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Examining the relationship between circular performance and financial performance of the European private sector.

MASTER THESIS BUSINESS ECONOMICS

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1. Introduction

1.1 Background

Worldwide there is increasing pressure to decouple economic growth from resource usage and move away from a linear economy to a circular economy (UNEP, 2011). The main reasons for the growing demand for natural resources are the large growing middle class in emerging economies and a growing world population. The result is resources scarcity, resource extraction and land cover change are causing higher environmental degradation and fragility (Giljum, Dittrich , Lieber , & Lutter, 2014). These circumstances confront the private sector to handle at the same time the pressure of stricter environmental laws and regulations, increased price volatility and risk in resource supply in addition to their daily operational processes (Lieder & Rashid, 2015). The risks inherent in the linear system can prevented by switching to a circular system. The circular economy is an economic system that is designed to maximize reusability of products and raw materials and to minimize value destruction, unlike the current linear system, in which raw materials are converted into products and destroyed at the end of their life (Murray, Skene, & Haynes, 2015).

Since the industrial revolution, the European economies have developed into a 'take-make-consume and dispose' system and assumes that resources are plentifully available, accessible to source and cheap to dispose. There is a growing awareness that this threatens the competitiveness of Europe and harms the ability of future generations to meet their own needs (Commission, 2014). Therefore, the European Union is committed to undertaking actions to make the shift from a linear economy to a circular economy to decouple economic growth from resource use and environmental degradation. The European Union assumes that the circular economy can improve the competitiveness of Europe by stimulating new businesses, innovation, efficient ways of producing and consuming and protecting companies against resource scarcity and price volatility. The circular economy will create local jobs and help to avoid irreversible damage towards the environment that is caused by using resources (Commission, 2014). The transition to a circular economy requires changes in the entire supply chain, from product design to new business models, new markets and new ways in which waste is converted into raw materials (Smol, Kulczycka, Henclik, Gorazda, & Wzorek, 2015). This requires a systemic change in innovation for both technologies, organizations, society, financing methods and policies. The private sector can play an essential role in the transition towards a circular economy and there is a growing awareness among companies that it is in their self-interest to reduce their dependency on the environment, because it can expose companies to a variety of risks (UNEP, 2016). The private sector could face increasing and more volatile prices of raw materials due to resource scarcity that is caused by overexploitation of resources (Crainer, 2013), higher physical risk due to severe storms that is a result of changing global weather conditions and changing laws and regulations could impact their business or market (UNEP, 2016).

1.2 Research Problem

There are a lot of institutions that claim that there are gains for companies that have a circular system instead of a linear system. The Ellen MacArthur Foundation suggests that circular businesses could utilize material cost-saving opportunities, mitigation of price volatility and supply risks, create entirely new profit streams, new demand for business services and an improved customer interaction and loyalty (Foundation, 2013). The disadvantages of circular businesses arise from the focus on product life extension, circular supply chain and the reuse of resources. To realize a circular business model, high investments must be made in the redesign of products, product- lines and the overall supply chain (Blokpoel, 2016).

In the current literature, there is already research conducted on the relationship of the environmental performance of companies compared with the business and financial performance of companies. Most studies found a positive or none relationship between the environmental performance and financial performance, although the outcomes in the current literature are very inconclusive (Horváthová, 2010) (Molina-Azorín, Claver-Cortés, Pereira-Moliner, & Tarí, 2009) (Albertini, 2013). Some studies have shown that environmental performance has a positive influence on the business performance of a company (Zeng, Meng, Yin, Tam, & Sun, 2010); (Yang, Hong, & Modi, 2010), some studies have shown that it has a negative influence (Wagner, 2005) and some studies have shown that there is no influence (Sarkis & Dijkshoorn, 2007); (Link & Naveh, 2006). The differences in outcomes could be the result of the differences in geographical regions and type of sectors that are studied and the different indicators that are used for measuring the environmental performance. Some studies used interpretations of environmental performance where there is in advance an unclear relationship with the financial performance. (Link & Naveh, 2006) measures the environmental performance by looking if iso14001 is implemented and (Wagner, 2005) measures the environmental performance based on the pollution level, although it is unlikely that these interpretations of environmental performance have any influence on the financial performance.

M. Lieder & A. Rashid studied the present research landscape of circular economy and concluded that it is an active area, although it mainly focusses on waste generation, resource use and environmental impact and neglected the business and economic perspectives of the circular economy (Lieder & Rashid, 2015). It is interesting that the business and economic perspectives are neglected, because the strength of circular economy is creating both economic and environmental value by resource efficiency and recycling.

The research gap in the current literature that compares environmental performance with the financial and business performance, do not measure the environmental performance based on the principles of circular economy, and the studies that are part of the current landscape of circular economy are neglecting the business and economic perspectives of the circular economy. There is one study that compares the financial performance of companies with a linear business model compared to the financial performance of companies with a circular business model (Blokpoel, 2016). This research classifies the business models of companies as either a linear model or as a circular model. The disadvantage of this method is that there is not a clear measurement scale used to measure the circularity of a business model. It is important to have a clear measurement scale, because there are not companies that have a supply chain that is for 100% circular and it is unlikely to find a company with a supply chain that is for 0% circular. By looking at the circular performance and comparing it with the financial performance, it could be possible to derive a better conclusion about the existence of the relationship between circularity and financial performance. This research contributes to the existing knowledge as it will examine the relationship between the circular performance and financial performance and focuses on the European private sector. The empirical evidence is mainly applicable for the US manufacturing Industry and not generalizable for the European private sector. There are studies conducted for the European private sector, but these studies are performed for the paper industry (Wagner, 2005), food industry (Aragón-Correa & Rubio-López, 2007), Welsh manufacturing SME's (Sarkis & Dijkshoorn, 2007), tourism sector (López-Gamero, Molina-Azorín, & Claver-Cortés, 2009), (Molina-Azorín, Claver-Cortés, Pereira-Moliner, & Tarí, 2009), and Dutch SME's (Blokpoel, 2016).

1.3 Objective of the Study

The purpose of this research is to examine the relationship between the circular performance and the financial performance of companies. Therefore, the overall research question is; *"Is there a relationship between the circular performance with the financial performance of a company?"*

The following sub-questions will be used to answer the general research question:

- Which key performance indicators (KPI's) are suitable to measure the circular performance and the financial performance of companies?
- Is there a difference in the circular performance of companies over time?
- Is there a difference in the circular performance across sectors?

1.4 Methods of Data Collection & Analysis

In this research, several methods are used to collect data. First, desk research is done to find more information about the principles of circular economy and to determine suitable indicators that could be used to measure the financial performance and the circular performance of the European private sector. The KPI's that will be used to determine the circular performance are not based on the three main pillars of sustainability (social, economic and environmental), but mainly on the economic and environmental components. In the circular economy, the social dimension is subordinated compared to the economic and environmental dimensions (Murray, Skene, & Haynes, 2015), because in the circular economy the environmental- and economic value is mainly created by achieving a higher resource efficiency performance. The database of Sustainalytics will be consulted to obtain the information that enables to measure the circular performance of multiple European companies. This information will be compared with the financial performance of the same companies. The financial data of those companies will be extracted from the database Orbis. The annual reports of companies will be consulted, in case the financial data of the companies can't be obtained from the database Orbis. The method Data envelopment analysis (DEA) will be used for the performance assessment of the financial performance and the circular performance. DEA is a non-parametric method to measure the efficiency of each decision-making unit (DMU) and is developed by (Charnes, 1978). The DEA uses the data from the indicators that are derived from Sustainalytics and Orbis. The rationale of using a DEA model is to obtain a composite indicator that combines a set of key performance indicators (KPI's) into a single summary measure of performance (Horta, Camanho, & Moreira da Costa, 2012). Bootstrapping will be used to analyse the sensitivity of the efficiency scores relative to the sampling variations of the estimated frontier (Simar & Wilson, 1998). A bootstrapped truncated regression model will be conducted (Simar & Wilson, 2007) to examine the relationship between the financial performance and the circular performance of a company.

1.5 Outline

The structure of this research is as follows. The second chapter presents a literature review of the present research landscape of the circular economy, including the pros and cons of the circular economy for businesses and ways to make circular economy measurable. The chapter also contains a literature study in how the financial performance of businesses can be determined. The third chapter describes the conceptual framework of this research and the hypotheses that are being tested. Chapter four describes the methods of data analysis that has been applied and chapter five provides information about the methods of data collection. Finally chapter six provides the results followed by a discussion, conclusion and recommendations for further research.

2. Review of Literature

2.1 The Circular Economy

The concept Circular Economy comes from different schools of thought (Ghisellini, Cialani, & Ulgiati, 2015), including the industrial symbiosis (Zhu, Lowe, Wei, & Barnes, 2007), industrial ecology (Esty & Porter, 1998), general systems theory (Ghisellini, Cialani, & Ulgiati, 2015), Cradle to Cradle (MacDonough & Braungart, 2002), the performance economy (Stahel, The Performance Economy, 2010), regenerative design (Lyle, 1995), Natural Capitalism (Hawken, Lovins, & Lovins, 1999) and Industrial Metabolism (Ayres & Udo, 1994). The main idea that all theories have in common is the aim for closed-loop material flows in the entire economic system that minimizes the matter-, energy flow and environmental degradation and fragility, without limiting the economic, social and technical growth. Some researchers attribute the origin of the circular economy towards (Pearce & Turner, 1990), who developed a conceptual framework representing the circular economy. The work of (Pearce & Turner, 1990) describes the influence of natural resources on the real economy, investigates the characteristics of a linear system and explains the transition towards the circular economic system. According to (Pearce & Turner, 1990), the development towards a circular economy is inevitable as a result of the law of thermodynamics, which involve the degradation of matter and energy (Pearce & Turner, 1990). The work of Pearce & Turner builds on the previous study of (Boulding, 1966), who describes the earth as a closed and circular system with limited assimilative capacity and the pressure of the economy must be equal to the earth's carrying capacity (Boulding, 1966).

