chemistry at Umeå University has further enabled contacts and networks to be set up with several companies active within the field of advanced biofuels. He is thus considered to hold extensive theoretical and practical knowledge of the technological and economic aspects of the advanced biofuels
industries. Knowledge that is considered relevant and important for the execution of this master thesis.

Both authors have a reasonably solid background within business administration, scientific research as well as general interest in the subject of business administration and economics. For collecting and analyzing data the authors have also taken statistical classes at Umeå University that have provided the theoretical and practical knowledge of statistical data analysis. The authors will review the literature with a critical judgment and develop an independent perception of since they also have a general knowledge of business administration providing they have different specializations.

The outcomes of these practical pre-understandings will enable the authors to appreciate that theories do not always apply to reality as intended. Especially since experience from practice sometimes does not make sense to the theories they have learned. Regardless of previous experiences they intend to hold an objective approach during this thesis. This thesis should not be biased due to the pre-understanding possessed the authors as the studied firms are foreign and listed on the NASDAQ and New York stock exchange, independent from the authors. Given that this will be a quantitative study where the data will be compiled from Thompson Reuter DataStream, it will be difficult for the authors to influence the outcome of it others than by choice of research methodology.

2.8 Research Design
The choice of research design depends on a number of factors, such as the purpose of the study, the time frame, availability of data as well as the research approach (Wilson, 2014, p. 127). The research design that is chosen should furthermore also emphasize several important dimensions of the research process within social science. These include the requirement for results to be generalizable, the possibility to investigate clausal relations between variables, as well as allow for a profound appreciation of specific behaviors and social phenomena within the social context (Bryman, 2004, p. 27).

There are several research designs that could potentially be suitable for the purpose of this study. In which the purpose was to investigate if the emerging advanced biodiesel industry is risker than the conventional biofuel industries and the market in general. Two of the possible research designs suitable for this purpose are the cross-sectional study design and the comparative study design. Both of these types of research approaches require data to be collected either from the entire population or a representative sample of the population to help answer the research question. Data collection in the former design is however limited to only one point in time across the selected sample or subset (Wilson, 2014, p. 125). The more suitable design for the proposed research question is rather the comparative study design that is performed to compare two samples or groups of samples on one variable, such as profit or risk (Wilson, 2014, p. 125). The comparative study design also allows for data to be collected over longer time frames rather than at just one point in time. The requirement for a comparative study is however that the studied sample or groups interpret the studied variable in the same way (Wilson, 2014, p. 125-126). The latter research design is partially suitable for this study as it is focusing on comparing financial risks and required returns within the biofuel industry, which is comprised by rather similar advanced and conventional biofuel sectors.
2.9 Research Strategy

The practical aspects of data collection and processing methods are dependent on the research question and the theoretical point of departure that allows a researcher to formulate a research design (Creswell, 2013, p. 11-12). There are several different practical strategies to be used, of which qualitative or quantitative designs are most common but it is also possible to sometimes utilize a mixture of both if this is deemed a better fit then to just use one of them (Creswell, 2013, p. 14). The quantitative research allows highlighting quantification regarding the analysis and collection of data (Bryman and Bell, 2011, p. 26).

There are normally a few characteristics regarding quantitative studies; they usually have a deductive and positivist approach in the link between theories and research as well as the view of only one objective reality. Qualitative research on the other hand focuses mainly on describing words rather than to quantifying numerical data and is also synonymous with generating theories (Wilson, 2014, p. 13-14). It also emphasizes how the individuals interpret their social world and that the social reality is created by how the individuals choose to percept the reality. Both quantitative and qualitative design has different characteristics regarding the view of knowledge and rationality although broader research projects may have characteristic of mixed methods (Bryman and Bell, 2011, p. 27-28).

Given the previously discussed theoretical point of departure, the formulated research question, the authors assume that a quantitative research design would be most suitable for the study since it’s consistent with the chosen functionalistic paradigm of financial research. The topic is specific as well as the variables the authors wish to examine in order to perform the valuations of the firms. The most proper way of doing so is to put a figure on the data collected from Thompson Reuter DataStream.

The authors choice to collect and analyze secondary data is also motivated by several other arguments; it is cost and time efficient compared to collecting primary data, the data provided by Thompson Reuter DataStream is audited and validated prior to publication, the amount of data that may be obtained from secondary sources also allows for a longitudinal or cross-cultural analysis to be performed if this should be deemed important for the study. The drawback with using secondary data is lack of control over the data quality, complexity of the data and lack of familiarity with the data (Bryman and Bell, 2011, p. 313-315, 317-321). However, the inability to collect primary data due to time constraints, instrumental limitations or amounts of necessary data may occasionally validate the use of secondary data (Wilson, 2014, p. 172).

2.10 Literature Search

The literature searches have been conducted from the available resources at Umeå University Library database. The business literature was accessed through several well-known search engines such as Business Source Premier, EconLit and Ebsco. Other databases such as Web of Science and Scopus were used for literature searches on biofuel literature from the technical and natural scientific fields. Google Scholar and Google Books were used to some extent for more general searches and previews of articles, which were subsequently accessed in full text through some of the mentioned databases. Thompson Reuter DataStream was used for data collection. The articles in this thesis are linked to the theories and models presented throughout the study. The authors also strive to use as recent articles as possible and as much peer reviewed literature as possible in order to minimize the risk of method or subjective biases. Some
of the search words that the authors have used in different combinations to find articles includes among them: financial valuation, biofuel, risks, financial risk, investment risk, valuation methods, discounted cash flow, net present value, Fama-French three factor model, capital asset model.

2.11 Ethics in Business Research
Ethics in business research may seem as an elusive and complex subject to underpin as it involves moral standards, ethical dilemmas as well as the matter if ethics is based on standards of idealism or relativism (Zikmund et al., 2012, p. 88). Furthermore, the arguments for the level of ethical standards may differ throughout history and individuals as they are not constant. Ethical considerations are however important within all aspects of business research and for all involved in the research. Typical ethical issues that are commonly discussed include the obligation to be truthful, the participant’s right to privacy, responsibility to avoid deception or to avoid external interests in the research (Zikmund et al., 2012, p. 89-93).

The research performed in this thesis will mainly be focusing on the correct access to the data contained in annual reports from the bio-fuel firms listed on NASDAQ and New York stock exchange, hence the data collected is public and available for everyone interested in accessing it. Authorization is thus no an ethical issue for the authors. The public database Thompson Reuter DataStream is a well-known and reliable source that the authors have used previously in scientific research. The theories and models derive from peer-reviewed articles and/or journals are also considered to be reliable. The authors do however thread carefully when considering which models and theories that may be suitable to use in order to avoid unintended deception through application of unsuitable models and theories to the collected data.

The authors strive to always have access to information without any legal obstacles and referring each source to the accurate format that Umea School of Business and Economics presented in their manual for thesis writing. Unintentional errors within the analysis/result of the data should be avoided by performing and re-testing the financial analysis of the data independently of each other, there is however always a small chance of “human-factor” errors which may introduce some minor inaccuracies. Furthermore, the research design the authors have chosen does not allow any subjective conclusions to be drawn from the data analysis.
3. Theoretical Framework

3.1 Effective Market Hypothesis

The theory of the effective market hypothesis is today one of the most essential theories in financial economy. A theory that many models are constructed from. The theory was originally developed by Eugene Fama (1970) who described an effective market as the state when the price of an underlying asset, for example a stock, reflects its rational value. This is possible under the preconception that the market has access to all the information that may affect the price of the asset. The main assumption for this theory to be applicable in finance is that investors are rational beings that take all available information into account to estimate the potential, hence determine the expected return and pricing of assets (Fama, 1970, p. 383-389; Bodie et al, 2011, p. 38-39).

Fama (1970) states that there are three criteria to be fulfilled in order for the theory to valid:

- No transaction costs shall exist when securities are traded on the market.
- No unknown/concealed information regarding the asset or market should exist – all information should be freely available for everyone at any given time.
- All actors on the market interpret the available information equally.

When all these criteria are fulfilled and reflected in the pricing of an asset on the market, the efficiency of the market is considered to be strong. However in reality transaction costs do still exist on most of the capital assets although the size varies along the type of asset that an investor might invest in. Furthermore, not all investors react in the same way on the available information on the market either. The interpretation may vary on the basis of knowledge levels of the investors as well as how much information they are able to find, e.g. some information might be hard to access, especially for the small players on the market. Fama (1970) states that this theory is despite the limitations still applicable on reality as long as the most important actors with a strong influence on the market value the information alike. As long as the transactional costs do not affect the investors decision to invest or not, it is enough to consider the market as effective (Fama, 1970, p. 383-389).

To test on which level the amount of information reflects the prices of securities on the market, Fama (1970) wanted to “pinpoint the level of information at which the hypothesis breaks down” and divided the effective market hypothesis into three types: strong, semi-strong and weak (Fama, 1970, p. 388). In a later article Fama criticized the state of the market when questioning the lack of costless and available information as well as the lack of absence of transaction costs, which are all necessary in order for the strong efficacy to be maintained (Fama, 1991, p. 1575-1610).

There are also other critics to this theory than the original author himself, Shleifer (2000) points out that not all investors are rational actors. The author does however clarify that these actors may not necessarily affect the market negatively in general. He summarizes the potential investors with three assertions that may have implications for the pricing of assets (Shleifer, 2000, p. 216):
• The investors on the market are rational.
• Some of the investors are irrational, however their investments even out against the rational investors, hence no effect on the market prices occur.
• Some of the investors are irrational, although their investments are considered randomized and evens out against each other.

3.2 Different forms of the Effective Market Hypothesis
As previously discussed, the effective market hypothesis theory does not only involve the most effective form of markets where all information is available to all actors at any given time. Nor do all market forms all time lack transaction costs or irrational investors. There are actually three forms of market efficacy within the theory that may be important to consider.

3.2.1 The weak form of market efficacy is when the prices of securities are based solely on previous information and may thus not give the investors any possibility to predict future prices or valuations. This is because the prices are based only on the historical data, that future prices may thus be considered as results of random chance. The only factor that could potentially influence the price of an asset is new and previously unknown public information. The weak form of efficacy is similar to the random walk theory which will be described later in this thesis (Fama, 1970, p. 388).

3.2.2 The semi-strong market efficacy form is an extension of the weak form of information on historical prices in addition to other public information related to the market that reflects on the asset prices. Examples of such are financial reports regarding the firms operations. According to this form of the theory, the investors will act rationally and prices will be corrected instantly upon the arrival of the information to the market. Leaving no opportunity to achieve higher profits than the average market returns, hence the information is already included in the price if the market is effective (Fama, 1970, p. 404-405). Examining how quickly asset prices reacts and adjust after new information is released is a way to test the semi-strong form of market efficacy (Fama, 1991, p. 1577).

3.2.3 The strong form includes all the information that may influences the price of a security on the market, including historical, public but also private information that is known by the market at any given time. The private information is considered to be inside information which suggests that only people actively working within the company have access to and can react to. This kind of information does however tend to become available to the market quickly and thus no advantage may be taken by the investors on the market that possess the information prior the information becoming public information (Fama, 1970, p. 409-410). On a market with strong efficacy the investors may thus not generate higher profits than the average market return by using historical, public or inside information or data, although they might be fortunate to outperform the market occasionally by random chance (Brealey et al., 2013, p. 325).

If the case of a strong market efficacy is prevailing within the emerging biofuels industries, the information that is available to investors should be the same at all time. The information, whether it is private, public or historical should affect investors willingness equally because no influence on asset prices should be possible by anyone or anything at any given time. It could thus be assumed that the firms that this thesis studies are correctly priced on the market through the available information that the market holds at this time. There might however be underlying and unknown factors that
may indirectly affect the pricing of the assets in the near future; such as the complexity of the technologies that are used, future demand for raw materials and thus raw materials prices, the potential for future innovation through intensive research and development, or even the possibility for changes within energy policies. Changes that may be unforeseen at this point in time. The studied firms will however be assessed on the information that is available today and under the assumption that the unforeseen potential events of the future are priced within current conditions as higher systematic risks.

3.3 Abnormal Return

When considering risks and related returns within securities such as banknotes, bonds, common stocks, et cetera, it is important to be aware of abnormal returns. Abnormal returns can somewhat simplified be described as the difference between the actual return of the security and the expected return of a security, i.e. equation 1. Abnormal returns may thus either be positive or negative, resulting in higher than or lower than expected returns from the investment that is made. The returns may thus become misaligned with the perceived risk that the investor is carrying when making the investment. This misalignment between the perceived risk and expected return may arise from several factors, such as unexpected events, random chance results, and over-reactions or under-reaction to information (Fama, 1998, p. 283). When positive abnormal returns occur the abnormal return may be perceived as the risk premium that the investor receives for carrying the risk of the investment (Berk and DeMarzo, 2011, p. 306). Investors are however commonly deferred from investing in sectors where abnormal returns may occur as they may be prone to pure risks outside of the investors control. Pure risks are in this case considered as liabilities that may only yield a negative outcome without the chance of a positive end result. The pure risks may arise from imperfect reactions to information, misinterpretation of information, or difficulties to access information by the actors that act on the market.

$$AR_t = R_t - E_t$$

(Equation 1)

Where:

- $AR_t$ = Abnormal return
- $R_t$ = Actual return
- $E_t$ = Expected return

The existence of abnormal returns may be appreciated by asset pricing models which estimate what level of return should be required from the market and the security to merit investment. The appreciated returns may thus be used to assess if abnormal returns do exist or not, hence if the returns are unexpected considering the access to available information and how individuals choose to interpret the available information (Bodie et al., 2011, p. 381). It is important to note that the anomalies that may cause abnormal returns are usually short term effects that tend to be corrected by the market over longer periods of time, in accordance with the efficient-market hypothesis and random walk theories. If these returns do persist over time it may be an indication of a market where risks and returns are difficult to quantify, assess and predict thus making the market unfeasible to invest in.
3.4 Random Walk
The random walk theory states that price changes within securities are independent and adjusted daily. The theory suggests that future prices within markets are randomly set under the assumption that investors use the available information instantly with the existing transactional costs in mind. Meaning that the actors on the market are able to react on new information instantly and eliminate the chance of abnormal returns on the market. This would also suggests that investors are unable to predict future asset prices based on historical prices/patterns since the prices are independently set each day on the availability of information on that particular day. Brealey (2013) compares this asset pricing theory as the tossing of a coin each time the price of an asset is set, e.g. the outcome may be one of two with both outcomes having the same initial odds, regardless of previous historical outcomes. The links to the effective market hypothesis is that random walk also considers all the information to be fully reflected in the prices of a security. In other words, the only thing that may change the price of an asset is new information that reaches the market at which time the probability of a positive or negative outcomes are equal (Brealey et al, 2013, p. 321-322; Fama, 1965, p. 54).

This theory was originally defined by Fama (1965) in the following manner:

\[ P_t = P_{t-1} + \varepsilon \]

Where

\( P_t \) = Price today
\( P_{t-1} \) = Price yesterday
\( \varepsilon \) = independent variable answering a random price change

The theory is relevant for this thesis due to close connection to the effective market hypothesis theory (EMH) and this thesis philosophical point of departure, the functionalist paradigm of financial research. Similarly to effective market hypothesis theory the random walk theory allows independent hypotheses to be formulated and tested with the use of publically available data. It does however contrast the effective market hypothesis theory in terms of how future pricing of assets is conducted, which will allow a more diversified results discussion to be performed later on.

3.5 Behavioral Finance
When using the effective market hypothesis (EMH) and random walk theories as theoretical frameworks, one of the assumptions that is included is that investors are rational at all times and that all information is refined in a rational manner at all times. There are however several scientific studies on EMH and the assumption of asset pricing on the market given the available information (Malkiel, 2003; Timmermann and Granger, 2004; Lamont and Thaler, 2005; Hong and Stein, 2007). Many of these studies have failed to show a consistent correlation between rational information processing and asset pricing by investors. These results do not necessarily propose that the market is inefficient as such but it does indicate that it may be important to consider additional financial theories. Theories that may help explain why prices on securities do not always reflect all the accessible information in the market. This is done to complement the theories of EMH and random walk and to give a different perspectives on why markets are not always as efficient as they should be (Bodie et al., 2011, p. 410). The theories are summarized briefly on the following pages as a complement to the previously discussed market theories.
Stakeholder theory

The stakeholder theory aims to describe the stakeholders’ relationship to an organization and the importance to respect their demands as they might have a significant impact on companies. Edward Freeman (1984) defined a stakeholder as “any group or individual who can affect or is affected by the achievement of the organization’s objectives” these include customers, governmental bodies, investors, suppliers, trade associations, political groups, communities and employees (Freeman, 1984, p. 46, 52-53). Generating value for a firm’s stakeholder is the pillar of this theory, although in some cases that may be complex as different stakeholder’s expectations may cause a conflict of interest. The theory also suggests that it is important for the firm to nourish its relationship with its stakeholders as these have major interests as well as power over the organizations future. It is also important that the firm strives to be as successful as possible in their present and future relationships in order to assure the support of its own stakeholders in turbulent and challenging circumstances (Freeman, 1984, p. 25-27). In other words it is important to establish and maintain positive value-generating relationships in order to be successful in the long term.

The firms that are studied in this thesis have major stakeholders within the investors that provide the financial support, lenders that provide the loans and financing but they are also dependent on governmental subsidization and direct support (Miller et al., 2013, p. 30; Eisentraut et al., 2011, p. 39-41). The US where the studied firms are listed and where most of them also operate are supported by the US government through the Energy Policy Act (EPAct) which includes the Renewable Fuel Standard (currently RFS2). The RFS2 mandates how much of the used transportation fuels in the US that must be renewable (Miller et al., 2013, p. 3). The levels were set to 9 billion gallons in 2008 and should increase progressively to 36 billion gallons in 2022, guaranteeing a strong demand for biofuels in the near future. The support also guarantees a minimum sale price for the producer which reduces the risks as they produce and distribute their product (Miller et al., 2013, p.8). These mandates are however changeable depending on the political support that the biofuel sector may or may not receive and it is thus important that the stakeholder perspective is considered as well.

Information Processing

There are a few common behaviors when investors process information which may result in difficulties to estimate the rates of return. Kahneman and Tverskys (1979) examined behavior patterns of investors and came to the conclusion that these commonly focus mainly on recent experience rather than prior beliefs when conducting forecasts and thus the forecasts do not reflect the nature of the information. This behavior is dubbed as a Forecasting Error (Kahneman and Tversky, 1979, p. 237-251; Bodie et al, 2011, p. 410-411:).

Conservatism is another behavioral bias which states that investors are unwilling to update their beliefs in response to evidence or information. When news about a firm become available to the market, it tends to tends to act inaccurately. Which in turn results in asset being incorrectly priced as investors fail to act on the available information (Fama, 1998, p. 288). Overconfidence may also influence the ability of information processing through the overestimation of investors own ability of forecasting asset prices (Fama, 1998, p. 289). Several different studies have shown that active trading usually results in mediocre investment performance due to factors such as overconfidence, among other variables (Barber and Odean, 2001 p. 1547; Bodie et al, 2011, p. 411).
Behavioral Biases

Framing is a psychological decision making factor for investors that puts emphasis on how bets or investments are being formulated and how that changes the investors attitude towards these actions. A bet or investment can for example be framed as either a potentially big gain or a potentially big loss. Depending on the individual preferences one may have a different attitude towards risk and gains. Investors may either accept potentially big gains as the results of risky investments or just see the potentially big losses of the same risky investment (Bodie et al, 2011, p. 412). The willingness to invest may thus strongly depending on how the investors frame the risks rather than the pricing of the assets or all the available information that the investor has access to.

The Prospect Theory is a theory explaining individuals’ reaction towards the outcomes of an investment, the curve proceeds from a reference point and examines how the investors’ perception changes with potential outcomes. It suggests that when the investors achieve gains on the investment the curve rises and then diminishes with further increasing returns but when investors lose and continue to lose the curve continues to fall. The conclusion is that investors’ tend to value the reduced utility by losses more than the increasing utility of a gain under the condition that it is the same amount. This theoretical model suggests that investors are not rational when appreciating the investment opportunities depending on the chances or risks of achieving gains or losing capital (Bodie et al., 2011, p. 413-414; Kahneman and Tversky, 1979, p. 279-280).

3.6 Hypotheses

The previously discussed theoretical methodology, theoretical frameworks, as well as the available body of knowledge regarding the biofuel industry necessitates a number of assumptions to be formulated and statistically tested. The formulated hypotheses may subsequently be tested through the application of inferential statistics and methods commonly used within business and financial research (Black, 2011, 296). This approach should allow for scientific reasoning to be conducted in order to answer the previously formulated research question. It should also advance the existing body of knowledge and further contribute to the understanding of the biofuel industry based on the discussed theories. The research question which this thesis is constructed around is repeated below in order to merit further discussion and formulation of hypotheses;

- What are the systematic risks and required returns on investment in publically traded advanced biodiesel companies with diversified product portfolios in relation to the general market and conventional biofuel companies?

The research question is formulated to allow investigation of advanced biodiesel firms and their valuations in relation to the conventional biofuel sector and the general market. In order to properly investigate the risks that the firms are exposed and the resulting valuations it is important to consider previous research in relation to the theoretical framework. Miller et al. (2013) suggest in their paper that the second generation bioethanol industries have difficulties generating adequate returns in order to attract investors under current policy and market conditions. The market is considered to be well aware of these difficulties and is thus suggested to consider the risks within the advanced biofuels sectors to be at levels which are considered to be too risky to merit investment at this point in time (Miller et al., 2013, p. 31).
There is unfortunately no comprehensive scientific study of the returns and risks within the conventional biofuels industries to be used for comparison. On the other hand, there is evidence that conventional biofuel production on the contrary to advanced biofuel production has made healthy returns on invested capital in the period of 2008-July 2014. A time frame that was very turbulent for other type of securities and investments. The returns on investment in the first generation biofuel industries are estimated from a model built by Don Hofstrand (2014) of Iowa State University. The model can be accessed from the website of the Iowa State University. The address to the models may be found in the reference list. The conclusion from the models is that the average return to investors from conventional bioethanol has been 16.4 percent annually and 13.2 percent for conventional biodiesel in the period of 2008-July 2014, Figure 1.

![Figure 1. Average annual return on equity for conventional biofuel production, adapted from data produced by Don Hofstrand (2014), Iowa State University. Bioethanol, light gray, Biodiesel dark gray.](image)

The general hypothetical point of departure that may be derived from the results of Miller et al., (2013) and the models of Don Hofstrand in relation to the theories previously discussed is thus; that the advanced biodiesel industry may require higher returns of investment than the conventional biofuel sector or average market. Hypothesis 1, 2 and 3 may thus be formulated from this hypothetical point of departure as;

Hypothesis 1:
- \( H_a 1 \): The required average returns of advanced biodiesel firms are higher than the average returns from conventional biofuel firms.

Hypothesis 2:
- \( H_a 2 \): The required average returns of advanced biodiesel firms are higher than average returns of the MLCX Biofuels Index, representing the biofuel industry as whole.

Hypothesis 3:
• $H_a$ 3: The required average returns of advanced biodiesel firms are higher than the average returns of the conventional indexes, such as the S&P 500.

An additional set of hypotheses on the systematic risks involved in these industries may be derived from the results of the returns of the conventional and advanced biofuels industries. The advanced biodiesel industries may also be compared to the systematic risks found in general indexes, such as the S&P 500. These hypothesis may be formulated as:

Hypothesis 4:
• $H_a$ 4: The average systematic risks of advanced biodiesel firms are higher than the systematic risks of conventional biofuel firms.

Hypothesis 5:
• $H_a$ 5: The average systematic risks of advanced biodiesel firms are higher than the systematic risks of MLCX Biofuels Index, representing the biofuel industry as whole.

Hypothesis 6:
• $H_a$ 6: The average systematic risks of advanced biodiesel firms are higher than the systematic risks of general indexes, such as the S&P 500.

It is important to inferentially test these hypotheses as the current perception of the entire advanced biofuel sector is solely based on studies of bioethanol firms. The industry is however emerging and does also consist of advanced biodiesel firms that so far have been overlooked due to the struggles of the analyzed bioethanol firms. The firms within the advanced biofuel sectors are however slightly different despite belonging to the same developing advanced biofuels industry. They should thus be scrutinized separately rather than mutually. The market risks and potential returns within the advanced biodiesel sector may in fact yield different results in relation to the profitable conventional biofuel sector as well as the general market than the previously analyzed bioethanol firms. The formulation and subsequent testing of these speculative hypotheses should allow for the research question to be answered and the purpose of this thesis to be accomplished. The testing of these hypotheses is furthermore motivated by the potential to advance the existing body of knowledge regarding the financial systematic risks and required returns within the developing advanced biofuel industry to also include knowledge regarding the emerging advanced biodiesel sector.
4. Practical Framework

4.1 Definition of Risk
There are several different and general definitions of risk within finance and financial research. One of the most common definitions of risk is something that can be “conceived as the variation of possible outcomes, their likelihoods and their subjective values” (March and Shapira, 1987, p. 1404). Risk per se can further more also be classified as either speculative or pure risk. The latter is defined as a category of risk in which a loss is the only possible outcome. Pure risk is usually related to happenings outside of the risk-taker's control and, therefore, it is not taken on deliberately by the risk-taker (Charupat et al., 2012, p. 136-137). Speculative risk on the contrary is a type of risk that enables outcomes where a gain or a loss is a possible outcome. All speculative risks are thus comprised of conscious choices and are not just the result of uncontrollable circumstances that may arise outside of the risk-takers control (Gupta, 2013, p. 6).

Individuals involved in capital investments should chose the risk exposure that yields the desired levels of returns for the right level of risk (Gupta, 2013, p. 6). Evaluating and assessing subjective attitudes of risk as either positive or negative is difficult as the same risk may be perceived differently by different individuals (Blair, 2008, p. 21). Mid-range risks are however in general considered to be mostly positive among investors, while high and low levels of risk are considered to be negative. This is because high risk ventures are so likely to fail and result in a loss of the invested capital that they usually do not merit investment, while low risk ventures usually lack sufficient returns in order to merit investment (Blair, 2008, p. 21). Quantifying, assessing, and relating expected returns to perceived speculative risks thus becomes a key practice for investors when making conscious investment decisions.

4.2 Risk-Free Interest Rate
When considering risk and investment it is important to include a rate at which investors may lend or borrow capital at a low risk. The interest rate on risk-free assets may be considered as a good benchmark for this purpose. In reality most investors use money market funds as the risk-free asset, which consist of treasury bills, bank certificates of deposit and commercial paper with a minimal default risk. Money market funds could thus be considered as the risk-free asset to use for benchmarking of investments (Bodie et al, 2011, p.198). Bodie (2011) further states that it is also common practice to consider treasury bills as a risk-free asset that represents a rate at which capital can be borrowed or lent. This thesis will use the 10 year average interest of three month treasury bills as a measure of a risk free asset. The interest rate was on average 1.9 percent over the last decade. The choice of the three month treasury is because it is time-consuming and complex to structure money market funds in order to reflect a risk free investments.

4.3 Capital Asset Pricing Model
The Capital Asset Pricing Model (CAPM) is an effective financial tool used to map the efficient portfolio of assets associated with medium to high risks without prior knowledge of the excepted return of securities. CAPM takes into account the optimal choices that investors are able to make in order to find the most efficient portfolio as
their market portfolio, choosing from all stocks and securities available in the market (Berk and DeMarzo, 2011 p. 357).

William Sharpe (1964) who was one of the first to describe the model stated that efficient combinations will be perfectly correlated and give an interpretation of the relationship between an assets risk and the expected return. This risk will remain even within the most efficient combinations of a portfolio, leaving only the responsive factor of an assets rate of return in relation to the level of economic activity as the key to assessing the assets risk. Diversification of securities thus enables the investor an opportunity to avoid risks without reducing their expected return (Berk and DeMarzo, 2011, p. 148). Sharpe concludes that the model reflects returns through economic activities; “an asset whom lacks response in relation to economic activities will return in pure interest rate, whilst those who tend to move with economic activities promises higher expected rates of return.” (Sharpe, 1964, p. 442).

CAPM can thus somewhat simplified be explained as a tool that is used for pricing of risk. A tool that provides the investors with a measure of what the minimum expected return for a specific stock or portfolio should be compared to the market returns as a whole in order to merit investment. To make this model applicable Berk and DeMarzo (2011) and Sharpe (1964) states that there are three assumptions to take into account when using the model:

- “Investors can buy and sell all securities at competitive market prices with no incurring taxes or transactions cost and can borrow and lend at the risk-free rate.”
- “Investors only hold efficient portfolios of traded securities, portfolios that yields the maximum expected return for a given level of volatility that is.”
- “Investors have homogeneous expectations regarding volatilities, correlations, and expected returns of securities.”

These assumptions are based on statements and assumptions that information regarding market prices and patterns are available to anyone at any given time, that investors have somewhat similar expectations of the securities in order to generalize the results of the model (Fama, 1997, 284). These statements are in turn derived from the effective-market hypothesis theory, i.e. the theory that suggests that assets and securities on the market are priced to fully reflect all the available information at any given time. It may thus be suggested that the investors expected return on a stock should at least be equal or exceed the CAPM of the portfolio in order to purchase the specific stock on the market and include it in the existing portfolio. To achieve this it is necessary to examine a firm’s beta value and the equity cost of capital. How to calculate the expected return of a stock will be examined later in this thesis.

The CAPM formula consists of the risk-free interest rate and the risk premium for the security:

\[
E[R_i] = r_i = r_f + \beta_i (E[R_{mkt}] - r_f)
\]

(Equation 2)
Where:
\[ E[R_i] = \text{Expected return of security} \]
\[ r_i = \text{Return of security} \]
\[ r_f = \text{Risk-free interest rate} \]
\[ \beta_i = \text{Beta of security} \]
\[ E[R_{mkt}] = \text{Expected return on the market} \]

There are a few limitations with CAPM since it does only consider one factor together with the assumptions of effective-market hypothesis, statements and assumptions that may be deemed quite unrealistic in the real markets. The reality of the investors might be somewhat different than assumed by the effective-market hypothesis theory as not all investors are rational. However it can be useful as an approximation tool and as a complement to other financial theories of expected returns. The model does furthermore not consider underlying factors such as psychological factors and investors’ attitude towards risk. Factors that are hard to quantify but that may influence investor behavior (Berk and Demarzo, 2011, p. 364). The model also has a limitation in that it does not predict expected returns on small stocks very well. Suggesting that in the event that a sample or portfolio is skewed toward smaller stocks, the risk adjustment produced with the CAPM may potentially result in false and abnormal returns (Fama, 1997, p. 292).

As this thesis will attempt to quantify and assess the valuations and risks within firms of the second generation biofuel industry, i.e. renewable diesel firms, this model can be somewhat useful despite its limitations. It may reveal the expected returns that these firms should achieve in order to merit investment from investors aiming at the second generation biofuel industries. It may also reveal the firms perceived returns and risks compared to the overall return and risks within the biofuel sector on NASDAQ and New York stock exchange, which is represented by the MLCX Biofuels Index. The MLCX Biofuels Index is a total return index that is aimed at providing a benchmark for the biofuels sector and investments within the sector.