Over time, the concept of the circular economy changed from a focus mainly on waste recycling, towards a broad efficiency-oriented control mechanism to analyse the closed-loop material flows in the entire supply chain (Su, Heshmati, Geng, & Yu, 2012). (Murray, Skene, & Haynes, 2015), defines the circular economy as an economy that has no net effect on the environment; instead it restores any damage done in resource acquisition while ensuring little waste is generated throughout the production process and in the life history of the product (Murray, Skene, & Haynes, 2015). (Geissdoerfer, Savaget, Bocken, & Hultink, 2016), defines the circular economy as a regenerative system in which resource input and waste, emission, and energy leakage are minimised by slowing, closing, and narrowing material and energy loops. This regenerative system can be achieved through long-lasting design, maintenance, repair, reuse, remanufacturing, refurbishing, and recycling (Geissdoerfer, Savaget, Bocken, & Hultink, 2016). The definition of circular economy that is used in this research, is the commonly used definition that has been framed by the Ellen MacArthur Foundation and sounds as follows;" The circular economy refers to an industrial economy that is restorative or regenerative by intention and design (Ellen MacArthur Foundation, 2013)." The meaning of restorative or regenerative by intention and design refers to the rely on sustainable energy, minimize the use of toxic chemicals and eliminate waste production due to a superior design. The circular economy consists of two materials flows which are the biological nutrients and the technical nutrients flow. The products of the biological flow are designed in such a way that the materials of the products can re-enter the biosphere safely. The nutrients from the technical flow are designed to circulate at high quality without entering the biosphere (Ellen MacArthur Foundation, 2013). The five main principles of the circular economy are; design out waste, build resilience through diversity, rely on energy from renewable sources, think in 'systems' and waste is food (Ellen MacArthur Foundation, 2013). The logic of the circular economy is to reduce the dependency of the economic system on resource extraction and reduce the environmental damage that is caused by waste generation (Stahel, 2013), with the aim to create a balanced material flow between the ecosystem and the economic system, by closing and narrowing the

energy and material loops in the economic system. Realization of this can be achieved by implementing the 3R technological elements of circular economy, which are traditionally; reduce, reuse, and recycle (Wu, Shi, Xia, & Zhu, 2013), but can be complemented with the additional technological elements; recover, remanufacture and redesign of (Jawahir & Bradley, 2016). Effective implementation of the circular economy in the manufacturing process can be obtained, by using the 6R technological elements and explains how a sustainable manufacturing process for the technical product flow can be accomplished (Jawahir & Bradley, 2016).

2.2 Linking Circularity with Financial Performance

The added value of circular economy

This chapter describes the possible relationship between the financial performance with the circular performance of a company, based on the current available literature. The section contains information about the financial results that a company can achieve when implementing the principles of circular economy in their business model. Based on the principles of circular economy, the Ellen MacArthur foundations derives four ways of value creation that could form an opportunity for companies with a circular business model in comparison with companies with a linear business model (Ellen MacArthur Foundation, Towards the circular economy: Economic and business rationale for an accelerated transition, 2013). The first possibility of value creation that can be utilized is the “the power of the inner circle” and consists of minimising comparative material usage relative to the linear production system. Products with a high level of circulation have the following benefit; the fewer adjustments that have to be made during reuse, refurbishment and remanufacturing phase to make the product ready for usage again, the higher will be the relative savings compared with a linear production process. Products with a high circulation require relatively less capital, material, and labour input compared with linear products. The second possibility of value creation can be achieved by maximising the number of consecutive cycles of products and is called “the power of circling longer”. The number of consecutive cycles of products can be increased by reusing, remanufacturing or recycling products and resources, and use it again to maximise the utility of the resources that are used. The third possibility of value creation is the “power of cascaded use” and includes alternating the use of materials and reuse them across diverse supply chains. The concept means that the waste of one sector can be utilized as the input materials for another sector. The fourth possibility of value creation can be realized by utilizing the “power of pure circles”. Purer material streams more accessible to collect, redistribute and recycle, and result in a higher efficiency in the circular supply chain, extends product longevity and increases material productivity (Ellen MacArthur Foundation, 2013).

The value propositions that is described by the Ellen MacArthur Foundation, are mainly related to an improvement of the internal resource management within a company and the supply chain. The circular business model may affect the financial performance and competitiveness of the company positively because it has the capability to reuse, reclaim end recycle the resources. The benefits are costs savings in resource and manufacturing costs and a reduction of the environmental impact (Park, Sarkis, & Wu, 2010) (Roos, 2014) (Linder & Williander, 2015) (Walsh, 2010). Literature has identified multiple drivers of implementation of a circular business model and are describes below. The drivers justify that the circular business model helps to improve competitiveness and financial performance of a company.

First of all, a circular business model can create additional revenue streams in multiple ways. In the circular economy, the customer does not pay for the ownership of the product. Instead the customer

will rent the product from the company and pays for the service that is provided by the product. This type of agreement implies a long-term relationship between the customer and the manufacturer and enables the manufacturer to reduce costs and generate stable and long-term revenue streams, due to product lifetime extension (Blokpoel, 2016). Due to the long-term agreement, there will be more contact between the user of the product and the manufacturer and result in an enhanced relationship with the customer (Walsh, 2010). The long-term agreement also provides the manufacturer statistical data about the functioning of the product even outside warranty. The data can be used design out the less critical failures that occur after the warranty of a product and enables the manufacturer to improve the long-term value proposition of the product (Walsh, 2010). The company can extract additional value from the products that flow back to the company at the end of their life, by selling the waste as a resource towards other sectors (Park, Sarkis, & Wu, 2010). The company might be able to increase their market share or obtain a price premium, due to the fact that customers are increasingly demanding environmentally friendly products and it might be the case that customers are willing to pay a higher price for green products (Roos, 2014); (Heese, Cattani, Ferrer, Gilland, & Roth, 2005). Research conducted by (Michaud & Llerena, 2011), showed that customers tend to assign a lower value on circular products concerning conventional products unless they are informed about the environmental benefits of circular products. Providing the environmental information decreases the willingness to pay for traditional products significantly and enables companies with an environmental production process to gain competitiveness advantage (Michaud & Llerena, 2011).

Secondly, the manufacturing industry is simultaneously confronted with pressure from environmental regulation, price volatility of commodities, public concerns and risks in the supply of resources for the manufacturing process (Lieder & Rashid, 2015). The enhanced internal resource management reduces the companies' dependency on raw materials and eventually reduces the risk of price volatility and the supply risk (Park, Sarkis, & Wu, 2010). The more environmentally friendly production method that comes along with the circular business model enables the company to mitigate the reputation and regulation risks (Roos, 2014) (Park, Sarkis, & Wu, 2010). The current developments in the external environment force companies to implement a green business strategy and could form an opportunity for companies to increase their market share and improve their financial performance. (Leonidou et al., 2015) showed that the implementation of a green business strategy generates a competitive positional advantage, and the relationship becomes stronger under conditions of high regulatory intensity, high market dynamism, high public concern, and high competitive intensity (Leonidou, Christodoulides, Kyrgidou, & Palihawadana, 2015).

Thirdly, the circular business model can have a positive influence on the performance of the employees of the company and improve the overall business performance. Choi & Yu investigated the relationship between the perceived corporate sustainability practices on the employees and organizational performance. The empirical evidence from the study suggests that the perception of the corporate sustainability practices of the company by the employees have a positive effect on the on their organizational commitment and organizational citizenship behaviour (Choi & Yu, 2014).

The drawback of circular economy

Although the benefits of a circular business model sound promising, the concept is still not widely implemented by manufacturing companies, due to several limitations and challenges that could be associated with a circular business model. First of all, circular businesses have to deal with three types of restrictions; customer type restrictions, product category restrictions and partner restrictions. The customer type restrictions occur because not every single customer is interested in the type of products that are accomplished by a circular manufacturer. John Pearce defines six different types of customer

segments that are applicable for companies with a circular business model (Pearce J. A., 2009). The first target group consists of customers that need to retain a specific type of product available for their operational processes, due to the technically defined role of the product in the operational processes. Replacing the current product for a new one will be a time-consuming process and therefore they decide that repairing or remanufacture the original product is the best alternative. The second target group contain customers who want to avoid the re-specifying, reapproving or recertifying of a product. Thirdly there is a group of customers who make a low utilization of new equipment and are price sensitive. The low utilization of the conventional product makes the high investment not justified and therefore seek for products that are already used before. The fourth target group refers to customers who will continue the usage of a product that has been discontinued by the original manufacturer. The fifth group consists of customers that want to extend the lifetime of the used products to benefit the longer-term usage. The sixth group is customers who are environmentally interested and therefore purchase circular produced products (Pearce J. A., 2009). The product category restrictions occur because some products are not suitable for reusing, recycling or remanufacturing (Linder & Williander, 2015). The third restriction implies partner restrictions, including the lack of willingness among crucial supply chain partners for the implementation of the required system of reverse logistics and realising synergy of the business models among supply chain partners (Mont, Dalhammar, & Jacobsson, 2006) (Linder & Williander, 2015). Realization of a reverse supply chain requires high investments, redesigning product-lines and the overall supply chain (Blokpoel, 2016). The lack of willingness or incentives among key supply chain partners can result in an inefficient reserve supply chain and a disproportionate distribution of the investment costs of realizing a reserve supply chain. These three type of restrictions can harm the financial performance of a company as the customer type restrictions lowers the potential customer segment. The product category restrictions could increase implementation costs of circular economy as some products are not suitable for recycling, reusing and remanufacturing. The partner restrictions can result in an inefficient reserve supply chain and a disproportionate distribution of the costs of realizing a reserve supply chain.

Secondly, the risks that could be associated with a circular business model and could negatively influence the financial performance of a company are; risk of cannibalization, operational risk, capital tied up, fashion vulnerability, and the return flow challenges (Linder & Williander, 2015). The risk of cannibalizations refers to the decrease in sales, when the new circular products with an extended product lifetime, reduce the sales of the previously produced products (Guiltinan, 2009). The operational risk arises from the shift in activities that were previously relevant for the consumer but is now relevant for the manufacturer (Kuo, Ma, Huang, Hu, & Huang, 2009). For example, maintenance conducted by the manufacturer. The risk of capital tied up occurs because the manufacturer retained the ownership of the product and it is leased by the consumer. The consequence is that the financial risk of the product makes a shift from the consumer towards the manufacturer (Mont, Dalhammar, & Jacobsson, 2006). Besch suggested that this risk could be overcome by making use of long-term contracts with the customer (Besch, 2005), although this could reduce the attractiveness of the offer for the specific type of customers (Linder & Williander, 2015). The risk of fashion vulnerability involves the risk of not being able to adapt the product towards the latest fashion trends and uncertainty in the future demand for the currently manufactured products (Linder & Williander, 2015). Especially in the circular economy, wherein product lifetime extension plays an important role. The changes in fashion could also be converted into opportunities, because in some industries a considerable part of the products is thrown away due to fashion trends, although the products are suitable for remanufacturing to fit with the current or future fashion trends (Mont, Dalhammar, & Jacobsson, 2006). The return flow challenges involves the efficient product retrieval from the customer towards the manufacturer, and has been identified by the current literature as one of the

challenging but crucial aspect for remanufacturing companies (Linder & Williander, 2015) (Pearce J. A., 2009) (Besch, 2005) (Blokpoel, 2016) (Östlin, Sundin, & Björkman, 2009). Manufacturers deal with uncertainty in the predictability and reliability of the return flow (Östlin, Sundin, & Björkman, 2009) and are highly dependent on the return flow to generate output. The inconsistency in the return flow can result in additional costs for the manufacturer, because it could become challenging to manage production lines and plan the available capacity efficiently with rising production costs as result (Blokpoel, 2016),

Thirdly, the additional costs of a circular business model are identified that are not described yet. Research conducted among SMEs by (Vasilenko & Arbačiauskas, 2012), have shown the importance of the financial results for companies, as it is one of the key drivers for implementing sustainability in the business model. The transactions costs can increase, because of the need for an improved interaction between the manufacturer and the consumer, due to service-related transactions costs and consumers bringing back their products after leasing it (Blokpoel, 2016). When the products have returned to the manufacturer, they will be reused, recycled, remanufactured or even redesigned and these processes require time, human resources, technological expertise and knowledge of the product and can eventually increase the operational costs of the company (Blokpoel, 2016).

Based on the advantages and disadvantages of implementing the principles of circular economy in the business model, it can be concluded that the financial results of the implementation of a circular business model differ depending on the product characteristics, technologies, and markets that are relevant for the company. The main disadvantage of a circular business model are the difficulties in the proactive assessment of business model hypotheses, due to the longer timespan of the key business model hypotheses. Especially in the case of a product-service type of business model, whereby the manufacturer retains ownership of the products. Due to the longer timespan, it takes the company time to verify whether the business model works or not, and in the meantime the amount of capital tied up in the products keeps growing. The high uncertainty related to the business model hypotheses, are likely to be an important reason for managers to abandon the shift from a linear business model towards a circular business model (Linder & Williander, 2015).

2.3 Measuring the Circular Performance

The current economic system is primarily based on the linear system, whereby resources and capital goods form the input for the production process and the produced products will be transformed into waste after consumption. A part of the waste can be recycled and converted into resources and used as input material for the production process. The part that can't be recycled and up into waste streams and flow back to the environment, partly due to missed recycling opportunities by humans and partly due to the second law of thermodynamics (Andersen, 2007). The second law of thermodynamics is also mentioned as the law of increasing entropy. The quantity of matter and energy remains the same (first rule of thermodynamics), but the quality of the matter and energy gradually deteriorates with the expiration of time (Pearce & Turner, 1990). An increase of the amount of energy and materials used in the linear economic system increases the degree of entropy. Because the degree of entropy is bound to the amount of materials and energy that is used in the economic system, circulating matter and energy will reduce the demand for inputs and will delay the increase in entropy (Andersen, 2007). Although the second law of thermodynamics will not allow a 100% circularity of energy and matter, the circular economy can still play an essential role in today's world, because it can delay the increase of entropy and reduce the impact of humanity on the environment.

In the current literature, there are several attempts made to measure the circular performance at the micro level. The first method that can be used is the "Reuse Potential Indicator" developed by (Park &

Chertow, 2014). The indicator has a value between one and zero and describes the percentage of materials that can be reused. The indicator can be derived by calculating the number of reusable materials that are economically and technologically feasible to reuse and divide it by the amount of waste that is generated. The potential reuse indicator can help management decision-making objectively about the technical ability of the materials to be reused in commerce (Park & Chertow, 2014). The second method for measuring the degree of circularity in a company is based on the "Material Circularity Indicator" defined by the Ellen MacArthur Foundation. The Material Circularity Indicator measures for a specific product the extent to which linear flow has been minimised and restorative flow maximised for its component materials, and how long and intensively it is used compared to a similar industry-average product (Ellen MacArthur Foundation, 2015). The indicator is a function of three main product characteristics, including the mass of unrecoverable waste that can be allocated to the product, the mass of virgin raw materials that are used in the manufacturing process and the utility factor that accounts for the intensity and the length of the products use (Ellen MacArthur Foundation, 2015). The companies Material Circularity Indicator can be determined, by estimating the weighted sum of MCIs for all products that are manufactured in a company. The third method involves the "Circular Economy Index" developed by (Di Maio & Rem, 2015) and is based on the ratio between the material value produced by the recycler (market value) with the intrinsic material value entering the recycling facility (Di Maio & Rem, 2015). The Circular Economy Index can be calculated by dividing the material value recycled from end-of-lifetime products with the material value needed for (re-)producing end-of-lifetime products (Di Maio & Rem, 2015). The fourth method is the longevity indicator proposed by (Franklin-Johnson, Figge, & Canning, 2016), and measures the contribution to material retention based on the amount of time a resource is kept in use. The indicator consists of the three components; initial lifetime, earned refurbished lifetime and earned recycled lifetime. The indicator can be used as a tool for decision making and performance assessment in the circular economy (Franklin-Johnson, Figge, & Canning, 2016).

To determine the circular performance of specific industrial sectors, there are several methods that can be used to measure the circular performance at the meso-level. The first one is the "Evaluation Index System" developed by (Li & Su, 2012), with the purpose to measure the development level of circular economy in chemical enterprises. The index is based on five criteria; economic development, resources exploiting, pollution reducing, ecological efficiency and developmental potential. The second method is based on the work of (Wen & Meng, 2015). The purpose of their study was to evaluate the contribution of industrial symbiosis to the development of the circular economy, and therefore they combined the Substance Flow Analysis approach with the Resource Productivity Indicator (Wen & Meng, 2015). The third method is developed by (Genovese, Acquaye, Figueroa, & Lenny Koh, 2015), to compare the performance of circular production systems in the food- and chemical industry. The method that was used is based Hybrid LCA methodology, which combine the traditional LCA with an environmental input-output analysis (Genovese, Acquaye, Figueroa, & Lenny Koh, 2015). The fourth method is developed by (Scheepens, Vogtländer, & Brezet, 2015) and involves the "LCA-based Eco-costs Value Ratio". The model integrates the eco-costs, effectively costs and market value, to determine the level of circular economy adoption in a regional water recreation park (Scheepens, Vogtländer, & Brezet, 2015).

(Elia, Gnoni, & Tornese, 2016) proposed a reference framework for the monitoring phase of a circular economy strategy and developed a four-levels framework for supporting measurement of the circular economy paradigm adaption. The four levels refer to the processes that should be monitored, the actions that are involved, the implementation level of circular economy and the requirements that should be met to measure circular performance in a sufficient way. These requirements are reducing

and use of natural resources, reducing emission levels, reducing valuable material losses, increasing the share of renewable and recyclable resources, and increasing the value durability of products. (Elia, Gnoni, & Tornese, 2016) concluded that there is a lack of standardized methods, especially in the micro level, and the assessment methodologies that are described above to evaluate the circularity of a system, do not meet all the five requirements.

2.4 Measuring Financial performance

In the current literature, there are a lot of indicators that could be used for measuring the financial performance of a company. An overview of the indicators that are used in empirical studies that measure the relationship between the financial performance and the environmental performance can be found in table 1. The main performance measurements that are used in the current literature are Return on Assets (ROA), Return on Equity (ROE), Return on Sales (ROS) and stock price (Molina-Azorín, Claver-Cortés, Pereira-Moliner, & Tarí, 2009) (Blokpoel, 2016). The financial performance measurements that are identified, can be distinguished into two categories; the accounting-based indicators and the market-based indictors (Gentry & Shen, 2010) (Masa'deh, Tayeh, Jarrah, & Tarhini, 2015). Based on the outcome of table 1, it can be noticed that most of the empirical studies used profitability ratios to measure the financial performance and neglected the liquidity and solvency ratios as an indicator for the financial performance, and the accounting based indicators are predominantly used in the existing literature compared with the market-based indicators. The accounting-based indicators can be defined as reflections of the past or short-term financial performance and include ROE and ROA. The advantage of using accounting-based measures is that it a subject of the allocation of internal disposable resources by the management and reflects the internal decision-making capabilities and managerial performance (Albertini, 2013). The market-based indicators can be defined as a future or long-term financial performance and are based on measuring the financial performance from a shareholders' perspective (Cochran & Wood, 1984) (Gentry & Shen, 2010). The most common used market-based measures are Tobin's Q and the share price. The advantage of market-based indictors regarding accounting-based indicators, is that market-based indicators are less susceptible to manipulation in a company's accounting records by the management and it represents the future expectations of investors about the firms' profitability (McGuire, Sundgren, & Schnee, 1988). The disadvantage of market based indicators is that it can be influenced by external forces that can't be controlled by the management of a company.