4.4 Fama-French Three Factor Model
Eugene Fama and Kenneth French (1992) have developed an expanded asset pricing model which takes three factors into account in contrast to one factor that is commonly used within the CAPM model. The Fama-French Three Factor Model (TFM) is more complex and comprehensive, which may render it useful as an alternative method regarding asset and risk pricing. The developers of the original model state that there are several more factors that are useful when pricing assets and risk besides the one used in the CAPM model, which is the correlation between systematic risks (Beta) and the average return. They argued that the correlations between average return and size/market equity (ME), leverage, earnings-to-price ratio (E/P) and book-to-market (BE) are all significant (Fama and French, 1995, p. 131). Market equity (ME) and book-to-market-equity ratio (BE) incorporate the earnings-to-price ratio (E/P) and leverage respectively into cross sectional average stock returns in their study from 1992. From the results of the same study it also suggested that stock risks have several dimensions, where one dimension is the size – or market equity (ME) of the firm and another one is the ratio of the book value of common equity to its market value - BE/ME (Fama and French., 1992, p.428). The model is thus designed to overcome the shortcomings of the CAPM model in terms skewed valuations of stocks from smaller firms or portfolios with exposure towards emerging industries and sectors.
When applying the CAPM-model there may be systematic risks that are not considered by the beta and the return premiums might become inaccurate, as previously discussed. The Fama-French model measures the size factor of each period as the variance in return on small firms in relation to the large firms as one factor and shortens it as SMB (Small minus Big). Another market factor is measured as the return on firms with high book-to-market ratios minus the firms with low ratio shortened as HML (High minus Low) and the model is constructed as follows in equation 3 (Bodie et al., 2011, p.447):

\[ E(r_i) - r_f = a_i + b_i[E(r_m) - r_f] + s_iE[SMB] + h_iE[HML] \]

(Equation 3)

Where;

* \( E(r_i) \) = Expected return of security
* \( r_f \) = Risk-free interest rate
* \( a_i \) = Active Return (portfolios actual return - benchmark actual return)
* \( \beta_i \) = Market beta of security
* \( E[R_{mk}] \) = Expected return on the market
* \( E[SMB] \) = Small (market capitalization) Minus Big
* \( s_i \) = Beta coefficient of SMB
* \( E[HML] \) = High (book-to-market ratio) Minus Low
* \( h_i \) = Beta coefficient of HML

Whereas SMB is derived from the historical mean returns from the firms with low market value and subtracts it with the mean returns from the firms with high market values, if the result is positive the firms with low market value yields higher returns under the measured period (Fama and French, 1993, p. 9). The HML factor is calculated from the ratio between equity and market value in the bigger firms subtracted with the same ratio for the smaller firms, a positive value indicates that the value stocks performing better than the growth stocks under the measured period (Fama and French, 1993, p. 9).

The Three Factor Model which is an extension of CAPM takes additional fundamental factors into account, and given the characteristics of the firms the authors of this thesis are aiming to examine, this model might yield more accurate results than the CAPM. Mainly because many of the firms that are of interest for this study are depending on external financing and are relatively small in the overall market. This model may give them a fairer pricing than the CAPM considering their size and relatively short time of operation. The model does however not take into account that the potentially limited equity and market values that may be evident in these firms is a result of extensive research and development (R&D) and costly the state-of-the-art technologies that the firms are testing/have recently developed. However, the technical potential and its value may might be too complex to quantify anyway.

### 4.5 Systematic Risk - Beta analysis, Linear Regression and Single Index Model

All tradable assets are to some extent exposed to systematic or non-diversifiable risk. Some assets are more sensitive to this risk than others and different assets within the same class. Stocks of different companies may have different systematic risks although
they are within the same asset class. This systematic risk may be quantified and compared to the general market, which is usually represented by the return of the market or a segment of the market, such as the NASDAQ or the S&P 500 index. The beta coefficient of an asset indicates the non-diversifiable market risk of the asset (Miller et al., 2013, p. 14). The beta coefficient is thus a measure of volatility of a particular stock relative to the volatility of the market as a whole.

Although the beta coefficient is used to estimate future returns it is based on correlation and volatilities of the historical returns of the security as well as historical returns of the market. These returns are divided by the variance of the returns of the market as a whole which yields a beta value, equation 4 (Berk and DeMarzo, 2013, p. 382-385, 407-408).

\[
\beta_{it} = \frac{Cov(R_{it}, R_{mkt})}{Var(R_{mkt})}
\]

(Equation 4)

Where:
\( R_{it} \) = Return of security
\( R_{mkt} \) = Return on the market
\( Var \) = Variance on the returns of the market

A beta coefficient value above 1.0 indicates that a security is more volatile than the market as a whole while a beta value of less than 1.0 indicates that the price of the security is more stable than the market (Miller et al., 2013, p. 14). These beta coefficient values may be used to estimate the required returns on investment that are needed to merit the expose to non-diversifiable risk that the security holds. There are several advantages of using and applying beta coefficients when considering systematic risks, most important is the ability of the tool to determine price stability of assets over time (Oran and Soytas, 2009, p. 234-235). It also offers the advantage that it may be calculated using longer longitudinal data series time, thereby enhancing the statistical validity of the tool.

On the contrary, the beta coefficient also has some disadvantages that may be important to be aware of when using the tool. As the coefficient is calculated on only two historical variables that adjust over time, it does not cover or take into account other important factors that may affect these variables. The tool does furthermore not incorporate new information, as it is based on historical data (Brigham and Houston, 2011, p. 274). There is thus a risk that it does ignore new and current knowledge regarding economics, policies, technological development or innovative breakthroughs that may affect the future. It also has a tendency to change its value and thus volatility indication over time when applied to a single asset, which makes it unreliable as a long term projection tool for single assets. As the tool has these major limitation it may possibly serve as a potential indicator of price movement in relation to a broader index as well as a component to the CAPM model. It should however not be used solely as an indication of systematic risk over longer periods of time as it has been shown that there is no clear correlation between a single assets historical beta and the returns that the single assets offers (Brigham and Houston, 2011, p. 286).

An alternative to utilizing the beta coefficients as sole and direct indication of systematic risk for individual or single assets is to calculate the beta value within a
linear regression to benchmark a single security with a given market index (Bodie et al., 2011, p. 277-288). The linear regression of an index gives a good overview of how the return of a security relates to the index that is exposed towards a sector or an industry. Thus allowing the estimation if a single asset is more or less risky than the industry or sector as a whole.

In order to achieve this analysis it is firstly necessary to determine the best-fitting line through linear regression based on historical returns in a scatter plot with the market index on one axis and the firm on the other. The best fitting line is the line with the highest correlation coefficient between the returns of the index and the analyzed firms. The slope of the line thus corresponds to the systematic risk of the asset – also known as beta. The systematic risk tells us how much a stock return swings in comparison to the market, in other words if the market returns changes of 1 percent and the beta value becomes 1.5 for the specific firm, the assets return will thus change with 1.5 percent when the market changes with 1 percent (Berk and DeMarzo, 2013, p. 409-411).

The regression line builds on an intercept, the sensitivity of the stock compared to the market and a residual term that is related to the diversifiable risk of the stock. The intercept – alpha determines the slope of the regression and tells us what the expected return of the security is when the market return is zero, equation 5. It corresponds as a measure of a risk-adjusted historical stock performance since it’s derived from the expected return on the security market line (Berk and DeMarzo, 2013, p. 409-411; Bodie et al, 2011, p. 277).

\[ \text{Linear Regression} = E[R_i] = r_f + \beta_i(E[R_{mkt}] - r_f) + \alpha_i \]  

(Equation 5)

Where:  
\( E[R_i] \) = Expected return of security  
\( r_f \) = Risk-free interest rate  
\( \beta_i \) = Beta of security  
\( E[R_{mkt}] \) = Expected market return  
\( \alpha_i \) = Active Return (portfolios actual return - benchmark actual return)

This simplified model allows the authors of this thesis to minimize the number of inputs for the single-index universe. Alternative models requires a large number of estimates in contrast to this model. The authors can also utilize this model in specialized industries which is the case in this thesis. On the other hand it does not consider the uncertainty of asset returns in the reality; also it does not include all variables regarding stock returns such as specific industry events (Bodie et al, 2011, p. 279-280). In regards to the time constraint of this thesis the authors believe that this somewhat simplified model is an appropriate compliment to the CAPM and Fama-French Three Factor Model. It should offer a good overview on how the analyzed firms’ stocks are valuated, although being aware that underlying factors that are not covered by the model might influence the valuation. This statistical tool is also interesting when examining a specific stock because the firm specific risk can be diversified through portfolios where the risk is spread across assets. This model will however not be used as a sole tool to assess required returns, but rather as a complement to test the asset pricing models, such as CAPM or Fama-French which was discussed earlier in this thesis.
5. Practical Method

The practical methods described in this chapter are derived from the theoretical framework and notably from the financial tools, which were all discussed in the previous sections of this thesis. The quantitative approach that the authors of this thesis have chosen in order to answer the research question will require the use of statistical analysis of the collected data.

There are commonly a few different approaches to statistical data analysis depending on the purpose of the study, the object of the study, the time frame as well as the type of data that is collected. The most basic type of statistical analysis is a descriptive approach in which the purpose is to give a general overview of the results and to allow general patterns to arise from large data sets (Black, 2011, p. 6). Descriptive statistics do however not allow any conclusions to be drawn beyond the data that has been analyzed, to reach conclusions or perform deductions in regards of hypotheses testing (Anderson et al., 2013, p. 33-34). Although some descriptive statistics will be used in this thesis to summarize overall data patterns and trends, the descriptive approach does not enable the research question to be thoroughly analyzed and answered.

The second statistical approach which is far more useful for the purpose of this study is to apply inferential statistics to the data that is collected. As this thesis aims to investigate quite a significant part of the biofuel sector it is not feasible to collect data from all the companies comprising this sector over several years. Inferential statistics comprises approaches and techniques that allow the use of a representative sample in order to make generalizations about entire populations without the necessity to conduct a census (Black, 2011, p. 6-7). It is however of outmost importance that the sampled data accurately represent the studied population as clearly as possible in order for the interpretation of data and statistical analysis to be valid. The methods of inferential statistics thus allows the business researcher to structure problems in such a way that statistical data may be used to test, i.e. “prove” or “disprove” business phenomena through the testing of derived hypotheses (Black, 2011, 296).

Before further practical approaches are discussed it is important to briefly describe the object of the study, the biofuel industries and the abundance of different types of transportation biofuels and their characteristics. This will be performed in order to highlight the delimitation of the study as well as to show from which type of stratified groups the sample is chosen.

5.1 Overview of Transportation Biofuels

There are different ways of how to classify biofuels. The classifications can be based on raw materials, greenhouse gas (GHG) emission levels, or technological maturity. The International Energy Agency (IEA) classifies biofuels as either conventional or advanced according to the maturity level of the conversion technology used to produce the biofuels (Eisentraut et al., 2011, p. 7). Conventional biofuel technologies, commonly referred to as first-generation biofuels, are classified to comprise biofuel technologies and processes that are currently produced and distributed across the world on a commercial scale. These biofuels include mainly bioethanol from sugar and starch crops, such as corn, wheat, and sugarcane as well as biodiesel from raw vegetable oils, from crops such as soybean, rapeseeds, palm oil, or used cooking oils and animal fats.
The classification also includes gaseous biofuels such as biogas that is produced from different types of organic and industrial wastes, animal manure or sewage sludge (Eisentraut et al., 2011, p. 7).

Advanced biofuel technologies, also referred to as second or third generation biofuels, are conversion technologies that are currently undergoing research and development (R&D), pilot, demonstration or early commercialization phases (Eisentraut et al., 2011, p. 7). This category includes second-generation/cellulosic ethanol produced from non-food lignocellulose feedstock such as wood, grasses, agricultural and forestry residues. The classification also includes several different types of diesel fuels, such as hydrotreated vegetable oil (HVO), which uses similar raw materials as conventional biodiesel but yields a chemically different product than the conventional biodiesel technology. The classification also includes diesel fuels called biomass-to-liquids (BtL)-diesel and bio-synthetic gas (bio-SG), fuels that are produced from lignocellulose feedstock. The classification also includes several innovative technologies that are in the early research and development (R&D) or early pilot stages. These fuels include biodiesel produced from algae and microalgae as well as microbiological or chemical conversion of sugars into diesel-type biofuels or gaseous hydrogen produced from biogas or water (Eisentraut et al., 2011, p. 7). The classification of biofuels is summarized in Table 1.

Table 1. Main biofuel technologies, their sources and status

<table>
<thead>
<tr>
<th>Conventional biofuels</th>
<th>Source/raw material</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bioethanol</td>
<td>Sugar and starch crops (corn, grain, sugarcane)</td>
<td>Commercial</td>
</tr>
<tr>
<td>Biodiesel</td>
<td>Raw vegetable oils (soybean, canola, oil palm, sunflower), animal fats and used cooking oil.</td>
<td>Commercial</td>
</tr>
<tr>
<td>Biogas</td>
<td>Organic waste, animal manure, sewage sludge.</td>
<td>Commercial</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Advanced biofuels</th>
<th>Source/raw material</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cellulosic ethanol</td>
<td>Lignocellulose (wood, grasses, agricultural and forestry residues).</td>
<td>Demonstration/Early commercial</td>
</tr>
<tr>
<td>Advanced diesel fuels</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>HVO diesel</strong></td>
<td>Raw vegetable oils (soybean, canola, oil palm, sunflower), animal fats and used cooking oil.</td>
<td>Early commercial</td>
</tr>
<tr>
<td><strong>BtL-diesel</strong></td>
<td>Lignocellulose (wood, grasses, agricultural and forestry residues).</td>
<td>Demonstration</td>
</tr>
<tr>
<td><strong>Algal diesel</strong></td>
<td>Algae, Microalgae.</td>
<td>Research and Development</td>
</tr>
<tr>
<td><strong>Sugar-based hydrocarbons</strong></td>
<td>Sugars from either lignocellulose or starch.</td>
<td>Research and Development</td>
</tr>
<tr>
<td>Hydrogen</td>
<td>Biogas, water.</td>
<td>Research and Development</td>
</tr>
</tbody>
</table>


Bioethanol is mainly used as transportation fuel in cars and to some extent in heavy duty vehicles. The fuel is either blended with gasoline to produce E10 (10 percent
ethanol), E85 (85 percent ethanol) used in conventional or modified spark-combustion engines or as ED95 (95 percent ethanol) which can be used in diesel engines (Cavka, 2013, p. 6). Diesel engines offer a far greater fuel flexibility that is unprecedented by any other type of combustion engines. The advantage of the novel advanced biodiesel fuels such as HVO diesel and BtL-diesel is that these fuels may be blended with fossil diesel in any ratio or even used as drop-in fuels, thus completely replace fossil diesel fuels in existing engines and vehicles (Eisentraut et al., 2011, p. 13, p. 41). Conventional biodiesel is currently blended with fossil diesel fuels in concentrations of two, five or 20 percent biodiesel (Eisentraut et al., 2011, p. 11). Blending more than 20 percent biodiesel into fossil diesel fuels may requires special handling of the fuel (Atadashi et al., 2010, p. 2004).

5.2 Population and Sampling

As previously discussed in the introduction section of this thesis, the focus of this study is the renewable biofuel industries, more specifically the advanced biodiesels and as well as first generation biofuels producers. The study will solely focus on firms that are publically traded and that are listed on the NASDAQ or New York stock exchange. The main reasons to study publically traded firms is firstly the easy access to public and unbiased financial information. Secondly because private firms are difficult to assess objectively as they can only be assessed on the information that is disclosed by the firm rather than by the information disclosed and held by entire market. Thirdly, most of the privately owned companies that are involved within the field of renewable diesel are either partners of or have a directly involvement with the petroleum industry. The small number of firms that comprise this study are selected through a stratified selection that is delimited through a number of limitations set by the authors prior to the creation of strata in order to narrow down the groups of renewable biofuel companies. These limitations are as follows:

(i) The study should focus on companies that are involved in production of commercial volumes (millions of liters) of advanced biodiesel.

(ii) The firms should have a diversified product portfolio to go along with their biofuel business.

(iii) The studied firms should not include companies that are either partly or wholly owned, strongly supported by or have direct collaborations with leading oil or chemistry industries such BP Biofuels, DSM, BASF, Chevron, Royal Dutch Shell, etc.

(iv) The study should exclude companies that have a significant stake in the fossil fuel industries, i.e. predominantly earning their revenues from petrochemical products or fossil fuels (≥50 percent). Such as Neste Oil, the world’s largest producer of advanced biodiesel.

(v) Producers of first generation biofuels should be included as a benchmark of financial performance as these are considered as established biofuel securities with low risk.

The analyzed biofuel firms were sampled through a stratified selection approach among stratified groups of advanced biofuel firms previously classified by Milbrandt et al., (2013) of the National Renewable Energy Laboratory (NREL), Golden, Co, USA. The groups from which the studied firms were sampled were divided into HVO diesel, sugar derived advanced diesel, and synthetic biology platforms as well as conventional biofuels firms. The sampling of companies are summarized in Table 2 below.
Table 2. Biofuel companies that are included and analyzed in this study.