2.5 Empirical studies

The empirical evidence is mainly based on the relationship between the environmental performance with the financial or business performance of the company, and an overview of the results is provided in table 1. Although the results are contradictory, it can be noticed that the majority indicates a positive or no relationship, between environmental performance and financial / business performance. The differences in outcome could be the result of the different indicators that are used for measuring the environmental performance, as a better performance for some environmental indicators will result in cost savings, and some environmental measurements can result in extra costs. Furthermore, research conducted by (Albertini, 2013) indicated that the relationship between environmental and financial performance could be influenced by the type of performance measurements that are used for both measuring the environmental performance and the financial performances. (Albertini, 2013) showed that it is more likely to find a positive relationship between environmental performance when accounting-based indicators are used, instead of using market-based indicators to measure the financial performance. Both (Albertini, 2013) and (Horváthová, 2010) indicates that the chance to find a positive relationship increases when qualitative indicators (environmental ratings) are used for measuring the environmental performance instead of quantitative indicators (amount of waste

generated). Besides the type of indicators that are used for measuring the performance, the geographical areas, the type of sector and the duration of the studies also have an influence on the relationship (Albertini, 2013). The empirical outcomes are mainly applicable for the US manufacturing Industry (Molina-Azorín et al, 2009) and are not generalizable for the European private sector. There is limited empirical evidence of the European private sector, but the studies that are conducted include the paper industry (Wagner, How to reconcile environmental and economic performance to improve corporate sustainability: corporate environmental strategies in the European paper industry, 2005), food industry (Aragón-Correa et al, 2007), Spanish tourism sector (López-Gamero et al, 2009) (Molina-Azorín et al, 2009) and Dutch SME's (Blokpoel, 2016). These studies do not give a overall representative picture in the relation between financial performance and environmental performance of the European private sector, as the outcomes of the studies are contradictory, the outcomes are applicable for a single sector in a specific geographical region of Europe, and some studies uses environmental indicators that are questionable. Furthermore, (Aragón-Correa & Rubio-López, 2007) used carbon emissions and (Wagner, How to reconcile environmental and economic performance to improve corporate sustainability: corporate environmental strategies in the European paper industry, 2005) used both emissions and the input index for water and energy to measure the environmental performance. These performance indicators are not sufficient for measuring the circular performance of a company because it focusses on a specific dimension(s) of environmental performance, but neglects a lot of other environmental aspects (Elia, Gnoni, & Tornese, 2016).

Table 1: Emperical studies in measuring the relationship between Environmental performance with the Financial/Business performance

Author	Content	Scope/Sector	Financial/Business performance	Environmental performance indicators	Effect
(Zeng et al, 2010)	Impact of cleaner production on business performance	Chinese Manufacturing Industry	Profitability, increase rate of net profit, ROE, Market share, Corporate reputation, Shareholders' confidence	low-cost and high-cost cleaner production activities	+
(López-Gamero et al, 2009)	Relationship between environmental variables and firm performance	Spanish Tourism sector	Growth in added value, economic development and financial profitability	The self-perception of managers related to environmental management-organizational aspects	+
(Molina-Azorín et al, 2009)	Environmental practices and firm performance	Spanish Hotel Industry	The occupancy rate per room, gross operative profit and gross operative profit per day	Questionnaire related to environmental protection & environmental commitment	+
(Konar & Cohen, 2001)	Relationship between the emissions of toxic chemicals with intangible asset value	Firms in the S&P 500	Tobin's Q	Toxic Release Inventory & environmental lawsuit	+
(Russo & Fouts, 1997)	Relationship between environmental performance with firm performance	Firms assigned by the FRDC	ROA	Environmental ratings by the FRDC on compliance, expenditures and waste reduction	+
(Wagner, 2005)	Relationship between environmental and economic performance	European paper manufacturing ind ustry	ROS, ROE and ROCE	emission-based and input (water, energy)-based index	-
(Sarkis & Dijkshoorn, 2007)	Relationships between solid waste management performance and environmental practice	Welsh manufacturing SMEs	Economic efficiency scores of the capability to manage the wastes in a cost-effective manner	Efficiency scores of solid waste management and recycling practices	None
(Link & Naveh, 2006)	Relationship between ISO 14001 implementation with business performance	ISO 14001 certified organisations in Israel (chemical industry, hi-tech, food and beverages, and services sector)	Gross profit margin	ISO 14001 rules, policies and procedures.	None
(Blokpoel, 2016)	The difference in business performance between a LBM and CBM	Dutch companies	Current ratio and solvency ratio	Dummy variable for circular business model	None/-
(King & Lenox, 2002)	Exploring the locus of profitable pollution reduction	US manufacturing firms	ROA and Tobin's Q	Total emissions & pollution reduction	+
(Alvarez, 2012)	Impact of CO2 Emission Variation on Firm Performance	International firms	ROA and ROE	CO2 emissions	-
(Aragón-Correa & Rubio-López, 2007)	Relation between environmental progress and financial performance	Food industry in French and the UK	ROI and ROE	Emission of organic carbon	None
(Clarkson et al, 2011)	Determinants and consequences of proactive environmental strategies	Pulp & Paper, Chemical, Oil & Gas, and Metals & Mining sector in the US	ROA, cash flow, leverage ratio	pollution propensity and it is calculated as toxics release inventory (TRI) in pounds per thousand dollar cost of goods sold	+
(Yang, Hong & Modi, 2010)	Impact of lean manufacturing and environmental management on business performance	International manufacturing firms	Sales, market share, ROA, ROS	Respondent perceptions regarding their environmental performance improvements, Environmental Management System, Life-Cycle Analysis, Design for Environment and ISO 14001.	+/-

3. Conceptual Framework

The conceptual framework provides an overview of the theoretical relationships that will be examined in this study. The conceptual framework consists of the blocks “financial performance” and “circular performance”, with an arrow that assigns in both directions for in case a causal relationship exists. The graphical representation of the conceptual framework is provided in figure 1. The block at the top of the conceptual framework involves the control variables, and these are operationalized in chapter 4. The control variables time and sector are added to the conceptual framework, to examine whether these elements have an influence on the circular performance and are used as control variables for the financial performance. The control variables company size is included, as prior research indicates that companies with a more prominent size are more profitable, although there are also arguments that firm size could have an adverse effect on the financial performance (King & Lenox, 2001), (Wang, Li, & Gao, 2014). The control variable age is included, because empirical studies indicated that the variable age could have a positive or a negative influence on the firm’s financial performance (Ilaboya & Ohiokha, 2016). Finally, the control variable region is included to control for the differences in social-economic factors between regions that could affect the financial or circular performance of companies (Ebbinghaus, 1999); (Sapir, 2004).

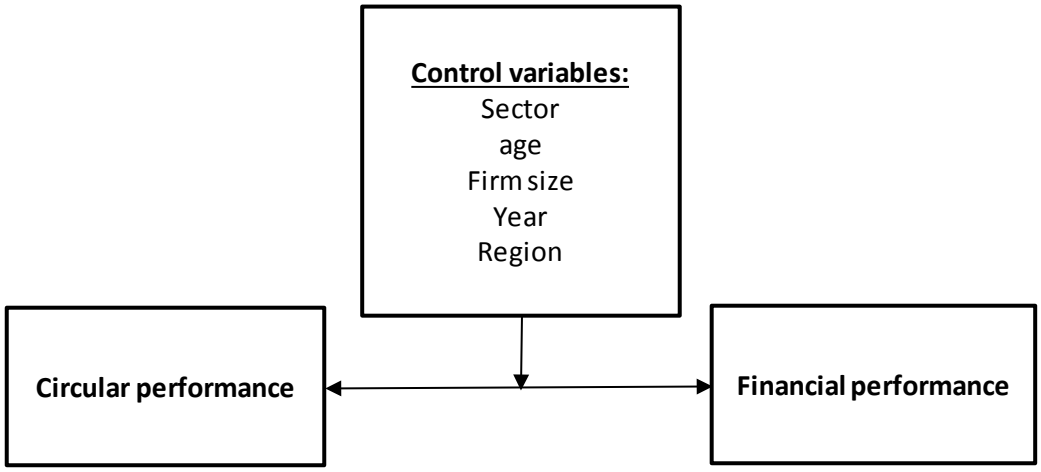

Figure 1

A positive relationship between circular performance and financial performance is expected, because the circular economy has the objective to minimize the resources that are used in the operational processes and it is likely that companies with a higher resource efficiency will have lower input costs resulting in a higher financial performance and a better environmental performance. The second reason why a positive relationship between circular performance and financial performance can be expected is based on the win-win hypothesis (King & Lenox, 2001), (Wagner & Schaltegger, 2004), (Guenther & Hoppe, 2014). This hypothesis suggests that the shift towards an environmentally-friendly governmental regulation can stimulate companies to implement circular economy in their business model and generate a first-mover advantage. This argument is especially relevant for

companies in Europe, because the transition to a resource-efficient and the ultimately regenerative circular economy is highly supported by the European Union (Bonciu, 2014), (McDowal, et al., 2017). The third reason for expecting a positive relationship is based on the studies conducted by (Horváthová, 2010) and (Albertini, 2013). Both types of research conducted a meta-analysis to examine the relationship between environmental performance and circular performance and discovered that there is a higher chance to find a positive relationship between environmental performance and financial performance, when qualitative indicators (environmental ratings) are used for measuring the environmental performance instead of quantitative indicators (amount of waste generated). (Horváthová, 2010) suggests that this could be the result that a qualitative indicator contains more information, although the qualitative indicators could be rather subjective and not correlate with the actual environmental performance of the company. The information that is used to determine the circular performance of a company consists only data of qualitative indicators. The fourth reason is that the circular economy reduces the companies' dependency on resources and this could result in a reduction of the pressure of stricter environmental laws and regulations, price volatility and risk in resource supply in addition to their daily operational processes. The fifth reason is that customers can attach a higher value proposition on products or services that have a green label and therefore could be willing to pay a price premium.

There are also some arguments that to assume the existence of a negative relationship between circular performance and the financial performance. Based on the trade-off theory, improving the environmental performance of the firm decreases the financial performance of the firm, because the environmental practices require financial and other resources that can't be used for additional value-creating investments (Guenther & Hoppe, 2014), (Preston & O'Bannon, 1997). Implementation of environmental practices could result in a shift in the resources from the core business off the company and could result in a competitive disadvantage, compared with competitors that are less environmental friendly. Especially the end-of-pipe technologies can be seen as costly investments for the firm, whereby there is not a clear advantage for in return (Lankoski, 2008). Furthermore, (King & Lenox, 2002) suggests that it conflicts with the primary objective of the firm to maximize shareholder value. Although section 2.2 mentioned a lot of disadvantages that are relevant for companies with a circular business model, it is assumed that these disadvantages are not relevant for the companies that are derived from the database Sustainalytics, because these disadvantages are related to the product-service system (PSS) type of business model and these type of business models are not widespread implemented yet (Linder & Williander, 2015). Therefore, this research assumes that the companies that are present in the database Sustainalytics, haven't implemented the concept of product leasing yet and do not face the disadvantages of this specific type of circular business model.

Non-linear:

The empirical evidence in the current literature shows contradictory results, and the relationship between circular performance and financial performance may be more complicated than only a positive or a negative relationship (Lankoski, 2008), (Orlitzky, 2013). According to (Hahn, 2010), the mainstream literature followed the win-win paradigm and neglected the trade-offs in the relationship between corporate sustainability and financial performance (Hahn, 2010). Therefore, this research follows the line of the meta-theoretical principle of the too-much-of-a-good-thing effect of (Pierce & Aguinis, 2013). The TMGT effect assumes that the seemingly positive relation reaches a specific inflection point after which the relation changes asymptotic and often in a negative relation (Pierce & Aguinis, 2013). The result is an overall curvilinear pattern. The theory is based on the law of diminishing marginal returns and argues that the theories in management studies are often based on the assumption that more of ordinarily beneficial antecedents always result in a higher desired

outcome (Pierce & Aguinis, 2013). The level of the dependent variable that is measured determines whether the type of relationship is negative, positive or none. The reason why the empirical evidence shows mainly a positive relationship between environmental performance and financial performance, could be the result of the assumption that a company only invests money in environmental practices when there is an economic incentive present, because the general objective of a firm is profit maximisation. In this case, a company will invest money in environmental practices till the point where the marginal revenues of environmental practices equal the marginal costs of environmental practices. In this optimum, there is no incentive to increase the environmental practices of the company, because the marginal costs will exceed the marginal revenue. This could be one of the reasons why the existing literature finds mainly a positive relationship between environmental performance and financial performance, because from an economic perspective it is likely that the majority of the companies will not exceed this optimum point and therefore the majority of the studies indicate a positive relationship, especially when the relationship is measured with a linear regression model. Therefore, this study assumes that there is an inverted U-shaped relationship between circular performance and financial performance and uses the following hypothesis;

H_0: *There is no relationship between the circular performance and the financial performance*

H_a: *There is a non-linear relationship between the circular performance and the financial performance*

The second hypothesis is based on the increasing pressure from the European Union towards companies to operate in a sustainable way, and the growing customer awareness resulting in a higher demand for sustainable products over time (Blokpoel, 2016) (Commission, 2014). These developments in the external environment of the private sector force them to make the shift towards the circular economy over time. Therefore, the second hypothesis investigated if the circular performance of companies changed over time.

H_0: *The circular performance of companies did not increase over time.*

H_a: *The circular performance of companies increased over time.*

The third hypothesis is based on the differences in outcomes, between studies that measure the relationship between environmental performance and financial performance. Table 1 shows that there are a lot of differences in outcomes in this relationship and a possible explanation could be that there are differences in environmental performance across sectors and that the profitability of circular activities differs depending on the type of sector of the company. (Linder & Williander, 2015) and (Horváthová, 2010) recommends further research in the difference in relationship between environmental performance and financial performance across sectors. According to (Geissdoerfer, Savaget, Bocken, & Hultink, 2016), there is a growing interest among companies in the opportunities that the circular economy has to offer and some established multinationals like Google, Unilever and Renault are active in it, although there is no empirical evidence of emerging circular economy practices in general among companies (Bocken, Ritala, & Huotari, 2017). (Bocken, Ritala, & Huotari, 2017) investigated the introduction of the concept "Circular economy" among the S&P 500 Firms and concluded: "*The circular economy is in its infancy, but the evidence of emerging circular economy practices such as recycling and maintenance is, unsurprisingly, omnipresent* (Bocken, Ritala, & Huotari, 2017)." Although it should be noted that it represents the U.S. stock market index and excludes European companies. In Europe, there are some circular initiatives in industries were companies implemented the principles of circular economy like in the textile industry (Fischer & Pascucci, 2017), the automotive industry (Saidani, Yannou, Leroy, & Cluzel, 2017), and some big

multinationals like Nestlé's recycling of polyethylene terephthalate (PET) packaging, ArcelorMittal's steel from 100% locally sourced steel scrap, the circular vacuum cleaner of Philips and the end-of-life product strategy of IKEA in Poland (BusinessEurope, 2017). It is logical that there will be differences across sectors, especially since the applicability for the implementation of circular economy differs depending on the product characteristics, technologies and markets that are relevant for the sector (Linder & Williander, 2015). For example, a study conducted 90 small Danish companies that repaired smartphones indicated that they did not emerge as a response to the sustainability agenda, although they contribute to the circular economy and a sustainable smartphone consumption by extending the product lifetime of the smartphones (Riisgaard, Mosgaard, & Overgaard Zacho, 2016). The reuse and reparation of smartphones became feasible, due to the high purchasing costs for a new smartphone (Riisgaard, Mosgaard, & Overgaard Zacho, 2016). Therefore, the third hypothesis is;

H_0: *There is no difference in the circular performance across sectors.*

H_a: *There is a difference in circular performance across sectors.*

4. Methods

4.1 Data Envelopment Analysis (DEA)

The objective of this paper is to examine the relationship between the circular performance and financial performance of the European private sector. Therefore, it is necessary to assess both the relative circular performance and the relative financial performance of a company in each year and compare it with the best practices that are observed during the same period in the sample. This will be done with the help of Data Envelopment analysis (DEA). DEA is a benchmarking technique and it is conducted for the performance assessment of the financial performance and the circular performance of the companies in the dataset. DEA was introduced by (Charnes, 1978) and is a mathematical programming technique for estimating the best practice production frontiers and evaluating the relative efficiency of multiple Decision-Making Units (DMU) (Bogetoft & Otto, 2011). DEA combines the estimation of the best practice frontier with the measurement of performance that is relative to the frontier, with the advantage that the DEA model defines the performance standard, the frontier and it evaluates the company's performance with the established standard. DEA determines the frontier by comparing the DMU's in the dataset with each other and it identifies a subset of DMU's of best practice. These DMU's will form the frontier and the magnitude of the inefficiency of DMU's is derived by calculating the distance of the inefficient DMU with the frontier (Coelli, Battese, Prasada Rao, & O'Donnell, 2005). The frontier will differ, based on the scale assumption that is applied in the DEA model. The most commonly applied assumptions are the constant returns to scale (CRS) and the variable returns to scale (VRS) (Coelli, Battese, Prasada Rao, & O'Donnell, 2005). The returns to scale assumption suggests that some rescaling is possible, whereby constants return to scale suggests that proportional change in inputs results in the same proportional change in outputs, and variable returns to scales implies that an increase in inputs does not necessarily leads to an increase in output (Coelli, Battese, Prasada Rao, & O'Donnell, 2005). In general, VRS implies that the firms are compared with other firms of similar size (Bogetoft & Otto, 2011). The constant returns to scale assumption will be used in this study, as this this research is based on the research line of (Cherchye, 2004). The regression model that is used in this study will control for the differences in firm size. The research line of (Cherchye, 2004) looks at the achieved output, without looking at the inputs that is used. The basic idea of this DEA model is to obtain a composite indicator that combines a set of KPI's into a single summary measure of performance (Horta, Camanho, & Moreira da Costa, 2012). The DEA model overcomes the problem of identifying a set of weights that reflects the relative importance of each KPI and therefore the DEA model let each company select in own weights that maximizes its composite indicator compared to the other composite indicators of the other companies in the sample. The DEA model allows each firm to select its own weighting system that emphasize the company's strengths for the performance assessment (Horta, Camanho, & Moreira da Costa, 2012).

The DEA model that is used for constructing a composite indicator describing financial performance is as follows:

$$FP_j = \min \theta$$

subject to

$$y_{ik} / \theta \leq \sum_j \lambda_j y_{ij}, \quad i = 1,2,\mathrm{K}, h,$$

$$\lambda_j \geq 0, \quad j = 1,2,...,n,$$

where $y_j = y_{1j}, y_{2j}, ..., y_{hj}$ represent selected KPI describing FP for the firm j, j indexes the firms in the analysis, *n* is the total number of firms in the sample, i indexes the KPI describing FP, h is the total number of selected KPI describing FP, and λ_j are the assigned weights for each firm.

The DEA Model for constructing a composite indicator describing circularity performance is as follows:

$$CP_j = \min \theta$$

subject to

$$\theta y_{ik} / \theta \leq \sum_j \lambda_j y_{ij}, \quad i = 1,2,\mathrm{K}, h,$$

$$\lambda_j \geq 0, \quad j = 1,2,...,n,$$

where $y_j = y_{1j}, y_{2j}, ..., y_{hj}$ represent selected KPI describing CP for the firm j, j indexes the firms in the analysis, *n* is the total number of firms in the sample, i indexes the KPI describing CP, h is the total number of selected KPI describing CP, and λ_j are the assigned weights for each firm.

The disadvantage of using DEA is that the efficiency scores are calculated relative to an estimated unobserved frontier (Simar & Wilson, 1998) and the statistical estimators of the frontier are obtained from a finite number of samples in the dataset, which could result that the efficiency scores are sensitive for the sampling variations of the estimated frontier (Simar & Wilson, 1998). Therefore, the bootstrap algorithm of (Simar & Wilson, 1998) is used to analyze the sensitivity of the obtained efficiency scores, construct a 95% confidence interval for the efficiency scores and obtain the unbiased performance estimates. The performance estimates are calculated separately for each year for all the companies that are present in the sample. Bootstrapping is introduced by (Efron, 1979) and is based on the idea of resampling the data from the original sample. The idea behind the bootstrap algorithm is that the sample is a random draw from the underlying population, and therefore the random draws from the sample are also random draws from the underlying population. The bootstrapping procedure that is used in this study, takes a predetermined number iterations from the original sample and together they form a distribution of the efficiency scores that represents an estimate of the unknown distribution of the underlying population. This study used the statistical software program R (version 3.3.3) with the software

package FEAR version 2.0 developed by (Wilson, 2008), to make the calculations and obtain the unbiased efficiency scores for all the firms.