<table>
<thead>
<tr>
<th>Name</th>
<th>Main products</th>
<th>Market Capa</th>
<th>Employeesb</th>
<th>Listed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amyris Biotechnologies</td>
<td>Renewable biodiesel and chemicals from plant sugars</td>
<td>170M</td>
<td>400</td>
<td>October 2010</td>
</tr>
<tr>
<td>FutureFuel Corp.</td>
<td>Range of renewable chemicals and HVO diesel.</td>
<td>500M</td>
<td>500</td>
<td>May 1986</td>
</tr>
<tr>
<td>Methes Energies International Ltd.</td>
<td>HVO diesel and technology for renewable diesel.</td>
<td>10M</td>
<td>50</td>
<td>December 2012</td>
</tr>
<tr>
<td>Solazyme</td>
<td>Oils, including aviation fuel, and sugar based renewable diesel.</td>
<td>170M</td>
<td>250</td>
<td>June 2011</td>
</tr>
<tr>
<td>Archer-Daniels Midland Co.</td>
<td>Conventional biofuels, agricultural services, i.e. handling and processing.</td>
<td>32B</td>
<td>33,000</td>
<td>January 1978</td>
</tr>
<tr>
<td>Green Plains Renewable Energy</td>
<td>Conventional bioethanol and distiller’s grain (animal nutrition).</td>
<td>800M</td>
<td>700</td>
<td>March 2006</td>
</tr>
<tr>
<td>Pacific Ethanol Inc.</td>
<td>Conventional bioethanol, distiller’s grain and corn syrup.</td>
<td>230M</td>
<td>200</td>
<td>January 2004</td>
</tr>
</tbody>
</table>

*a Market value as of July 2014, given in Million USD (M) or Billion USD (B).

b Number of employees as of July 2014.

5.3 Data Collection

Possible data sources of financial data for the selected companies include among them several databases such as Google Finance, Yahoo Finance, Bloomberg, CNN Money and many more. The authors of this thesis have however chosen to retrieve financial data from the Thomson Reuters database DataStream. The database is selected because it is commonly used in scientific financial research while also offering a profound collection of important financial figures and statements that may be used by the authors to perform inferential statistics. The collected financial data is exported and transformed into a Microsoft Excel file that is possible to import into Excel or Minitab 17. Some formatting of the data will be necessary in order to import the data correctly to Excel and Minitab as the database exports data that is recognized by the software as text rather than as numerical data.

5.4 Statistical Tests and Data Handling

Minitab 17 (Minitab Inc., State College, PA, USA) and Microsoft Excel (Microsoft Corp., Redmond, WA, USA) will be used for the purpose of data handling, to perform statistical tests as well as to produce figures and tables that are found throughout this thesis. The choice of software for data analysis is founded on the experience and familiarity by the authors with the selected software.
5.5 Time Frame
The time period during which the randomly selected biofuel firms have been available and publically traded on the NASDAQ and the New York stock exchange are unfortunately quite different. Some of the firms have been on the stock exchange for several decades while yet others were listed as late as December 2012. This difference complicates the choice of the potential time frames during which the firms could be analyzed. Most financial research is set to time frames between 5 and 15 years as it eliminates biases that may arise from the use of longer or shorter time frames (Chang et al., 2012, p. 696). The most feasible approach is to set the time frame to 5 years, but as many of the selected firms are far younger than 5 years this approach is unfeasible. The next best approach is to set the time frame from when the most recently listed firm became available for trading on the stock exchange. This approach does however limit the time frame to less than two years, it would actually be 18 months. The authors have decided to forgo this approach and set the time frame from the second youngest firm among the selected companies, Renewable Energy Group Inc., which was listed in January 2012. This offers a time frame that is 30 months or two and half years, i.e. from January 2012 to July 2014. Setting the time frame to 30 months may cause inconclusive results to be derived from the data of the youngest firm, Methes Energies International Ltd., as the data available only cover 18 months of trading. The firm was despite that included in the analysis as there are few older companies on the market that it may substituted against. However, as the results of the firm caused an unexplainable deviation or decreasing correlations of the total data sets it was removed from further analysis after the initial results were obtained. The time frame is quite short but many of the studied firms are in the early stages of commercialization of state-of-the-art technologies and the industry as a whole is quite novel as well.

The length of the time frame may have important implications for the analysis of the results for several reasons. Many of the firms have been traded for longer periods of time than the analyzed period, which may enable them to be perceived as less volatile than the younger firms. Shorter time frames may also reflect financial information differently than longer time frames. Systematic risk, measured by the beta coefficient has been shown to work better under shorter time frames (King, 2009, p. 71). Furthermore, many of the analyzed firms were listed during a period (2005-2010) when the biofuel industries and the technologies behind these industries enjoyed a strong support and confidence from governmental programs, policy makers and the public alike. Their valuations and variance during longer time periods may thus be negatively reflected as the once promising outlook of the industry has been called into question in recent years. A time frame of 30 months does thus offer a period which should be valid in regards of statistical analysis while it also removes some of the negative publicity that the firms may have suffered from in the past.

5.6 Data Frequency
Looking ahead into the future in terms of making financial forecasts of the value and returns of financial asset and prices should be based on as relevant financial information as possible. There are however different types of financial information that could be used for this purpose, i.e. daily, intra-daily, monthly, quarterly or even annual data (Brooks, 2014, p. 4). Previous studies of financial and macroeconomic forecasting do however suggest that the use of quarterly, monthly or longer data series in general have a tendency to produce mixed and inconclusive results (Stock and Watson, 2003; Fonzi et al., 2003). Using shorter data frequencies than daily data series may on the contrary
cause observations that hold a risk of a significant bias since trades are usually not equally spaced throughout the day (Goodhart and O'Hara, 1997, p. 81). Using daily data is also of importance as it will yield the highest number of observations when short time periods are analyzed. The use of daily frequency data series thus eliminates the risks of shorter and longer data frequencies while also improving the generalization of results. Using daily data may however occasionally result in downward bias when betas are estimated for firms that have low trade volumes (Miller et al., 2013, p. 17). As the size and trade volumes of the analyzed firms are roughly equal, it is estimated that this bias will affect all beta estimates equally. Daily data frequency rather than longer data frequencies will be used in this thesis despite the risk of bias as they offer the highest numbers of observations in a short time frame.

5.7 Hypothesis Testing
The results of the above formulated hypotheses provide the authors of this thesis with a ground work to answer the posted research question. T-statistics were used to test the null hypotheses. Tests were conducted as one sided t-tests at a confidence level of 95 %, i.e. p-values ≤ 0.025. If correlation was 0, i.e. p ≥ 0.025, it would indicate that the null hypothesis should be retained, while at a p ≤ 0.025 it should be rejected and the alternative hypothesis should be retained because of sufficient evidence in the sample supports it.

5.8 Reliability, Generalization and Validity
Reliability refers to the concept of consistency within measurements of method and sample over time (Zikmund et al., 2012, p. 301). In order to consider an investigation reliable, the data and method should not fluctuate over time in order to render measurements and thus conclusions reliable. The type of study and data used for this investigation should ensure replication, decrease method bias, and allow consistent statistical analysis to be performed. The statistical tests that are performed should further increase the reliability as the analyzed data is produced in a quantitative manner outside of the author’s control.

Generalizability of theories and empirical evidence is considered to be one of the most important aspects of business research (Lee and Baskerville, 2003, p. 237). The criteria for generalization is sometimes so strong that researchers develop almost law like principles of how much data and how data sampling should be performed in order to generalize results. These criteria are however important in order for the results to be considered as general. Results must be applicable and observable within the entire population from which the sample was taken in order to be considered as general (Lee and Baskerville, 2003, p. 222). Although the study is based on a rather small population and a rather short time period which should suggest that there is no guarantee that the data will be possible to generalize to the entire population studied. However, as the population is small to start with, and as the industry is still emerging, the results should despite that provide some insight into the current state of the advanced biodiesel industries. The results should also contribute with novel knowledge about a sector of the industry that has only been sparsely studied previously. The research undertaken may thus to some extent guarantee generalizable results as well as to provide some insights new results of the state of the advanced biodiesel industries.
The issue of validity within research is concerned with the suitability of certain tools or methods for measurements of concepts, i.e. does the tool measure what it is supposed to measure (Zikmund et al., 2012, p.303). The models and tools that are utilized within this thesis are chosen and derived from theories that are commonly used with financial research. They are frequently used by researchers within finance and as well as within investment analysis, which should indicate that the tools are valid for the purpose that they are used in this thesis. The data is collected from a trustworthy financial database, i.e. the Thomson Reuters DataStream which further authenticates the validity of the study.
6. Results and Discussion

6.1 Tracking Crude Oil and Raw Material Prices

The existing body of knowledge regarding the biofuel industry tells two different tales of the conventional and advanced biofuel sectors. The conventional/first generation biofuel sector is consisted to be mature and represent a business sector that is yielding healthy returns on investment (Hofstrand, 2014; Figure 1). The advanced/second generation biofuel sector is on the contrary considered to be too risky to even merit investment (Miller et al., 2013, p. 31). The reasons behind this were discussed previously but as a reminder the most prominent reason were the higher production costs that are associated with advanced biofuel production (Demirbas, 2010; Milbrandt, 2013). While conventional biofuels may be produced at costs of 2.00-2.50 USD per gallon, the advanced biofuels are estimated to cost anywhere between 5 USD per gallon (renewable diesel from soybean) to as high as 10 or even 20.5 USD per gallon (biodiesel from algae) (Milbrandt, 2013, p. 7-10). An additional factor is also the low crude oil price from which competitive fossil transportation fuels are made (Eisentraut et al., 2011, p. 39).

The average Brent oil price was at levels of just above 100 USD per barrel in 2011 when the International Energy Agency deemed second generation biofuels non-competitive at contemporary fossil oil prices (Eisentraut et al., 2011, p. 39; IEO2013, 2013, p. 58). The Brent oil price for the time period that this study covers are charted below in Figure 2. As the chart shows, the price has varied around 95 USD, not significantly higher than 2011.

![Figure 2. Brent crude oil price in USD per barrel for the period 2012-01-01 – 2014-07-31](image)

As previously discussed it is also extremely difficult to project future oil prices, which exposes the second generation industry to risks outside of the investor’s control. The reference case shown in Figure 3 presented by EIA projects an increase of the Brent crude oil price from 81 USD per barrel in 2010, to 117 USD per barrel in 2025 and 163
USD per barrel in 2040 (IEO2013, 2013, p. 25). The price variance and insecurities within the reference case are however major and the prices could also be as low as 75 USD per barrel or as high as 206 USD per barrel in 2040. The insecurities of projecting future crude oil prices were clearly evident shortly after the studied time period, i.e. the fall of 2014. In July 2014 at the end of the studied time period the crude oil price was around 100 USD per barrel after which it went into free fall and in December 2014 the price had dropped to around 55 USD per barrel. An incredible drop of over 45 percent in only six months’ time. Such a development does undoubtedly show the difficulty to project crude oil prices even during very short time frames.

Figure 3. EIA projected prices of Brent oil. Black line represents the reference case, dark grey the high oil prices and light gray the low prices.

While the oil price has varied around similar levels that were evident in 2011, the raw material prices have on the contrary increased significantly since Demirbas (2010) deemed advanced biodiesel production too expensive from soybean oil at a cost of 1.26 USD/gallon. Tracking the price of soybean oil is particularly interesting as most U.S. biodiesel plants operate on soybean oil as their raw material. The price at the start of the studied time period was 4 USD/gallon and has since dropped to around 2.8 USD/gallon in the summer of 2014, see Figure 4 on the next page. A price that is more than double the price that was evident in 2010 when the raw material prices were considered to be too high to yield profit from biodiesel operation.

In view of the price development of crude oil, soybean oil and the uncertainty surrounding the future crude oil and raw material prices there are very few factors that would even remotely indicate a potentially different scenario in this study than those indicated by Demirbas (2010), Eisentraut et al., (2011), Milbrandt et al., (2013), Miller et al., (2013) and Hofstrand (2014). The comprehensive scenario presented by these studies advocates a biofuel industry where the first generation biofuel sector is considerably less risky and more profitable for investment than the second generation biofuel sector. Furthermore, as previously illustrated, not much has changed in favor of the emerging advanced biodiesel industries that would indicate that the situation even remotely could be different than results of the advanced bioethanol sector. A sector which was deemed too risky to even merit investment (Miller et al., 2013, p. 31).
6.2 Capital Asset Pricing Model and Beta

As previously discussed there are different types of risks that any type of business may be exposed to. These include among them firm level risks such as price risks, resource availability, credit and operational risks as well as macroeconomic risks such as political uncertainty, changes in regulatory policies or support from stakeholders or even exchange and interest risks (Miller et al., 2013, p. 14). While many of the firm level risks are within the control of the management responsible for the operation of the firm, the systematic market risks are outside of the managements reach. Suggesting in accordance with the effective market hypothesis theory that all the information available to the market regarding the firm will have an immediate impact on the perception and valuation of the firm.

Knowing the level of the systematic risk in relation to the market will in turn result in a certain required return on investment for the investor to even consider investment. Within the second generation biofuel sector the systematic risk consists of many different factors. As previously discussed these are mainly the current and future crude oil prices, raw material prices, future uncertainties on policies and stakeholder loyalty. Other factors may on the contrary be internal, such as the levels of profitability, access to liquidity reservoirs or internal business structures such as diversification or specialization of the business.

Systematic risks may be appreciated by the beta coefficient of the capital asset pricing model (CAPM) as it represents a measure of the non-diversifiable systematic risks that the market sets on each firm. Beta values were in this study calculated through regression analysis on both daily and weekly return data despite the fact that daily data were deemed most appropriate for the studied period. The inclusion of weekly data is performed due to the fact that the beta values presented by Miller et al., (2013) were based on weekly return data rather than daily. The inclusion of weekly data to the analysis was done mainly in order to circumvent potential criticism regarding the use of daily return data as an attempt to intentionally bias the results in favor for the emerging
advanced biodiesel sector. Secondly this approach would also allow the results of this study to be directly comparable with those presented by Miller et al., (2013). An analysis that was performed on the advanced bioethanol sector.

The average market risk in the CAPM model is represented by the S&P 500 index, which has yielded an average return of 8 percent annually for the last decade. The risk free interest is represented by the average of the three month US Treasury Bill during the last 10 years, which was on average 1.9 percent. A beta value of 1.00 suggests that the firms are considered to carry the same systematic risk as the S&P 500 index which is comprised by the 500 biggest publically traded firms in the world. A beta coefficient below 1.00 suggests that the firm is considered less risky than the market in general. Beta value of above 1.00 suggest that the firm is considered riskier than the market in general. The systematic risks and required returns which on the analyzed biofuel firms in this study are presented in Table 3 below.

Table 3. Systematic risks and required return on investment in the advanced biodiesel sector and the conventional biofuel sector.