4.2 Bootstrap-truncated regression

To examine the relationship between the circular performance and the financial performance and to determine the other factors that could have an influence on the financial performance of the companies in the sample, a bootstrap-truncated regression model will be used that is based on the algorithm 2 of (Simar & Wilson, 2007). The reason why this model was chosen, has to do with the fact that the relation between financial performance and circular performance will be examined based on the DEA estimates. A problem arises when the DEA estimates of the circular performance and the financial performance are regressed on other variables, because the DEA estimates from both the circular performance as the financial performance are serially correlated (Simar & Wilson, 2007). Furthermore, the DEA estimates are based on an underlying data generating process and therefore the DEA estimates are censored, because they have all a value between one and zero. The bootstrap-truncated regression of (Simar & Wilson, 2007) showed that this is an appropriate approach to deal with the problems that arises when DEA estimates are regressed. This study uses the unbiased performance inefficiency scores of the financial performance and the inefficiency scores of the circular performance. It was not possible to obtain the unbiased performance score for the circular performance, because the data of the circular performance did not contain enough variation. Therefore, the DEA estimates of the circular performance are used in the bootstrap-truncated regression model.

Two bootstrap-truncated regression models are conducted, whereby in the first bootstrap-truncated regression model the unbiased financial inefficiency scores will be regressed on the unbiased circular inefficiency scores and the control variables age, region, sector, year and firm size. The financial performance functions as the dependent variable and the purpose of this regression is to examine whether the circular performance have an influence on the financial performance of the company. The only difference between the second regression model and the first regression model is that the circular performance is moved to the left-hand side of the function and the financial performance to the right-hand side of the function. The purpose of this regression model is to analyse if the circular performance of companies changed over time and if there are differences in the circular performance of companies across sectors.

The Anglo-Saxon model, the sector energy and the year 2009/2012 functions as the baselines for the dummy variables. The second circular performance variable involves the squared circular performance, and is based on the too-much-of-a-good-thing effect of (Pierce & Aguinis, 2013). The TMGT effect assumes that the seemingly positive relation reaches a specific inflection point after which the relation changes asymptotic and often in a negative relation (Pierce & Aguinis, 2013). By adding the squared circular performance in the regression model, it is possible to identify a possible non-linear relationship. The regression model that is used in this research is as follows:

$$FP_J = \beta_0 + \beta_1 CP_j + \beta_2 CP_j^2 + \beta X_j$$

In the second bootstrap-truncated regression model, the unbiased circular inefficiency scores functions as the dependent variable, too look if the circular performance inefficiency is related to the financial performance inefficiency and to analyse if the circular performance differs across sectors and to determine whether companies became more circular over time. The second bootstrap-truncated regression model is as follows;

$$CP_J = \beta_0 + \beta_1 FP_j + \beta_2 FP_j^2 + \beta X_j$$

5. The Data

5.1 Financial performance indicators

Referring to table 1 in section 2.5, it can be noticed that the accounting based indicators are predominantly used compared with the market based indicators to express the financial performance of the company. The commonly used accounting based indicators are return on equity (ROE), return on assets (ROA) and the return on sales (ROS). The market based indicators that are commonly used in the existing literature are the stock market performance and Tobins Q. The advantage of using market-based indicators is that they provide the future expectations of market participants in the company's profitability and growth and (Lubatkin & Shrieves, 1986) argue that market-based indicators measure all relevant information, in contrast to accounting based indicators that measure a single aspect of financial performance. Some researches argue that maximization of the shareholders' equity is the ultimate economic goal of the company and therefore the market-based indicators are more relevant to use for the performance assessment (Gentry & Shen, 2010). Although the disadvantage of using market-based indicators is that the stock price does not necessarily reflects the correct value of the firm, because it is partly based on the information that is provided by the management of the firm and they can determine which information they provide the shareholders. Both performance indicators have their specific implications and therefore a lot of researchers accept both market-based and accounting-based indicators as valid indicators for the performance assessment (Gentry & Shen, 2010)

This study will use both types of indicators to develop a composite index for financial firm performance. Although the study makes a distinction between accounting-based and market-based indicators, the financial ratios are traditionally grouped into five categories; short-term solvency ratios, long-term solvency ratios, asset management/turnover ratios, profitability ratios and market value ratios (Hillier, Ross, Jaffe, & Jordan, 2013). The short-term solvency or liquidity measures are ratios that provide information about the company's liquidity and focus on the current assets and the current liabilities of the company. The advantage of using short-term solvency ratios is that the book values and market values are very similar, and the disadvantage is that the current assets and liabilities can change rapidly and can be manipulated by managers. So, today's measured amounts may not be a good reflection of the future or the average yearly amounts. Therefore, this study will not include short-term solvency ratios. The long-term solvency or financial leverage ratios addresses the companies long-run ability to meet its financial obligations. Although the capital structure can for a part be determined by the managers of the company and changing the capital structure can be used as a tool to improve the profitability due to the tax-shield (Hillier, Ross, Jaffe, & Jordan, 2013), it is still a suitable indicator for the financial performance, because it addresses the financial healthiness of the company. The Asset management or turnover ratios intended to address the efficiency and effectiveness of how a company uses its assets to generate revenues or sales (Hillier, Ross, Jaffe, & Jordan, 2013). The study will include the total asset turnover ratio and can be calculated by dividing the turnover with the total assets of the company. The ratio indicates how much turnover is generated by every euro assets (Hillier, Ross, Jaffe, & Jordan, 2013). The profitability ratios address how efficiently the firm uses its assets and how efficiently the firm manages its operations (Hillier, Ross, Jaffe, & Jordan, 2013). The most commonly used profitability ratios are the return on equity (ROE) and the return on assets (ROA). Both performance indicators measure the profitability of a firm, and the term indicates the ratio between a company's profit and the ability to achieve this profit. These

profitability measures indicate how efficiently the firm manages its operational processes and how efficiently the firm uses its assets. The ROE can be calculated by dividing the EBIT with the firms' total equity. The ROA can be calculated by dividing the firms' EBIT with the total assets and it provides information about the profit per asset. This study uses the ROA as indictor for the financial performance, because the focus is on the overall profitability of the firm. The final group of measures includes the market value measures and contains information about how the market valuate the firm. The market based indicator that is used in this research is the Tobin's Q. This indicator is included, because it is commonly used in existing literature, it is not influenced by the number of outstanding shares like the price-earnings ratio (Hillier, Ross, Jaffe, & Jordan, 2013), and provide a good overview of the ratio market value compared with the book value of the firm. Tobin's Q is the ratio between the company's assets in relation to the market value of the company. The ratio can be calculated by dividing the market capitalisation with the total assets of the company. The market capitalisation can be calculated by multiplying the share price of the company with the shares outstanding and the total assets can be obtained from the consolidated balance sheet. A Tobin's Q ratio between 1 and 0, indicates that the replacement costs of the company's assets are higher than the company is worth. When the Tobin's Q ratio is higher than 1, it indicates that the value of the company is higher than their assets are worth and theoretically it means that the company is overvalued (Hillier, Ross, Jaffe, & Jordan, 2013).

5.2 Financial performance data

The key performance indicators that are used to describe the financial performance of a firm are the total asset turnover, return on assets, Tobin's Q and the solvency ratio. An explanation of why those indicators are selected can be found in section 5.1 of this report. The financial data of where the calculations of the financial key performance indicators are based on comes from the database Orbis and the annual reports of the companies. To compare the financial performance with the circular performance of a specific company, is it necessary to link the database Sustainalytics with the database Orbis. The companies are linked based on the International Securities Identifying Number (ISIN) that is mentioned in the database Sustainalytics, and this number is used to search for the financial data of the corresponding company in Orbis. All the companies that are used in this study are stock listed, and therefore it was possible to link most of the companies based on their ISIN number. The data that is extracted from the database Orbis involves the company's balance sheet, profit & loss account and the market capitalization for the years 2009 to 2016. It was not possible to link all the firms of the database Sustainalytics with the database Orbis based on their ISIN number. Therefore, some companies are linked based on their company name in the database Sustainalytics with the corresponding company name in the database Orbis. After this step, there were still some companies that are not present in the database Orbis, and there were companies that had some missing values in the dataset that was exported from Orbis. Therefore, the dataset is supplemented with the data from the annual reports that were provided on the company's website. The companies that still had a missing value on one of the control variables or the KPI's are deleted from the dataset. The next step after obtaining a full dataset was to identify and delete outliers. An outlier can be defined as an observation or a score that is very different from the rest in the dataset (Field, 2013). The outliers are deleted from the dataset because it can bias the results and the observations are not representative for the underlying population of interest. The outliers are identified, by calculating the Z-scores for each observation and for all the four key performance indicators that express the financial performance of a company (Rousseeuw & Hubert, 2011); (Field, 2013). The companies that have a Z-score that is

not between -2,575 and 2.575 (confidence interval of 99%) on one of the four financial performance indicators are deleted from the dataset, because those observations are identified as an outlier. An overview of the descriptive statistics of the sample after deleting the outliers is presented in table 2.

5.3 Circular performance indicators

This section describes how the circular performance indicators are selected from the database Sustainalytics. The criteria of (Elia, Gnoni, & Tornese, 2016) is used to select suitable circular performance indicators. (Elia, Gnoni, & Tornese, 2016) defined a reference framework for an effective measurement process of the adoption towards the circular economy. The framework can help monitoring the phases of the implementation of a Circular Economy strategy and consists of four levels, describing the requirements that should be measured, the processes that should be monitored, the actions that are involved and the implementation level (Elia, Gnoni, & Tornese, 2016). For this study, the requirements that should be measured are relevant, because it includes five requirements to measure the circular performance of a company, product, or service. Those five requirements are; reducing input and use of natural resources, reducing emission levels, reducing valuable materials losses, increasing the share of renewable and recyclable resources and increasing the value durability of products (Elia, Gnoni, & Tornese, 2016).

The objective of the "*reducing input and use of natural resources*" requirement is to reduce the environmental damage that is resulting in greater environmental degradation and fragility caused by the linear system. The purpose is to achieve more value from fewer materials. The second requirement is "*Reducing emission levels*" and refers to the direct as well as indirect emissions. The third requirement is "*Reducing valuable materials losses*" and refers to closing the material cycle by recycling, and recovering materials and the reverse material flow allows waste prevention and the loss of valuable materials. The fourth requirement is "*Increasing share of renewable and recyclable resources*" with the objective to create less waste and emissions throughout the supply chain by using less raw materials and more on more sustainably sourced materials. The fifth and last requirement is the "*Increasing the value durability of products*", and this can be achieved by product lifetime extension, the development of user-oriented business models whereby products are leased instead of sold, and products are re-used and components remanufactured (Elia, Gnoni, & Tornese, 2016). The requirement "*reducing emission levels"* will not be used in this study to select circular performance indicators, because based on the circular performance measurements in the current literature, it can be noticed that the main focus of circular economy is on a sustainable use of physical raw materials in the products and less of on the emission levels of the company's operations (Park & Chertow, 2014);(Ellen MacArthur Foundation, 2015); (Di Maio & Rem, 2015); (Franklin-Johnson, Figge, & Canning, 2016).

The indicators that are used in this research and selected from the database Sustainalytics and are based on the four requirements that are mentioned above. Sustainalytics is a database that provides the ESG ratings of companies across the world and can be used for research, investment decisions and other purposes. The dataset is made of three main pillars; environmental, social and governance and each main pillar contain several categories with his specific indicators. Sustainalytics the companies among 42 different peer industry groups and each group has some fixed amount of core indicators and some sector specific indicators. The score that each company gets assigned is ranged between 0 and 100 and is on based on particular guidelines. This research uses only the environmental indicators to determine the circular performance of a specific

company. The database consists 57 indicators that measure the environmental performance of a specific company in a specific sector and in a specific time-period. The first step of selecting suitable indicators to express the circular performance is by looking at the description of the indicator and select those that are in line with the four requirements that are used. Some indicators are in line with one of the four requirements, but are specific to a single sector and will not be used in this study. The second step is to exclude the indicators of which a small sample size is available, or the indicators that measure only the environmental performance of a couple of sectors. The indicator "Data on Percentage of Recycled/Re-used Raw Material Used" sounds interesting to use, but the data is only available for seven sectors, including sectors that do not use a high amount of raw materials in their daily processes (Media, diversified financials, etc.). Including these indicators will limit the ability to investigate whether there are differences in the relationship between the circular performance and financial performance across sectors. The third step is to select the environmental indicators based on the four requirements of (Elia, Gnoni, & Tornese, 2016). The selection process aims to find the best combination of environmental indicators to measure the circular performance, whereby there is a sufficient sample size available, the requirements of (Elia, Gnoni, & Tornese, 2016) are met, and the dataset contains information on multiple sectors. Therefore, the selection process requires a trade-off between the sample size, the relevance of the sectors that are included in the dataset, and the fitness of the environmental indicators with the requirements to measure the circular performance. Based on this procedure the following circular performance indicators are selected; Formal Environmental Policy, Percentage Primary Energy Use from Renewables, Formal Policy or Programme on Green Procurement and finally the indicator Waste Intensity.

5.4 Circular performance data

The key performance indicators that are used to measure the circular performance are; formal environmental policy, waste intensity, percentage primary energy use from renewables and the formal policy on green procurement. An explanation of why those indicators are selected can be found in section 5.3 of this report. The data that is used in this study comes from the database Sustainalytics and involves the raw scores of the companies on each circular performance indicator. In the data that Sustainalytics contains are differences in the number of observations of the individual companies. Some companies have more observations in a single year than other companies, and there are also differences in the time-period over which a particular company has been measured. Therefore, the data is transformed by calculating the average score on each KPI for each company in each year, with the option "pivot table" in Excel. The result is that the average score of an individual company in 2009 could be based on eight observations, and the average score of another company in 2009 could be based on three observations. Table 2 provides an overview of the descriptive statistics of the sample that is used in this research for both the control variables, the financial performance indictors and the circular performance indicators. All the observations in the sample have a score between 0 and 100 for the circular performance indicators, and a higher score means a better circular performance.

Table 2: Descriptive statistics of the sample 2009-2016

	Mean	SD	Min	Max
DEA Circular Performance Indicators				
Average of Formal Environmental Policy	54.88	32.76	0	100
Average of Waste Intensity	60.26	25.37	0	100
Average of % Primary Energy Use from Renewables	14.57	33.83	0	100
Average of Formal Policy or Programme on Green Procurement	40.53	31.24	0	100
DEA Financial Performance Indicators				
Total asset turnover ratio	0.749	0.356	0.012	1.802
ROA	0.076	0.060	-0.121	0.290
Tobin's Q	2.083	1.427	0.155	7.803
solvency ratio (EV/TV)	39.236	15.159	8.104	81.644
Bootstrap-truncated regression				
LN (Total assets)	8.969	1.549	2.263	12.494
Age	66.099	62.536	0	402
Year 2009, 2010, 2011, 2012. (Dummy)	0.948	0.222	0	1
Year 2013, 2014, 2015, 2016. (Dummy)	0.052	0.222	0	1
Anglo-saxon model (Dummy)	0.148	0.356	0	1
Nordic model (Dummy)	0.151	0.358	0	1
Centre-model (Dummy)	0.422	0.494	0	1
Southern model	0.261	0.439	0	1
Eastern model (Dummy)	0.017	0.131	0	1
Energy (Dummy)	0.052	0.222	0	1
Materials (Dummy)	0.210	0.408	0	1
Industrials (Dummy)	0.307	0.462	0	1
Consumer Staples (Dummy)	0.025	0.157	0	1
Health Care (Dummy)	0.083	0.276	0	1
Information Technology (Dummy)	0.102	0.302	0	1
Telecommunication Services (Dummy)	0.091	0.288	0	1
Utilities (Dummy)	0.130	0.336	0	1

5.5 Control variables

This study includes five control variables in the conceptual framework as several studies have indicated that these variables could influence the financial performance of a company. The first is the company size, as prior research indicates that companies with a more prominent size are more profitable, although there are also arguments that firm size could have a negative effect on the financial performance (King & Lenox, 2001), (Wang, Li, & Gao, 2014). Larger companies could have the advantage of the economies of scale, more bargaining power against the other supply chain partners, brand name recognition, learning effects, and they could be more competitive, because of their monopoly position and the ability to keep the prices above the competitive level (Fiegenbaum & Karnani, 1991). On the other hand, small firms have the advantage of being more flexible in adjusting their key competencies to external developments against relative low costs (Horta, Camanho, & Moreira da Costa, 2012), lower cost of coordination and a faster decision-making process (Fiegenbaum & Karnani, 1991). The firm size will be operationalized by using the logarithm of the total assets of the company. The second control variable is the age of the

company, as empirical studies indicated that the age could have a positive or a negative influence on the firm's financial performance (Ilaboya & Ohiokha, 2016). One stream of literature suggest that there is a positive relationship between age and financial performance, because firms learn from their experience and build up relationships with other firms and this enables the firm to improve the efficiency of their processes over time (Bahk & Gort, 1993). Another stream in the literature suggests that older firms suffer from the liability of obsolescence and the company's performance decreases over time. Older companies are prone to inertia and not able to adjust to the changing external environment of the organization (Ilaboya & Ohiokha, 2016). The variable age will be operationalized as the number of years of incorporation.

The third control variable is the sector of where the company is active in. Section 3.1 describes the reason why this variable is included as control variable. The companies assigned towards a sector based on the data that is provided by Sustainalytics. The companies that are present in the dataset assigned towards multiple sectors based on the Global Industry Classification Standard (GICS). This standard is developed by MSCI and the Standard & Poor's to assign companies to a specific sub-industry (MSCI, 2017). The classification system contains 11 sectors, 24 industry groups, 67 industries and 156 sub-industries (MSCI, 2017). The companies in the database Sustainalytics are already classified among the 24 industry groups of the Global Industry Classification Standard, but this study will divide the companies among the 11 main sectors of the Global Industry Classification Standard based on the data of Sustainalytics. The reason for this is to decrease the number of control variables for the sectors in the bootstrap-truncated regression model. Table 3 provides an overview of the number of observations in each year and in each sector. The table contains only nine sectors, because there were no observations in the sectors Financials and Real Estate, so they are left out from table 3.

Table 3: Categorization of the sectors by GICS of the sample 2009-2016

Year	Energy	Materials	Industrials	Consumer Staples	Health Care	Information Technology	Telecommunication Services	Utilities
2009	11	41	62	5	18	15	18	29
2010	14	48	66	5	16	19	21	33
2011	14	51	77	5	19	28	22	34
2012	0	8	13	0	3	11	3	0
2013	0	2	2	0	0	0	2	1
2014	0	3	6	0	3	1	1	0
2015	0	2	2	2	1	1	1	0
2016	0	2	2	2	2	1	0	0
Total	39	157	230	19	62	76	68	97

The fourth control variable used in this research is the region of where the company is located in. This control variable could be operationalized by looking at the country of where the company is located, although this would result in 21-1=20 dummy variables for the countries. Therefore, the countries will be grouped too reduce the number of dependent variables in the regression model. The countries are grouped based on similarities in their capitalist model which is based on multiple social-economic factors. (Ebbinghaus, 1999) and (Sapir, 2004) described and verified the following four capitalist models; Anglo-Saxon, Nordic, Continental and Mediterranean model. The models differ in multiple social-economic factors like the levels of regulation, taxes and services that are provided by the public sector (Ebbinghaus, 1999). Empirical evidence indicated

that the differences in the capitalist model could have an effect on the relationship between corporate social responsibility and the financial performance of companies (Martínez-Ferrero & Frías-Aceituno, 2015).

The Anglo-Saxon model include low levels of regulation by the government and low levels of taxes. The public sector provides fewer public services compared with the other type of capitalism models. The companies in those countries are mainly stakeholder oriented and the stakeholders have a greater degree of investor protection (Sapir, 2004); (Farkas, 2011); (Martínez-Ferrero & Frías-Aceituno, 2015); (Barr, 2004). One of the main differences between the Anglo-Saxon model and the Nordic and Centre model is the collective bargaining rights and corporatist policies (Sapir, 2004). The Nordic model includes a free-market capitalist economic system with a high level of tax and a high degree of private ownership and a comprehensive welfare state (Sapir, 2004); (Sanandaji, 2012). The Centre-model is characterized by the combination of a free market capitalist economic system with social policies. The Centre model allows both fair competition as the establishment of a welfare state. The southern model is characterized by an inflexible labour market, high level of employment protection and high expenses on social support (Amable, 2003). The Eastern model is characterized by the lack of capital a weak civil society and low R&D expenditures (Farkas, 2011). Both (Ebbinghaus, 1999) and (Sapir, 2004) looked only at the West-European countries and ignored the Eastern European countries. (Farkas, 2011) included the Eastern European countries and identified an Eastern European model of capitalism. The variable will be operationalized by making use 5-1 =4 dummy variables to control for the type of capitalism. Table 4 provides an overview of the number of observations of the type of capitalist model in each year.