<table>
<thead>
<tr>
<th>Company – Industry</th>
<th>Ticker Symbol</th>
<th>Beta (daily)(^a)</th>
<th>Expected Return (%)(^b)</th>
<th>Beta (Weekly)(^c)</th>
<th>Expected Return (%)(^b)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Advanced biodiesel</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Amyris Biotechnologies</td>
<td>AMRS</td>
<td>2.16</td>
<td>15.09</td>
<td>3.35</td>
<td>22.35</td>
</tr>
<tr>
<td>FutureFuel Corp.</td>
<td>FF</td>
<td>1.37</td>
<td>10.23</td>
<td>1.08</td>
<td>8.47</td>
</tr>
<tr>
<td>Methes Energies International</td>
<td>MEIL</td>
<td>0.04</td>
<td>2.14</td>
<td>0.03</td>
<td>2.07</td>
</tr>
<tr>
<td>Renewable Energy Group Inc.</td>
<td>REGI</td>
<td>1.26</td>
<td>9.62</td>
<td>1.52</td>
<td>11.15</td>
</tr>
<tr>
<td>Solazyme Inc.</td>
<td>SZYM</td>
<td>1.24</td>
<td>9.44</td>
<td>1.07</td>
<td>8.42</td>
</tr>
<tr>
<td><strong>Conventional biofuels</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Archer-Daniels Midland Co.</td>
<td>ADM</td>
<td>0.98</td>
<td>7.88</td>
<td>0.97</td>
<td>7.82</td>
</tr>
<tr>
<td>Green Plains Renewable Energy</td>
<td>GPRE</td>
<td>1.41</td>
<td>10.50</td>
<td>1.17</td>
<td>9.01</td>
</tr>
<tr>
<td>Pacific Ethanol Inc.</td>
<td>PEIX</td>
<td>1.58</td>
<td>11.55</td>
<td>1.76</td>
<td>12.63</td>
</tr>
</tbody>
</table>

\(^a\) Calculated through regression analysis using daily return data for the period 2012-01-01 to 2014-07-31.  
\(^b\) Required return are calculated with the risk free interest set to 1.9 percent and the average return of the market to 8 percent.  
\(^c\) Calculated through regression analysis using weekly return data for the period 2012-01-01 to 2014-07-31.

Considering that the analyzed firms are operating within a novel and emerging market it is not farfetched to expect these firms to be riskier than the firms comprising the S&P 500 index. The results of the beta analysis do indeed suggest that the firms at a first glance may be considered to be riskier. This will however need to be tested with the use of the previously set hypothesis through inferential statistics.

One of the firms, Methes Energies International Ltd. returned a deviating and unreasonably low beta coefficient compared to market and compared to the other firms. The reason behind the very low beta coefficient is probably the very low trading volumes of the firm at the NASDAQ stock exchange. As previously discussed, the beta coefficient may be biased towards artificially low values if the trading volumes are low, which was evident in this particular case. An attempt to determine the beta coefficient for Methes Energies International Ltd. with the use of monthly data with higher trading
volumes was attempted but the results were similar to those in Table 3. Considering the artificially low beta coefficient, it was decided that the firm would be excluded from further financial analysis in order to avoid further complications or biasing of the results. An additional reason why Methes Energies International Ltd. was excluded from further analysis was due to the fact that the firm’s initial public offering was in October 2012. The comparison with other firms could thus potentially be biased or inaccurate given the time frame that the thesis employs. The authors initial intention was however to include Methes despite that as it did match the set sample criteria and as there were few other firms that could fulfill those criteria better.

The low beta coefficients of 0.98 and 0.97 for Archer Daniels Midland Co. (ADM), should not come as a surprise for those familiar with the conventional biofuel industries. ADM is an S&P 500 component and global food-processing and commodities trading conglomerate. The firm operates 285 production plants, 420 crop processing facilities and has 33,000 employees worldwide (AMD Worldwide, 2014). The firm’s stake in the conventional biofuel industry includes production of conventional bioethanol from corn and grain as well as biodiesel from vegetable oils. The inclusion of the ADM in this study does creates a point of reference for the rest of the conventional biofuel sector as well as the emerging advanced biodiesel sector in terms of risk and required return. The beta coefficient for the other analyzed firms do indicating that they may be considered as risker than ADM as well as the market in general at a first glance. This result could be expected considering that the other firms are smaller than ADM and far less vertically integrated in terms of raw material supplies. This exposes them stronger to external factors such as raw material prices, crude oil prices as well as other macroeconomic risks.

The highest beta coefficient of the analyzed firms is held by Amryis Biotechnologies that has a beta coefficients of 2.16 (daily) and 3.35 (weekly), suggesting that the firm is considered to hold a far greater systematic risk than the market in general. This is also reflected by the required return on investment which are either 15.08 or 22.35 percent depending on if daily or weekly return data are used. This is considerably higher than the expected return from the S&P 500 index that returns on average 8 percent. The beta coefficient and required return on investment of Amryis Biotechnologies resembles the required returns on investment that were appreciated by Miller et al., (2013) for firms within the advanced bioethanol industries. Firms that were considered to be too risky to merit investment.

As previously mentioned the results of the other analyzed firms operating within conventional biofuel and advanced biodiesel sectors suggest that the beta coefficients for these firms may be higher than the average market, represented by S&P 500 index. The results do however surprisingly show that several of the analyzed advanced biodiesel firms have lower beta coefficients and expected returns than the conventional biofuel firms included. The beta coefficients on daily data were, as is evident in Table 3; 1.37 for FutureFuel Corp., 1.26 for Renewable Energy Group Inc., and 1.24 for Solazyme Inc. compared to those apparent in Green Plains Renewable Energy and Pacific Ethanol Inc. that were 1.41 and 1.56, respectively. These results, based on daily return data, seem to contradict the expected outcome based on previous studies on the advanced bioethanol sector and the recent development of the crude oil and raw material prices, see Figures 2 and 4. The average required returns based on the resulting beta coefficients suggest that the average required return from the conventional biofuel
industry is 10 percent while it on average would be 11 percent from the analyzed advanced biodiesel firms. Both required returns are only slightly higher than the average return achieved from the S&P 500, which was around 8 percent annually during the last decade.

When weekly data are used the results of the analyzed firms diverged somewhat compared to when daily data were used. As previously mentioned, the weekly data could be used to avoid the downward bias that may arise from the use of daily data about firms that have low trade volumes (Miller et al., 2013, p.17). The results of the betas based on weekly data do however result in lower beta values for most firms, contrary to the expected higher values due to downward bias of daily return data. Using the weekly return data to calculate the betas decreases the beta values for FutureFuel Corp. from 1.26 to 1.08, for Solazyme Inc. from 1.24 to 1.07 and for Green Plains Renewable Energy from 1.41 to 1.17. The betas do increase for Renewable Energy Group Inc. from 1.26 to 1.52 and for Pacific Ethanol Inc. from 1.56 to 1.76. The average returns do increase for the advanced biodiesel firms when weekly return data are used compared to daily data, mainly due to the increase of Amyris Biotechnologies as was previously discussed. The average returns increases from 11.09 to 12.60 for the advanced diesel firms when the deviating result of Amyris Biotechnology is included. The average required returns do however decrease when Amyris Biotechnology is excluded from the calculation, i.e. from 11.09 to 9.35. In the conventional biofuel sector the average returns only change slightly when daily and weekly return data are used, they are on average 9.98 and 9.82 respectively.

Using weekly return data compared to daily return data indicate that the use of weekly data in the CAPM do yield somewhat more diverging results than the use of daily return data. The beta values do however not seem to suffer from a general downward bias from the use of daily return data. The results on weekly return data are in fact in most cases lower than those of daily return data, suggesting that it would have been impossible to intentionally bias the data in favor of the advanced biodiesel sector by solely using daily return data rather than weekly. Daily data were thus used exclusively in the subsequent statistical testing and analysis in order to compress and simplify further presentation and discussion of the obtained results.

Beta coefficients and required returns were also calculated for the all of the analyzed firms with the MLCX biofuel index as the reference index rather than the S&P 500 index. The MLCX is a total return index that attempts to diversify risk within the biofuel industry by investing in commodities that are used for biofuel production. The results of the beta coefficients and required returns indicate that all the analyzed firms carry far less systematic risk than the index targeting raw material commodities used in the biofuel industries. All beta coefficients were in the range of 0.2-0.3 with required returns being just below 3 percent on average. The results are somewhat surprising but they are probably the result of the high variance of the index during the studied time period and the low average return that the index has achieved, which was 3 percent on average in the last five years.

Previous studies and knowledge regarding the conventional biofuel sector suggest that firms operating in the conventional biofuel sector are considered to be mature and yield healthy returns for investors, see Figure 1 for details. While the advanced biofuel sector is considered risker and in some cases too risky to even merit investment to further

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develop and grow the sector. The results of the advanced biodiesel sector do however suggest that the studied firms defy previous knowledge and expected results considering the evident macroeconomic external risks. They are not only similar to the conventional biofuel sector but they are also considerably lower than the betas and required returns that were evident in the advanced bioethanol sector which was analyzed by Miller et al., (2013). The advanced bioethanol sector required an average return on investment of around 15 percent rather than 11.09 or even the lower 9.35 when the deviating results of Amyris Biotechnologies were removed from the results of the advanced biodiesel sector. The initial results of the CAPM do seem to indicate a noteworthy difference between the systematic risks evident in the advanced biodiesel sector compared to the advanced bioethanol sector. Despite the fact that the sectors share many external risks, such as low crude oil prices, risks of changing governmental supports or long term stakeholder loyalties. One of the potential explanations behind this difference may lay in the delimitation and sampling that was performed in the selection of firms to be analyzed for this thesis. This is further discussed in the section 6.5, covering earnings, working capital and cash flows among the analyzed companies.

6.3 Fama-French Three Factor Model
The results of the CAPM model indicate that the systematic risks and required returns within the advanced biofuel industries are not considerably higher than within the conventional biofuel industries. Although both sectors seem to be somewhat higher than the market in general. The CAPM does however as previously discussed in the practical framework only use one factor to perform the risk analysis, i.e. the correlation between systematic risks (Beta) and the average returns. The Fama-French Three Factor Model (TFM) is on the contrary to the CAPM is more complex and comprehensive, which allows for a more accurate analysis to be performed. The model should also offer a more accurate assessment of risk and return of stocks from smaller firms with exposure towards emerging industries and sectors. It may thus capture factors that are excluded by the CAPM which in turn may render results of systematic risks that are different from those achieved with the CAPM. On the contrary, if the results are consistent between the two models it should further support that the results of the indicated risks and returns among the analyzed firms have been correctly assessed.

The factor loadings used in the TFM model are commonly constructed using either value- or equally-weighted portfolios from stocks listed on the New York Stock Exchange (Fama and French, 1988, p. 252). The former summarizes the market returns of large stocks while the latter is leant towards stocks with smaller trading volumes and values. The construction of Fama-French factors that accurately reflect the industry to which the analyzed stock belongs may seem laborious and time consuming, and forthrightly it is. The factors are however constructed and published through the Kenneth R. French Data Library which is made available online by the Tuck Business School at Dartmouth College (Kenneth R. French Data Library, 2014). The database offers equally- and weighted-factors from as far back as 1927 and all the way until the previous calendar month. The approach of using value- or equally-weighted factors that are publically available should allow for more accurate factor loadings to be used. This should subsequently result in factor returns that more precisely estimates the correlation between size and average returns as well as lower errors of factor risk premia (Fama and French 1993, p. 7-8). The results of the TFM model that are summarized in Table 4 below does however not use the portfolio factors that are made available by the Data Library at Tuck Business School.
The main reason why the value- or equally-weighted portfolio factors are not used to estimate the cross sectional average stock returns of the emerging biodiesel sector are the result of Ang et al., (2008). The study clearly shows after extensive empirical mathematical and statistical analysis that the use of portfolio factors does not result in more efficient estimates of factor risks (Ang et al., 2008, p. 2). On the contrary, the study shows that grouping of stocks into portfolios based on the firm characteristics actually destroys the cross-sectional information of the individual firms and inflates the standard error of the analysis (ibid.). Using an approach that estimates factor loadings and expected returns of individual stocks by using portfolios is however still common practice since Fama and French (1992). The approach should as previously mentioned result in more precise estimation of factor loadings while also improving the efficiency by using all stocks as observations. This assumption does however not seem to be valid according to the results of Ang. et al., (2008).

The results clearly indicate that grouping stocks into portfolios based on firm characteristics does rather obstruct the information contained in each individual stock factor loading. It does furthermore tend to decrease the cross-sectional distribution of betas (Ang. et al., 2008, p. 24). Such an analysis runs the risk of creating a downward bias of the analyzed firms as being less risky than they actually are if factors are estimated by the use of portfolios. Individual stocks rather than grouped portfolios were for this reason used to perform the TFM analysis of the emerging biodiesel sector in this thesis. This should permit more accurate estimates of the models loading factors to be performed and thus allow the pricing of risk to be more accurately determined for each individual firm. The factor loading used in to estimate the expected returns are summarized in Table 4 below together with the estimated returns.

Table 4. Fama-French Three Factor Model analysis of factor loadings and required returns.

<table>
<thead>
<tr>
<th>Company – Industry</th>
<th>Ticker Symbol</th>
<th>SMB Factora</th>
<th>HML Factorb</th>
<th>Market Betae</th>
<th>Expected return (%)d</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Advanced biodiesel</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Amyris Biotechnologies</td>
<td>AMRS</td>
<td>1.68</td>
<td>0.58</td>
<td>2.16</td>
<td>10.43</td>
</tr>
<tr>
<td>FutureFuel Corp.</td>
<td>FF</td>
<td>0.13</td>
<td>0.12</td>
<td>1.37</td>
<td>10.52</td>
</tr>
<tr>
<td>Methes Energies International</td>
<td>MEIL</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Renewable Energy Group Inc.</td>
<td>REGI</td>
<td>0.64</td>
<td>0.58</td>
<td>1.26</td>
<td>7.99</td>
</tr>
<tr>
<td>Solazyme Inc.</td>
<td>SZYM</td>
<td>0.17</td>
<td>0.16</td>
<td>1.24</td>
<td>9.02</td>
</tr>
<tr>
<td><strong>Conventional biofuels</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Archer-Daniels Midland Co.</td>
<td>ADM</td>
<td>0.09</td>
<td>0.02</td>
<td>0.98</td>
<td>8.14</td>
</tr>
<tr>
<td>Green Plains Renewable Energy</td>
<td>GPRE</td>
<td>0.04</td>
<td>-0.16</td>
<td>1.41</td>
<td>10.33</td>
</tr>
<tr>
<td>Pacific Ethanol Inc.</td>
<td>PEIX</td>
<td>0.67</td>
<td>-1.3</td>
<td>1.58</td>
<td>9.06</td>
</tr>
</tbody>
</table>

a Small minus Big (SMB) factors were determined with the use of regression analysis using monthly return data for the period 2012-01-01 to 2014-07-31 with each individual stocks as the benchmark.
b High minus Low (HML) factor was calculated through regression analysis using monthly return data for the period 2012-01-01 to 2014-07-31 with each individual stocks as the benchmark.

c Market betas were determined through linear regression with the S&P500 as the reference index.
Expected returns are calculated with the risk free interest set to 1.9 percent and the average return of the market set to 8 percent.

The TFM equation (Equation 3) is restated below from the method section in order to take the discussion of the results back to first principles and further promote the discussion of the results there were obtained.

\[ E(r_i) - r_f = \alpha_i + b_i [E(r_m) - r_f] + s_i E[SMB] + h_i E[HML] \]

(Equation 3)

The estimation of the factor loadings, i.e. SMB and HML factors that were based on individual stocks did to some extent result in higher standard errors when the factors were estimated on monthly data for each individual stock. The risk of obtaining high standard errors in the estimation of factor loadings on individual stocks rather than groups of stocks is rather intuitive. This may be particularly evident if data points are spaced 30 days apart over a period of 30 months as they were in the analysis performed, i.e. the value of the stock may change quite considerably from month to month. Despite the higher standard errors the approach was deemed as more suitable than grouping the individual stocks with others as this grouping may have obstructed valuable information contained in each individual stock.

The results of the factor loading were quite different across the analyzed stocks as is evident by the results displayed in Table 4. The lowest factors loadings were achieved for the largest firm included in the analysis, i.e. Archer Daniels Midland Co. (ADM). ADM had a SMB that was 0.09 and the HML was 0.02 which results in a marginal increase compared to the expected returns of the CAPM model. TFM resulted in estimated return of 8.14 percent compared to the estimated return of 7.88 that were achieved from the one factor model that was the CAPM. The marginal difference between the CAPM and TFM on firms of the size of ADM may have been expected. Particularly as the TFM model is designed to overcome the shortcomings of the CAPM model in terms of biased or distorted valuations of stocks from smaller firms (Fama and French, 1992, p. 428).

The results obtained for the smaller firms were quite different and the results were to some extent quite unexpected. The differences between the TFM and CAPM were most significant for Amyris Biotechnologies as the estimated returns appraised by the TFM were 10.43 compared to 15.09 expected by the CAPM. The rather remarkable difference in the results can only be credited to the inclusion of additional dimensions or factors in the estimation. Particularly as the market beta, the risk free interest rate and expected return of the market was identical to that of the CAPM. The SMB factor was quite large for Amyris Biotechnologies as it reached 1.68 while the HML was somewhat smaller at 0.58. With the beta holding a negative value for the SMB of -2.9 the factor alone thus decreased the expected return with 4.87 percent. The HML contributed with a marginal increase of 0.23 (beta 0.4).

Many of the other firms that were analyzed had quite similar results between the CAPM and TFM. FutureFuel Corp. had an estimated return of 10.23 in the CAPM while achieving 10.52 in the TFM. The loading factors were in this case quite low with an SMB of 0.13 and a HML of 0.12, much smaller than was evident with Amyris
Biotechnologies. Solazyme Inc. moved on the opposite direction of FutureFuel Corp. as the estimated return decreased from 9.44 to 9.02 on low SMB of 0.17 and HML of 0.16 factor loadings. Renewable Energy Group Inc. and Pacific Ethanol Inc. yielded results that were somewhere between those of Amyris, FutureFuel and Solazyme. The estimated returns of both firms decreased in the TFM compared to the CAPM. Renewable Energy Group Inc. moved from an estimated return of 9.62 to 7.99, which is essentially the estimated return of the general market at 8.00 percent. Pacific Ethanol Inc. decreased the estimated return from 11.55 in the CAPM to 9.06 in the TFM, also moving closer to the market average compared to previous estimates.

The CAPM uses only one factor to estimate the expected return of a security, i.e. the difference in stock price on daily or weekly basis compared to the market, represented by the S&P 500. As previously discussed, the weakness in such a model is that the actual potential of a small firm may be obscured by the risk that the model yields. By including additional factors as is done in the TFM the risks and estimated returns may be more accurately appreciated as several more factors are used to estimate the returns. Many of the analyzed firms did not differ very much between the CAPM and TFM, such as ADM, FutureFuel Corp. and Solazyme Inc. while others had remarkably different results as is evident in the result of Amyris Biotechnologies. Renewable Energy Group Inc. and Pacific Ethanol Inc. were estimated to have notably lower estimated returns that approached the average market or were essentially the same as the market average.

The average returns of the emerging biodiesel sector was in the TFM analysis 9.49 percent compared to 11.09 in the CAPM when the deviating results of Amyris Biotechnologies were included. When excluding Amyris Biotechnologies in the CAPM the average decreased to 9.35 while achieving 9.18 in the TFM under the same circumstances. The conventional biofuel industry had an estimated average return of 9.98 in the CAPM compared to 9.18 in the TFM. The results of the estimated returns will be used to further analyze the differences between the sectors when the set hypotheses of the study are tested statically further on in section 6.5. The average estimated returns of the TFM are at a first glance not very different between the first and second generation biofuel sectors, 9.18 and 9.49 respectively. The results correspond rather well to the results achieved in the previous analysis with the CAPM. The CAPM results were slightly higher on average for the renewable biodiesel sector due to the deviating results of Amyris Biotechnologies that had an estimated return of 15.09 compared to the average of 9.35 for the other three firms.

The risk estimates by the two models should however not be taken as absolute evidence that the firms hold a certain level of risk in reality. Particularly as risk and investment returns may be effected by many additional factors that are not covered in these models. However, in the words of the late Prof. George E. P. Box; “...all models are essentially wrong; the practical question is how wrong they have to be to not be useful.” (Box and Draper, 1987, p. 74). The CAPM and TFM models are commonly used to estimate market risks by financial market analysts as well as scientist and researchers alike. They may thus be valid to use for the analysis of market risks and provide some valuable and important insights into the state of the emerging biofuel industries.
The CAPM model was the centerpiece in the analysis that was performed by Miller et al., (2013) on the advanced bioethanol sector. The risk free interest rate and average market returns were in that study were set to the same levels as were done in the CAPM used in this study, i.e. 1.9 and 8.00 percent respectively. The results of this study do however differ from that of Miller et al., (2013). While the advanced bioethanol sector was deemed to be too risky at 15 percent, the CAPM in this study yielded average estimated returns of 11.09 percent while being even lower when the TFM was used, achieving 9.35 percent for the advanced biodiesel sector. To our knowledge, this is the first study that applies the TFM to the emerging biofuel industries in general and the first study of the emerging renewable biodiesel sector in particular. For that reason it is difficult to compare the results of this study with any other study in order to validate or compare the achieved results. The results of the TFM do however concur with the results of the CAPM and together these models indicate that the advanced biofuel industry cannot be judged solely on the results of the advanced bioethanol sector. The firms in the advanced renewable biodiesel sector are apparently quite different from those of the bioethanol sector in terms of financial risks and required returns.

6.5 Hypothesis testing

A number of hypothesis were derived from the existing body of knowledge regarding the risks and potential returns of the advanced biofuel industry, the conventional biofuel industry and the market in general. The results of the statistical tests of these hypotheses are summarized in Table 5 on the next page.

All hypotheses in section 3.9 were formulated on the foundations of existing literature and evident external factors, such as low crude oil prices, high raw material prices, and the higher levels of profitability in the conventional biofuel sector. The current conditions of the circumstances in which the firms operate did not provide any indication that these firms would be any different from those previously studied. The existing body of knowledge did furthermore indicate that the risks within the advanced biofuel sector in general would be high and require higher returns than the general market indices, i.e. S&P 500 (Miller et al., 2013). The hypotheses were thus formulated to provide a complete picture of the studied firms and to allow statistical test of the obtained results to be performed.

The results derived from the inferential statistical testing of the hypotheses formulated in section 3.9 are presented in Table 5. They support the previously discussed notion that the results from the factor models on average risks and estimated returns are not significantly higher for the studied advanced biodiesel firms than conventional biofuel firms. Contrary to what could have be anticipated from the results of previous studies and current external market factors. Surprisingly, the testing of the set hypotheses also indicate that the studied advanced biodiesel firms are on average not significantly riskier than the general market indices, represented by the S&P500. A results which is truly surprising considering that the studied firms all operate in an emerging and growing market where there are many different factors of uncertainty.

The statistical tests furthermore also indicate show the average risk of advanced biodiesel firms are not significantly higher than those of the conventional biofuel firms, according to hypothesis four. The result could be anticipated as the factor models did not indicate a significant difference in the estimated risks that were vastly different between the two sectors. The results are furthermore expected as same models showed
that the returns between the two sectors were not found to be significantly different. As the risks and returns of the studied advanced biodiesel firms were not found to be significantly higher than the S&P500 index it is not surprising that they would be similar or lower than the conventional biofuel sector.

Table 5. Interferential statistical testing of hypotheses regarding the studied advanced biodiesel firms.

<table>
<thead>
<tr>
<th>Hypotheses</th>
<th>95% Confidence</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>( H_1 ): The required average returns of advanced biodiesel firms are higher than the average returns from conventional biofuel firms.</td>
<td>X</td>
<td>P-value: 0.074</td>
</tr>
<tr>
<td>( H_2 ): The required average returns of advanced biodiesel firms are higher than average returns of the MLCX Biofuels Index, representing the biofuel industry as whole.</td>
<td>X</td>
<td>P-value: 0.083</td>
</tr>
<tr>
<td>( H_3 ): The required average returns of advanced biodiesel firms are higher than the average returns of the conventional indexes, such as the S&amp;P 500.</td>
<td>X</td>
<td>P-value: 0.054</td>
</tr>
<tr>
<td>( H_4 ): The average systematic risks of advanced biodiesel firms are higher than average risks of the systematic risks of conventional biofuel firms.</td>
<td>X</td>
<td>P-value: 0.045</td>
</tr>
<tr>
<td>( H_5 ): The average systematic risks of advanced biodiesel firms are higher than the systematic risks of MLCX Biofuels Index, representing the biofuel industry as whole.</td>
<td>X</td>
<td>P-value: 0.076</td>
</tr>
<tr>
<td>( H_6 ): The average systematic risks of advanced biodiesel firms are higher than the systematic risks of general indices, such as the S&amp;P 500.</td>
<td>X</td>
<td>P-value: 0.054</td>
</tr>
</tbody>
</table>

\(^aX = Do \text{ not reject } H_0 \text{ because of insufficient evident support for } H_1; V = \text{ Reject } H_0 \text{ and accept } H_1 \text{ because of sufficient evidence in the sample in favor of } H_1.\)

Considering the unexpected results of the factor models and the inferential statistics it is important to consider what factors that could be responsible for the achieved results. Some of these were already discussed in the previous section but it is important to
consider internal firm specific factors as it appears that the external factors cannot alone explain the achieved results.

6.5 Earnings, Cash Flow and Working Capital

There are many different performance indicators that may be used to assess a firm’s financial health and long term potential. The indicator which is used to assess the studied firms of this thesis is the earnings before interest, taxes, depreciation, and amortization (EBITDA) of all the analyzed firms in this study. Although not being a generally accepted accounting principle, the EBITDA is widely used among commercial lenders and credit analysts alike as a measurement of cash flows and profitability when assessing the performance of specific firms (Eastman, 1996, p. 64; Grant and Parker, 2002, p. 205). EBITDA is useful for its simplicity and because it allows firms to be compared on basis of their operations, without taking into account how the firms actually chose to finance their assets (Peterson-Drake and Fabozzi, 2012, p. 183). The tool is particularly useful for industries that are heavily capital intensive, such as the biofuel industry. This is because EBITDA in contrast to other measurements of profitability and financial performance such as Net Income does not take into account large depreciation expenses that may arise from heavy investment into expensive production facilities (ibid, p. 183).

Prior to discussing the results based on this simple one equation measurements it should be noted that the tool has received criticism for being overly simple (Eastman, 1996) and that it omits potentially significant outgoing cash flows such as interest payments and amortizations (Peterson-Drake and Fabozzi, 2012, p. 183). Factors that may put a considerable strains on the cash flow of capital intensive firms such as those analyzed in this study. Although being an imperfect tool, the EBITDA may provide a better measurements of profitability than many alternative tools that may have be applied instead. It should however be stated the tool will not be used for analysis of cash flow as the tool is deemed to be unsuitable for cash flow analysis. The results of the analyzed firms are summarized in Table 6 on the next page for the entire studied time period and given in an annual periodicity.

The EBITDA’s found in Table 6 indicate that the year 2012 was a quite meager year for the biofuel industries as most analyzed firms show rather low positive or even negative EBITDA, Archer-Daniels Midland Co. excluded. This notion is supported by the models of Hofstrand (2014) that indicate a negative average return from the conventional biofuel industries (Figure 2). One of the main reasons for this is probably the high raw material prices that were evident during 2012, with soybean oil trading at a price of above 3.5 USD per gallon on average (Figure 4).

Amyris Biotechnologies, Solazyme Inc. and Pacific Ethanol Inc. were the firms with the lowest profitability during 2012, with EBITDA of -186, -79 and -18 million US dollars (MUSD), respectively. The former firms did in contrast to Pacific Ethanol Inc. show continuing negative EBITDA for 2013 as well as 2014 when the overall industry did become more profitable due to decreasing raw material prices (Figures 2 and 4). Pacific Ethanol Inc. did on the contrary displayed positive EBITDA of 31 MUSD for 2013 and 71 MUSD for the first two quarters of 2014. Low profitability does however not directly correlate to higher financial risks and thus subsequently higher required returns, as the study of Allied Product Corporation by Dugan and Sampson (1996) shows.
Dugan and Sampson (1996) studied Allied Product Corporation because the firm had shown significantly diverging results of earnings and operating cash flows over almost a decade. While earnings (measured by net income) were positive during the studied time period, the cash flow from operations was largely negative during the same time period. Once the cash flow from operations climbed into the positive range, the stock which was traded between 2-3 US dollars when cash flows were negative was suddenly traded at 25 US dollar when cash flows were positive, with sustained levels of earnings. The study thus found that the economic reality and perceived risks within a firm are better reflected by its cash flow from operations rather than the firm’s earnings. Furthermore, as EBITDA was deemed a quite ineffective tool for cash flow analysis in capital intensive firms the results in Table 6 should not be interpreted as the firms with negative earnings should have had higher systematic risk than the CAPM and TFM models showed. The results should however merit further financial analysis into the state and affairs of the firms with negative earnings, particularly their cash flows.

Table 6. Earnings before interest, taxes, depreciation, and amortization (EBITDA) for the period 2012-01-01 to 2014-07-31.

<table>
<thead>
<tr>
<th>Company – Industry</th>
<th>Ticker Symbol</th>
<th>2012-12-31</th>
<th>2013-12-31</th>
<th>2014-07-31</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Advanced biodiesel</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Amyris Biotechnologies</td>
<td>AMRS</td>
<td>-186</td>
<td>-210</td>
<td>0</td>
</tr>
<tr>
<td>FutureFuel Corp.</td>
<td>FF</td>
<td>65</td>
<td>108</td>
<td>24</td>
</tr>
<tr>
<td>Methes Energies International</td>
<td>MEIL</td>
<td>-3</td>
<td>-5</td>
<td>-3</td>
</tr>
<tr>
<td>Renewable Energy Group Inc.</td>
<td>REGI</td>
<td>36</td>
<td>203</td>
<td>4</td>
</tr>
<tr>
<td>Solazyme Inc.</td>
<td>SZYM</td>
<td>-79</td>
<td>-104</td>
<td>-68</td>
</tr>
<tr>
<td><strong>Conventional biofuels</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Archer-Daniels Midland Co.</td>
<td>ADM</td>
<td>3054</td>
<td>3295</td>
<td>1705</td>
</tr>
<tr>
<td>Green Plains Renewable Energy</td>
<td>GPRE</td>
<td>116</td>
<td>157</td>
<td>169</td>
</tr>
<tr>
<td>Pacific Ethanol Inc.</td>
<td>PEIX</td>
<td>-18</td>
<td>31</td>
<td>71</td>
</tr>
</tbody>
</table>

*All earnings are given in million USD (MUSD).*

Archer-Daniels Midland Co. (ADM) showed quite large positive earnings during the entire period, in excess of 3 billion US dollars for both 2012 and 2013 and on path to similar levels in 2014. It should be noted that ADM is a giant within the industry as a conglomerate involved in agriculture and related services with a vertically integrated biofuel production. Meaning that they are not as exposed to high external raw material prices as the other firms in this study. Besides, although being a giant within both conventional bioethanol and biodiesel production, the firm also has significant earnings from other related businesses. This may help to explain the high earnings of ADM.

The results of FutureFuel Corp., Renewable Energy Group Inc., and Green Plains Renewable Energy shown in Table 6 indicate that these firms were profitable during the entire analyzed period, even though they were exposed to the high raw material costs of 2012. This would suggest that these firms either have other profitable business that offset the potentially negative earnings from the biofuel business or that they have different production technologies or platforms that the non-profitable firms do not
EBITDA was previously in this section deemed as an inappropriate tool for measuring cash-flows precisely although it may be suitable as a measure of profitability. The performance indicator of cash flow was however considered rather important to analyze as it more appropriately reflects the economic reality of a firm than the earnings of the firm (Dugan and Sampson, 1996). Cash flow may however be measured and related to many different factors within a firm depending on the purpose of the analysis and it is thus immensely important to understand the differences between different cash flow measurements and ratios (Peterson-Drake and Fabozzi, 2012, p. 814). Cash flow-on-operation which is deemed important and is popularly used to assess financial risks does however ignore capital expenditures. A factor that may be a significant part of the financial risks in a growing and capital intensive firm, such as those studied in this thesis. Ignoring capital expenditures through ratios of cash flow-to-operation may thus be very misleading when attempting to explain the systematic risks that were evident in the CAPM and TFM models by analyzing the firm’s cash flow-to-operation. In the words of Warren Buffet of his famed letter to the shareholders of Berkshire Hathaway Inc. in the year 2000; “…does management think the tooth fairy pays for capital expenditures?” (Buffet, 2000, p. 3).

A far better cash flow measure which better reflects the systematic risks that this study investigates is the cash flow-to-price or the inverted price-to-cash flow ratio. This measure gives an overview on two key fundamental characteristics within the firms as a complement to the return based models previously used. It thus offers a compliment and additional factors together with the previously discussed earning to further map and explain the resulting risks of the studied firms. The main reason why price-to-cash flow (P/CF) ratios are used rather than other cash flow measures is the study of Hou et al., (2011). This study covered the returns on 27,000 stocks in 49 countries throughout the time period of 1981-2003 (Hou et al., 2011, p. 2528). The study measured and tested several factors that may drive stock returns, including the factors found in the Fama French three factor model amongst others (Hou et al., p. 2569). The conclusion from the results that were achieved was that the cash flow-to-price (CF/P) or the inverted price-to-cash flow (P/CF) gives significant return spreads in different countries and industries which the other factors or models tested do not capture. The CF/P along with the Fama French Three Factor Model (TFM) model had the lowest rejection rate and lowest error in pricing of stocks (Hou et al., 2011 p. 2570).

The P/CF ratios together with the working capital for the analyzed firms are summarized in Table 7 as a compliment to the previously discussed factor models and earnings. As the analyzed firms of this study operate within an emerging biodiesel industry they may be required to make large investments into costly manufacturing plants. A standard sized production facility may cost as much as 150 million USD (Milbrandt, 2013, p. 9), resulting in the non-cash charges being large and it may thus seem as the firms are lacking profits until most of the plants have depreciated significantly. As seen in Table 7, four out of seven firms have negative P/CF ratios for 2012, as previously discussed this may be due to the high raw material prices and low earnings during the year 2012. A less likely but possible reason could also be because of
reasons such as lack of external financing, overvalued stock or as described earlier large
depreciation and amortization for instance. On the other hand a negative P/CF does not
have to be a disadvantage because these firms might have a great product or technology
but lack the capital necessary for further development or investments. As previously
mentioned the results for the year 2012 are most probably due to low earnings and low
profitability during the year, which was a rough year for the entire industry.

For 2013 two of the firms’, i.e. Amyris Biotechnologies and Solayme, had a negative
P/CF and also negative earnings which might raise some warning signs that they did not
manage to break the negative trend and refine the invested capital. It may thus be
considered that these firms should have had a large risk premia, i.e. higher expected
returns then what the factor models stated. Although it should be clarified that the
CAPM did distinguish Amyris Biotechnologies as considerably risker than the other
firms. Alternatively these firms could also be undervalued by the market, which can
create a problem when attempting to raise capital for future investments, i.e. the market
may not judge the potential correctly within the firms.

Stocks with large positive P/CF might on the contrary be overvalued because they may
be perceived as liquidly stable and profitable, prompting the market to consider them as
less risky while running the risk of possibly overestimating their potential. However the
size of the firms should also be considered when examining this ratio because larger
firms may be expected to be stable financially. The firms with a relatively small positive
P/CF could indicate undervaluation since the share price reflects the cash flow better.
For 2013 the majority of the firms examined had a positive ratio and smaller spread but
the level of ratios are difficult to assess as the industry is rather small and the companies
that comprise it are all relatively small and rather new to the industry. It may thus be
complex to determine an optimal P/CF ratio for the biodiesel industry to weigh the
appropriate levels of P/CF against.

Table 7. Price-to-cash flow and working capitals of the analyzed advanced biodiesel
and conventional biofuel firms.

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<tr>
<td><strong>Advanced biodiesel</strong></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Amyris Biotechnologies</td>
<td>AMRS</td>
<td>-0.85</td>
<td>4</td>
<td>-3.51</td>
<td>-0.4</td>
</tr>
<tr>
<td>FutureFuel Corp.</td>
<td>FF</td>
<td>8.83</td>
<td>177</td>
<td>15.64</td>
<td>243</td>
</tr>
<tr>
<td>Methes Energies International</td>
<td>MEIL</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Renewable Energy Group Inc.</td>
<td>REGI</td>
<td>6.31</td>
<td>109</td>
<td>3.76</td>
<td>249</td>
</tr>
<tr>
<td>Solazyme Inc.</td>
<td>SZYM</td>
<td>-5.95</td>
<td>140</td>
<td>-8.25</td>
<td>166</td>
</tr>
<tr>
<td><strong>Conventional biofuels</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Archer-Daniels Midland Co.</td>
<td>ADM</td>
<td>16.6</td>
<td>12,769</td>
<td>6.67</td>
<td>12,872</td>
</tr>
<tr>
<td>Green Plains Renewable Energy</td>
<td>GPRE</td>
<td>-6.43</td>
<td>136</td>
<td>8.46</td>
<td>224</td>
</tr>
<tr>
<td>Pacific Ethanol Inc.</td>
<td>PEIX</td>
<td>-1.48</td>
<td>45</td>
<td>6.13</td>
<td>51</td>
</tr>
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* All figures are given as million US dollars (MUSD).
In other words; what the P/CF ratio adds to the analysis of the firms is an additional factor for each company’s valuation through other potential risks than what the financial factor models covered. ADM which has a relative large P/CF factor might not be the riskiest investment of the firms examined as the factors models show a risk similar to the S&P 500. However, since the price of the asset is so much higher then what the cash flow per share is, there might be a risk that the stock is overvalued. Subsequently it could demand higher returns than what the factor models state, this could also be the case for FutureFuel Inc. As for Solazyme and Amyris Biotechnologies who both hold negative ratios it should be considered a compliment to previous results as an indication of potentially higher risks than the factors models showed. Although the firms are still young and consideration has to be taken to their relative short history and expanding of novel businesses. These companies were involved in the bioethanol sector not far ago (Miller et al., 2013).

This factor leads to the final part of the financial performance indicators of the analyzed firms, i.e. the working capital and its connection to the cash flow. Working capital is a measure of a firms’ ability to finance their operations in the short term (Hawawini and Viallet, 2010, p. 83-84). A negative working capital indicates that a firm may not be able to pay their creditors in time and thus are forced to liquidate fixed assets, take on more debt or in the worst case; declare bankruptcy. A very large positive working capital is not optimal either since the excess current assets could have been used in the operations in order to make additional profits and thus achieve excess returns. However as ADM by far is the biggest firm in the sample it may also help to partly explain the very large working capital. Pacific Ethanol Inc. has a small positive working capital which could be interpreted in terms of aggressive investment strategies, i.e. that they invest most of their current assets into their operations. Indicating that they are willing to take on more financial risk with the aim of making excessive returns. For the remaining part of the firms’ they have similar level of working capital. If this is to hedge financial risk, or that they may have already achieved full utilization of their operations or unwillingness to take on further investments cannot be answered.

The trend for these firms is however slightly positive which could depend on slow efficacy on accounts payable as it is important to keep in mind that these firms are fairly small compared to the giant petroleum companies that they trade their products with. Whereas Solazyme has the assets to at least finance their short term operations through the level of possessed working capital Amyris Biotechnologies may not as it has a negative working capital. Suggesting that the firm might be forced to liquidate assets or take on more long term debt. Pacific Ethanol Inc. has turned the cash flow to positive values in 2013 from 2012 but not at the same pace as the share price nor as the working capital, suggesting that the firm might be overvalued. Renewable Energy Group Inc. has been able to reduce the P/CF ratio to a better level while simultaneously increasing the working capital from 2012 to 2013. This may on the contrary to Pacific Ethanol Inc. indicate an undervaluation when taking these factors into account. This should indicate a potentially rather low systematic risk, which was also evident in the factor models, e.g. the TFM assessed the risk of the firm close to the market average of the S&P 500.
Green Plains Renewable Energy has a large P/CF ratio and but it has been able to increase its working capital, however as the share price is eight times higher than the cash flow per share, this may also indicates that the stock may be overvalued even if the other financials are in order.

6.6 Biorefineries and the Renewable Fuel Standard (RFS)
As was discussed in the previous section of earnings and working capital, it appears as the analyzed firms are showing positive cash-flows as well as increasing earnings during the studied time period. Considering that the external factors of crude oil prices, high raw materials and sale prices of the end products this should not be possible from a business producing only advanced renewable biodiesel fuel. Particularly as the technologies used to produce advanced biofuels are not less expensive than the technologies used to produce conventional biofuels (Milbrandt et al., 2013, p. 7-10).

The general preconception of profits within the biofuel industry based on the existing body of knowledge is that the first generation biofuel sector is yielding healthy returns (Hofstrand, 2014; Figure 1). The main cause behind this appear to be the lower production costs found in first generation biofuels compared to second generation biofuels (Milbrandt et al., 2013, p. 7-10; Hofstrand, 2014). This fact was however evident already a decade ago when the Renewable Fuel Standard (RFS) was created by the Environmental Protection Agency (EPA) and later expanded under the Energy Independence and Security Act (EISA) (Miller et al., p. 3). The program was created under the assumption that the advanced biofuels would be more expensive to produce and would thus need governmental support to become competitive. As previously discussed it is important to create and provide stable, long-term frameworks and programs to create incentives for further investment into the biofuel industry. Particularly as the success of any type of emerging business depends significantly on their ability to secure necessary financing and to attain and maintain the investor’s confidence (Miller et al., 2013, p. 14).

The explanation for the financial state of the firms must thus be found elsewhere and there are two potential factors that have so far not been discussed in detail which may help to explain the results achieved in this thesis. The first factor may be found in the delimitation of this study which explicitly stated that the analyzed firms should have a diversified product portfolio to go with their renewable biodiesel business. A business concept that is also referred to as a biorefinery (Cavka, 2013, p. 4). Similarly to conventional biofuel firms and traditional petroleum refineries, the analyzed firms do produce and retail several different products produced from the same original raw material (Table 2). All of the analyzed firms of this study are structured in this manner, i.e. as biorefineries. The fact that the firms are structured to spread their financial and operational risks across several business and products may help to explain the lower perceived risks than were previously achieved in the more specialized bioethanol sector.

The existing literature regarding impacts of diversification on firm-specific risks is extensive within management and financial research. The two fields are however not completely in agreement if diversification results in lower or higher firm specific risks (Raynor, 2002, p. 371). A well cited paper from 1989 by Chang and Thomas suggest that firms are able to decrease their firm specific risks by either diversifying into less risky product markets, i.e. products with established long-term demands, or withdrawing from high-risk businesses (Chang and Thomas, 1989, p. 272). Furthermore, the firm specific risk may also be perceived as lower if the firm is
successful in performing diversification changes that result in increasing firm assets. Lower risks may also be achieved if the firm decides to transfer resources or create large reservoirs of resources that may absorb external risk (ibid.). As previously discussed; large working capital structures are examples of resource allocation that may protect the firm against unexpected events and thus decrease the firm-specific risks.

Financial studies on the contrary have shown that diversified firms commonly have inferior performance and lower returns to shareholders compared to focused and specialized firms (Raynor, 2002, p. 372). The main reason behind this is considered to be that diversification efforts may be value destroying, e.g. the resources used to diversify could be more efficiently used to exploit opportunities available to focused and specialized firms. This argument is however only valid under the assumption that the diversification is mainly performed through either vertical integration, i.e. expanding the range of business activities up- or downstream from the core business, or through unrelated diversification (Raynor, 2002, p. 373-375). These types of diversification strategies are expected to increase firm specific risks by creating activities that may not be synergetic with the core capabilities of the firm. It is however important to note that risk perception of diversification strategy is strongly dependent on the industries in which the firm operates and, the number of industries that the firm is involved in, the size of the firm, as well as the diversification strategy that is chosen (Chang and Thomas, 1989, 273).

Diversification that is based on interrelationships, i.e. related diversification, is on the contrary considered to be the form of diversification that yields the highest likelihood of success (Porter, 2008, p. 375). This is because diversification through interrelationships results in possibilities to increase already existing competitive advantages or to create new such advantages in related businesses. The type of related diversification strategy that may be important for the analyzed firms in this thesis is the technology-oriented strategy. This strategy involves utilizing the core technologies owned or developed by the firms to create either completely new products or to produce already existing products through a novel approach to trade on existing or new markets (Porter, 2008, p. 377).

An additional diversification strategy that may be important to consider is the “options-based” diversification strategy (Raynor, 2002, p. 380). That is to keep the opportunity open for firms to act in accordance with shifting industry circumstances and exploit opportunities that may arise from a shifting market. This type of diversification strategy is suggested to allow firms to evaluate real options on future synergies between operating divisions where there currently are none. The strategy should thus allow flexibility for firms to choose between different strategic paths in the future depending on the state of relevant external factors. Most importantly for the discussion of the results of this thesis is however that the capital markets seem to have actually identified the “options-based” diversification strategy as an existing capability of future potential value within firms (Raynor, 2000). Suggesting that the capital markets are perceiving this type of diversification strategy as an insurance against firm-specific risks arising from what currently may be perceived as potentially unrelated businesses.

All the analyzed firms of this thesis have different product portfolios to go with their renewable biodiesel business as was shown in Table 2. These may include such products as specialty chemicals produced from renewable resources rather than fossil raw materials (FutureFuel Corp., Amyris Biotechnologies), conventional biodiesel
(Renewable Energy Group Inc.), or even oils and nutritional additives (Solazyme). These firms thus appear to possess both interrelated products and to some extent also unrelated products with their advanced biodiesel business. The results of the CAPM and TFM models could potentially indicate that the market is already well aware of this, in accordance with the effective market hypothesis and random walk theory.

It may despite the strategic benefits seem contra productive or even capital destructive to use profits generated by other related- or unrelated products to invest in the advanced biofuel industry in times when the conventional biofuel industry is as profitable as it is. There are however additional factors which should be taken into account besides the strategic implication that were previously discussed. Firstly the demand for energy in the transportation sector is expected to increase steadily over the coming decades as was discussed in the introduction section of this thesis. The increase may be as high as 82 percent if governments attempt to regulate markets (GTS 2050), 2011, p. 4-5). It should be clarified that there is not one type of renewable fuel which may offset this increase in demand. As the potential to produce conventional biofuels may be nearing the maximum it is important to consider other type of fuels and raw materials. The shift to more renewables will require the utilization of a variety of renewable energy sources, which also include the use of bioethanol, gas, electricity, fuel cells and other technologies besides the renewable biodiesel.

Secondly, although advanced biodiesel production has difficulties to offset the costs of production in the current state of the market it does not necessarily propose that it will have the same difficulties in the near future. Further technological development, economies of scale achieved through bigger and more efficient production plants may contribute to such developments. Additional motives to invest profits generated by other products into the advanced biodiesel business could have important future implications for the firms. It is not farfetched to suggest that once the sector does become more profitable and investors show a greater willingness to invest, it will beneficial to be one of the firms with a proven track records. Previous experience from the industry, possession of unique or even protected production technologies and knowhow may tilt the confidence of investors and lenders in the favor of the analyzed firms. Particularly as the investments necessary to build and operate a standard production facility may be as high as 150 million USD (Milbrandt et al., 2013, p. 9). Investing in the advanced biodiesel sector in the studied time period may thus actually be a long term strategy which may yield a significant payoff for those that have decided to exploit this strategy of the “first mover advantage”.

An additional factor can be found in the works of the Enviromental Protection Agency (EPA) that was responsible for developing a Renewable Fuel Standard (RFS) which helps to make renewable fuels competitive with petroleum-derived fuels and encouraged the initial market penetration in the United States (Milbrandt et al., 2013, p. 11). When the program was created it was expected that advanced biofuels would be more expensive to produce than fossil fuels and that the producers would need financial support by the government to offset the external risks (Miller et al., 2013, p. 8). Established in 2005, the program had some initial success and was expanded in 2007 under the EISA. The act also includes biodiesel and increases the proposed volume of renewable fuel to be blended progressively from 9 billion gallons in 2008 to 36 billion gallons in 2022, divided into different categories of renewable fuels (Miller et al., 2013, p. 2-3). The strong increase in blending mandates suggest that the demand for biofuels
is guaranteed by the US congress during a foreseeable future promoting further development and investment into the sector.

The RFS may thus have very important implication for the results of this thesis and the analysis that was performed. As previously discussed, all previous knowledge and external market factors that were taken into account suggested that the results of this thesis should be unexpected. But as the RFS program offsets the difference in production cost and sale prices it does also help to make advanced biofuels profitable for the producers although external factors should make it unprofitable to currently produce and trade renewable biodiesel fuels. Coupled with the structuring of the analyzed businesses as biorefineries and the strategic implications that this may have, the RFS is probably one of the most important factors that contribute to the explanation to the results of this thesis. Particularly as the results cannot be explained by market factors alone.

One additional interesting aspect of the RFS is that it does not seem to help in offsetting the risks found in the second generation bioethanol industry which was studied by Miller et al., (2013). Advanced bioethanol is indeed also covered by the RFS but it seems that the risks in the analyzed firms despite that are higher than those that were evident in the results of this thesis. The explanation behind this may lay firstly in the structuring of the firms that were analyzed by Miller et al., (2013) as most of the firms that showed high beta numbers do not have profitable businesses to go with their advanced bioethanol business. Secondly the analysis was only performed using the CAPM model on weekly data which may have implications for the results of the analyzed studies as the CAPM does not take into account of size or turnover within the firms. Some of the firms that were included in the study of Miller et al., (2013) are firms that were also analyzed in this study, for most of the studied firms the results do actually correspond quite well. Implying that the high average returns of Miller et al., (2013) are the results of a few deviating firms that are not structured in a way that offer any comprehension of an “option-based” diversification strategy. Indicating that such business strategies may be quite important for the perception of risk and pricing by the market, as previously discussed in terms of the “options-based” diversification strategy.

The contribution of the “options-based” and interrelated strategies together with RFS are factors that create a comprehensive image that may explain the achieved results of this thesis. Particularly in times when the achieved lower systematic risks of the advanced biodiesel sector should have been thought-provoking due to the levels of the crude oil and raw material prices evident during the studied time period.

6.7 Effective Markets or Irrational Investors?
The theory of the effective market hypothesis from which the models of CAPM and TFM are derived may contribute to explain some of the unexpected results presented in this study. The theory that was originally developed by Eugene Fama some 45 years ago assumes that the financial market on which the firms are publically traded are of a certain efficacy. Suggesting that the pricing of an asset is reflected by all the available information regarding the asset, e.g. the risk assessment and estimated returns are reflections of all available information of the firms at the time of analysis. This is possible under the presumption that investors on the market use the access to available information that may affect the assessment of value and risk of an asset to price the risk (Fama, 1970, p. 383-389; Bodie et al. 2011, p. 38-39). This is however strongly dependent on the level of market efficacy that is prevailing at a particular point in time.
To suggest that the market regarding the advanced biodiesel sector is one characterized by the weak form of market efficacy is farfetched. It would suggest that the results of risks and estimated returns that were achieved by the CAPM and TFM are solely based on retrospection without any possible inclusion of foresights or uncertainties regarding the analyzed advanced biodiesel sector. As previously discussed, it is very difficult to estimate the direction of external risk factors such as crude oil prices, raw material prices or stakeholder loyalties towards the sector. However, as the uncertainty within these factors are well known and evident to the market, it is implausible to suggest that the market would ignore them and assess the risks solely on historical factors.

On the contrary, one would be hard pressed to envision that the market is in a state of strong market efficacy in which unbiased, accurate and necessary information is available to all potential investors at all times. Particularly as the analyzed sector is emerging and innovative with much emphasis put into further research and development. Considering these factors it is also difficult to suggest that accurate and unbiased information regarding all the external factors which may affect perception of risks and returns are available to the investors during the analyzed time frame. Making a state of strong market efficacy unlikely.

The state of market efficacy that is the most probable for the advanced biodiesel sector is the semi-strong form, which is an extension of the weak form. The semi-strong market efficacy would suggest that the results of risks and estimated returns achieved by the CAPM and TFM are the results of all the available information during the analyzed time period. The uncertainty of external factors are taken into account by the market in the semi-strong state through the assumption that the market will act rationally and instantly on the arrival of new information. Leaving no opportunity for investors to take advantage of the uncertainties to achieve abnormal returns as the information becomes priced at the moment it becomes available to the market (Fama, 1970, p. 404-405). This would suggest that as long as the future state of the external uncertainty factors are difficult to predict they will not be fully included in the present-day assessment of the risks and estimated returns. Further suggesting that the results achieved by the CAPM and TFM models are a reflection of the state of the market that was evident during the time frame in which the analysis was performed.

The random walk theory in resemblance to effective market hypothesis theory suggests that the only thing that may change the price of an asset is the publication of new information. On which the market may react to adjust risks and prices of securities. The random walk theory does however propose that the probability of positive or negative outcomes are equal once the information reaches the market (Brealey et al, 2013, p. 321-322; Fama, 1965, p. 54). It further suggests that investors are actually unable to predict future asset prices based on historical prices/patterns since the prices are independently set each day. This would suggest that the risks and estimated returns of the studied time frame are the results of information that was made available to the market regarding the studied firms in that time frame. As is suggested by the effective market hypothesis theory and the semi-strong state of the market.

It was shown in the first section of this chapter that the oil price has not changed significantly in favor of the advanced biodiesel industries during the studied time frame. The price was similar to the crude oil prices at which Eisentraut et al., (2011) considered advanced biofuels to be non-competitive to fossil fuels. The raw material prices have also not changed in the favor of the industry as they have more than doubled.
from the 1.25 USD/gallon that was deemed non-profitable by Demirbas (2010). There are actually no major changes in external factors that might explain the lower risks of the advanced renewable biodiesel firms compared to advanced bioethanol firms that were analyzed by Miller et al., (2013). The results that were presented in the previous sections of the Capital Asset Pricing Model (CAPM) and the Fama-French Three Factor Model (TFM) further indicated on the contrary to what might be expected that the analyzed firms are not considerably risker than the conventional biofuel industries.

The explanation to the achieved results can apparently not be found in changes of the external factors such as high crude oil prices or low raw material prices that were not evident during the time when previous studies were performed. Theories previously discussed regarding behavioral finance and information processing suggest that investors may to some extent behave irrationally, conservatively or even with overconfidence (see sections 3.6, 3.7 and 3.8). It does however seem farfetched that the results achieved in this study are the results of mainly overconfident, irrational or even ignorant investors that are flocking to the advanced biodiesel sector for some unobvious reason. That these investors should be unaware of the state of the external factors such as crude oil prices, the raw material prices or even the uncertainty among policy makers that may impact the risks within the sector. Some investors may be acknowledged as irrational but their investments will either even out against the rational investors or be randomized to offset each other (Shleife, 2000, p. 216). Most investors on the market are on the contrary presumed to be rational and behave in accordance with the effective market hypothesis theory and random walk theory. They make use of the available information once it becomes available to them. Their reactions may not always be proportional to the information that is made available but in the long run the risks and estimated returns should reflect the total perception of the market on basis of the available information that the market holds.

In accordance with the theories of the effective market hypothesis and random walk the market is considered to have access to all the information that was presented in this thesis. Both the external market factors and the internal firm specific factors. The investors as thus believed to weigh these against each other and price risk on all this available information regarding the studied firms. The results of the study would thus imply that the firm specific factors in the studied firms are more important than the previously studied external market factors in the pricing of financial systemic risks. A result which may not be unexpected but it does however make an unforeseen contribution to the research as such factors are commonly overlooked when studying systematic market risks. Perhaps due to the nature of the risk, the factors behind such risks are commonly expected and are perhaps mostly found within the external factors rather than internal firm specific factors.
7. Conclusions

7.1 Conclusion of Achieved Results

The results achieved in this thesis put forward the notion that the analyzed publically traded firms that comprise a part of the advanced biodiesel sector do not carry any higher systematic risk than the conventional biofuel sector nor the market in general. The findings thus indicate that the answer to the research question previously set up is that the financial risks and estimated returns are not significantly higher in the advanced biodiesel firms than in the conventional biofuel sector nor the market in general.

The results were at first somewhat unexpected considering the available body of knowledge and previous studies regarding the advanced bioethanol sector and maturity of the conventional biofuel sector. The estimated systematic risks estimated by the Capital Asset Pricing Model and the Fama-French Three Factor Model could not be explained by favorable external market factors such as higher crude oil prices, lower raw material prices, higher certainties regarding the future of crude oil prices nor stakeholder loyalty. These factors had in fact remained similar or even become unfavorable in contrast to prevailing conditions of previous studies that indicated higher systematic risks in the advanced biofuel industry compared to the general market.

Investigations into the internal conditions of the analyzed firms showed favorable and promising conditions for most of the analyzed firms that could contribute to explaining the lower and beforehand unexpected systematic risks. Earnings before interest, taxes, depreciation, and amortization (EBITDA) showed rather stable earnings during the studied time period which in part helps to explain the lower systematic risks. Although EBITDA cannot be interpreted as a fail-safe measurement of financial health it does indicate that most of the analyzed firms are profitable. This was somewhat unexpected considering the low crude oil prices and high raw material prices that are used for production. The analyzed firms had furthermore considerable working capital structures that could help the firms to hedge risks by creating a financial reservoir or cushion to fall back on in case of unexpected external strains. Price-to-cash flow ratio (P/CF), which was deemed as an important financial indicator for firm stability were also rather appropriate to the sizes of the analyzed firms.

The analyzed firms shared a seemingly very important structural component that could potentially make a significant contribution to explaining the lower than expected estimated systematic risks. All of the analyzed firms are structured as biorefineries, e.g. they produce and trade several different products from renewable resources. The concept of biorefining offers an “option-based” diversification strategy which appears to be identified by the capital markets as an existing capability of future potential value within the firms. Resulting in an apparently lower than expected systematic risk. The profitability and sound financial health of the analyzed firms could subsequently also be the contribution of the government programs that are in place in the USA. The Renewable Fuel Standard II (RFS2) guarantees the producer of advanced biofuels a demand for biofuels as it stipulates the volumes of biofuels that must be blended into fossil fuels until 2022 in the US. Although considered a limited driving force by some studies it does actually force the retailers of transportation fuels to blend biofuels into their products. A fact which evidently seems to contribute to the sale of biofuels even at
low crude oil prices. The RFS2 thus contributes to profitability and lower financial risks within the analyzed firms.

The effective market hypothesis theory and random walk theory suggest that the market and investors most probably have access to all this comprehensive data during their analysis of the studied firms and price the risks accordingly. It could explain why the results of this thesis contradict the results of previous studies. Most previous studies of the advanced biofuel sector have focused solely on external market factors such as crude oil prices, raw material prices, the renewable fuel standard, the high returns of the competing conventional biofuel sector et cetera. Little attention has been directed at the internal factors, such as earnings, working capital structures, cash flows nor the business structures of the analyzed firms. These factors may not alone explain the lower systematic risks but they do most probably contribute together with additional external and internal factors that are not covered by the comprehensive analysis of this thesis.

This thesis does not state that the financial risks that are estimated for the studied time period should be interpreted as being guaranteed also in the future. However, based on the results achieved it seems that the analyzed firms have several different internal factors that make them successful even under the dire evident external market factors of the studied time period. This would suggest that the firms stand well-founded going into the future thus giving a boost of confidence to the investors and stake-holders that may be interested in investing further into the advanced biodiesel sector. Furthermore, as advanced biofuel firms that are supported by, partly or whole owned by giant oil and chemical firms were excluded from the analysis it would suggest that there are additional firms to consider. As such owners or supporters give additional financial security they could potentially contribute to further lower the financial risks and further promote the advanced biofuel industry as a whole. A notion that thought-provoking by much of the existing body of knowledge that is focusing solely on external market factors. The comprehensive analysis presented here is thus considered to fulfill the purpose to assess and estimate the financial risks and estimated returns based on available external market factors and internal firm specific factors.

7.1 Contributions

The practical contribution is first and foremost found in the similarities in risks and returns between the studied advanced biodiesel firms and the conventional biofuel sectors. As this is mainly directed towards external stakeholders and potential investors, the contribution of the work may improve their confidence regarding the potential investment opportunities in the studied advanced biodiesel sector. A contribution which should not be underestimated considering the difficulties that the advanced bioethanol sector has had with attracting investors. With support of Miller et al. (2013) and the results of this thesis it is justified to state that there are differences between the advanced bioethanol and biodiesel sector in terms of risks which reflects on the models presented. The underlying factors are still elusive and difficult to pinpoint with accuracy but as an indication the authors of this thesis point to the diversification in the biodiesel sector and the RFSII as important components. Although it is important to point out that these results are based on a limited number of financial tools and a small sample, the practical contribution may be that product and process diversification among these firms should be encouraged to promote more confidence from investors and stakeholders alike.
Theoretical contributions that are made are those of novel knowledge of the risks and returns that potentially could be found in the emerging advanced biodiesel sector. To our knowledge this is the first study of its kind, regarding the financial risks and returns in existing firms rather than hypothetical or modeled firms producing renewable advanced biodiesel. This fact makes the results of this thesis an important theoretical contribution to the existing body of knowledge of biofuel firms and their risks. An additional important theoretical contribution is also made through the use of an evolved Fama-French Three Factor model that makes use of individual, firm specific factor loadings in the analysis. The use of firm specific factor loadings preserves the information contained in each individual stock and eliminates the risk of using a model that depicts the firms as less risky than they actually are by using loadings based on clustered portfolios. This may be an immensely important theoretical contribution but further research and testing is necessary regarding the validity of model and the use of individual factor loadings.

Furthermore, the results also indicate that the potential causes responsible for the state of the analyzed firms are mainly internal rather than external. A notion which may be thought-provoking as the systematic risk is usually one outside of the management's grasp, suggesting that there is little that the management can do to impact it. This study may suggest otherwise although further research is necessary regarding some of the external factors, such as the renewable fuel standard and stakeholder loyalties.

Lastly, it should be stated that the authors do not in any way claim to have found the goose that lays the golden eggs within the advanced biofuel industry with the few sampled firms. Further research is necessary, particularly as the results of this thesis are contradicting previous research and conventional knowledge regarding the industry as a whole. Additionally the authors are not in any way certain that the results are one hundred percent accurate or valid due to the complexity of the emerging and rapidly changing industry as well as the small sample size. The authors have however taken every measure possible to perform an as methodologically accurate study as possible to ensure that the results are not the consequence of faulty models or invalid research methods.

7.2 Future Research

As the purpose of this thesis was to assess the risks of conventional biofuel and advanced biodiesel sectors by using simplistic financial models and a few financial fundamentals, future research options are many. For instance one might consider examining internal factors that may drive the perceptions of systematic risks as these seem to be important. Other research topics that could be of interest are those that could further be expanded from the results of this study to include firms that are focused and specialized solely on advanced biodiesel. This could be particularly interesting as the firms studied in this thesis are diversified in their operations. A factor that potentially serves as a risk hedging strategy. As this thesis only focuses on stocks listed in the United States on the NASDAQ and NYSE stock exchanges with their operations mainly being in the US, one might research biodiesel firm and the risks that are present in another market with similar conditions as the ones examined in this thesis. The use of individual factor loadings in the Fama-French Three Factor model may also merit further attention.
7.2 Ethical considerations

The results that are presented in this thesis are as previously stated somewhat contradicting and unforeseen based on the existing body of knowledge and the state of external market factors. The use of the somewhat more comprehensive Fama-French Three Factor Model together with the commonly used CAPM model to study systematic risks has been useful. The former allows additional factors to be covered and thus increase the accuracy of the achieved results. Furthermore, the use of individual factors weights rather than aggregated groups of studied firms should help to preserve the information contained in each security rather than obscuring it with information originating in other similar securities. These steps were taken to ensure that the results should not only be as valid and accurate as possible but also to ensure that the outmost effort was taken to perform the study in a scientifically correct manner.

The authors of this thesis are furthermore aware that some of the previous research on which the thesis builds its theoretical foundation on was conducted by political organizations and interest groups. The literature that has such origin includes among them Eisentraut et al., (2011) and Miller et al., (2013). The authors did prior to including these among the utilized literature in the thesis thoroughly analyze their content in order to search for obscurities and other suspicious variables that could question the validity and reliability of the studies. No such factors were however found. The sources were furthermore included as few alternative sources were available due to the low output of financial papers regarding advanced biofuels. All these discussed measures were taken in order to ensure that there was never any intention to obscure the results or factors that could potentially contribute to results of this thesis. The authors are proud to present the results of this thesis as their own original works and invite further discussion and research on the topic.
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