Table 4: Categorization of the capitalist model based on country of the sample 2009-2016

Year	Anglo-saxon model	Nordic model	Centre-model	Southern model	Eastern model
2009	29	37	70	61	2
2010	34	37	83	62	6
2011	33	37	111	65	5
2012	2	2	30	4	0
2013	0	0	6	1	0
2014	4	0	10	0	0
2015	4	0	3	2	0
2016	5	0	3	1	0
Total	111	113	316	196	13

The fifth control variable that will be included in this study is time. The variable will be operationalized by making use of a dummy variable. The years 2009, 2010, 2011 and 2012 are grouped together and the years 2013, 2014, 2015, 2016 are grouped together. The variable for years are grouped together to reduce the number of dependent variables in the bootstrap-truncated regression model. The number of observations in each year can be found in table 5.

The initial idea was to include the control variable Research and Development expenditures of the company, as the current literature suggest that the R&D intensity could have a positive effect on the long term financial performance of the company, but in the short term it could result in a negative effect (Fujii et al, 2013); (Iwata & Okada, 2011). The R&D intensity will not be used in

this study, because the data of the R&D expenditures of the companies in Orbis was incorrect and incomplete, as there were big differences in the data of Orbis and the numbers in the financial statements of the company.

6. Empirical Results

Table 5 shows the results from the DEA model that is used to obtain a composite indicator that expresses the financial performance of a company. The table shows the results of the estimated technical efficiency scores, the unbiased efficiency scores, the bias itself, the standard deviation and the 95% confidence interval for the technical efficiency scores. The DEA scores are calculated based on a comparison with a frontier that represents the best practice observed in the eight years that are analysed. The unbiased efficiency scores showed that the financial performance of companies increased over time, which shows that the financial performance of the companies improved over the years. An increase from an unbiased efficiency score of 56,9% in 2009 to 58,1% in 2010 implies an increase of approximately 1,2% of the financial performance of the companies. The column with the bias correction is approximately 3% in the first three years and this implies that the technical efficiency is decreased with 3% too account for the sample variation appropriately. The bias in the last four years is a little bit higher, because the unbiased efficiency scores in those four years are relatively higher compared with the previous years. The 95% confidence intervals provide information about the statistical confidence for the bias corrected efficiency scores. The bias corrected efficiency scores fall within the relatively narrow confidence intervals. It is also possible to conclude that there are significant differences in financial performance between the years, based on the mean bias corrected efficiency scores and the values for the upper and lower bound. For example, the mean bias corrected score for 2016 is 0,62, which is higher than the upper bound of the 95% confidence interval of 2009. This implies that the financial performance in 2016 is significantly higher than the financial performance of 2009. Furthermore, it is possible to conclude that the means values for the bias corrected efficiency scores of the years 2012, 2013, 2014 and 2015 are all significantly higher than the bias corrected efficiency scores for the years 2009, 2010 and 2011. It was not possible to obtain bootstrapped results for circular performance indicators, because of the low variation in the data. Therefore, the original DEA estimates of the circular performance are used in the bootstrap-truncated regression model and provided in table 6.

Table 5: DEA results Financial Performance

	Number of	Efficiency	Unbiased Efficiency			95% Confidence Interval	
Year	Observations	Scores	Scores	Bias	SD	Lower Bound	Upper Bound
2009	199	0.5986236	0.569381011	0.029243	0.00022	0.552084417	0.591581873
2010	222	0.6122045	0.581051067	0.031153	0.000254	0.563549233	0.604725099
2011	251	0.6133402	0.582883556	0.030457	0.000262	0.565728787	0.606352567
2012	38	0.7046063	0.676516978	0.028089	0.000229	0.658242208	0.698347264
2013	7	0.6641036	0.628652609	0.035451	0.00033	0.60782808	0.656077637
2014	14	0.7208833	0.676675896	0.044207	0.000504	0.654521884	0.710811009
2015	9	0.7462546	0.698448432	0.047806	0.000572	0.671441586	0.736746005
2016	9	0.6713447	0.622639324	0.048705	0.00063	0.599981227	0.661081025

Table 6: DEA results Circular Performance

Year	Number of Observations	Efficiency Scores	SD	Min	Max
2009	199	1.00000	0.00000	1	1
2010	222	0.96063	0.12666	0.25	1
2011	250	0.78140	0.23797	0.25	1
2012	38	0.63289	0.21062	0.5	1
2013	7	0.72857	0.25635	0.5	1
2014	14	0.69571	0.22020	0.5	1
2015	9	0.75556	0.23511	0.5	1
2016	9	0.68889	0.23688	0.5	1

Table 7 shows the results from the bootstrap-truncated regression model. The estimates of the 95% confidence interval show that some of the parameters are significantly different from zero and some parameters are not significant differently from zero. The main parameters of interest are the circular performance inefficiency and the circular performance inefficiency squared. In order to determine the effect of circular performance on financial performance is it necessary to calculate the marginal effect of circular performance on financial performance. The marginal effect can be calculated by taking the first derivative of the function of the financial performance. When we fill in the estimates for the coefficients from the bootstrap-truncated regression into the function: FPI = $\beta 0 + \beta 1 CPI + \beta 2 CPI^2$, we get the following function;

$$\text{FPI} = -0{,}0788718 + 0{,}1411542 CPI - 0{,}2125002 CPI^2 \quad (6.1)$$

The marginal effect of the circular performance can be calculated by taking the first derivative of the function in 6.1:

$$\frac{\partial FPI}{\partial CPI} = 0{,}1411542 - 0{,}4250004 CPI \quad (6.2)$$

Where $\partial \text{FPI}/\partial \text{CPI}$, indicates the marginal change in the financial performance inefficiency by changing the circular performance inefficiency. Based on the first derivative of function 6.1 it is possible to calculate the marginal function for each CPI value. The outcome of CPI value in function 6.1 indicates the slope of the tangent at that point. Notice that;

$f'(CPI) > 0, is\ f(CPI)\ increasing$

$f'(CPI) < 0, is\ f(CPI)\ decreasing$

$f'(CPI) = 0, is\ f(CPI)\ stationair$

When multiple values between 0 and 1 are filled in the function of 6.2, the outcomes show that there is in the first place a seemingly positive relation, but reaches a specific inflection point after the relation changes asymptotic and in a negative relation. This specific inflection point can be calculated by using the equation of 6.2 and set the first derivative equal to zero and solve for "CPI" to find the inflection point. The solution for this equation is CPI = -0,1411542/-0,4250004 = 0,332127217. This value indicates that when the CPI of a company is 0,3321, the financial performance inefficiency is at its maximum.

Table 7 shows that both parameters that express the circular performance inefficiency are not significantly different form zero at the critical level of 5%. This implies that the circular performance

of the company does not have a significant relationship on the financial performance of the company. This finding is not consistent with the win-win theory, which hypothesizes that the shift towards an environmentally-friendly governmental regulation can stimulate companies to implement circular economy in their business model and generate a first-mover advantage (King & Lenox, 2001), (Wagner & Schaltegger, 2004), (Guenther & Hoppe, 2014). Furthermore, the win-win theory suggests that companies with a higher environmental performance are able use natural resources more efficiently and can generate both a competitive advantage for the firm and lower emissions for the environment on the same time (Porter & van der Linde, 1995). The results are also inconsistent with the theory of the Too-Much-Of-A-Good-Thing effect, because both values that are used to calculate the marginal function are not significantly different from zero. The theory of Too-much-Of-A-Good-Thing assumes that the seemingly positive relation reaches a specific inflection point after which the relation changes asymptotic and often in a negative relation (Pierce & Aguinis, 2013).

The findings in table 7, shows that the logarithm of firm size has a positive effect on financial performance inefficiency. The coefficient of 0.035 means that an increase of 1 percent in firm size results in an increase of financial performance inefficiency of 0.035. This implies that firm size has a negative relation on the financial performance of a company. This is an interesting result, because the findings suggest the absence of economies of scale (King & Lenox, 2001), (Wang, Li, & Gao, 2014). The economies of scale hypothesize that larger firms have a better financial performance, because they have the advantage of more bargaining power against the other supply chain partners, brand name recognition, learning effects, and they could be more competitive, because of their monopoly position and the ability to keep the prices above the competitive level (Fiegenbaum & Karnani, 1991). On the other hand, the results are in line with the hypothesis that suggests that firm size has a negative effect on the financial performance, because small firms have the advantage of being more flexible in adjusting their key competencies to external developments against relative low costs (Horta, Camanho, & Moreira da Costa, 2012), lower cost of coordination and a faster decision-making process (Fiegenbaum & Karnani, 1991). Another interesting finding of the results in table 7 is that the age is not significantly related with the financial performance, although empirical evidence indicated that the variable age could have a positive or a negative relation with the firm's financial performance (Ilaboya & Ohiokha, 2016). The results do not support the stream of literature which hypothesis that there is a positive relationship between age and financial performance, because firms learn from their experience and build up relationships with other firms and this enables the firm to improve the efficiency of their processes over time (Bahk & Gort, 1993). Although the results are not neither in line with another stream in the literature, which suggest that older firms suffer from the liability of obsolescence and the company's performance decreases over time, as older companies are prone to inertia and not able to adjust to the changing external environment of the organization (Ilaboya & Ohiokha, 2016). The coefficient for the period dummy shows a negative significant sign, which represents a -0.027 difference in change in financial performance inefficiency score for a company in year 2013 to 2016 compared to a company in year 2009 to 2012 which functions as the baseline. This suggests that companies in the years 2013 to 2016 had a higher financial performance then the companies in the years 2009 to 2012, although the value of the parameter is not significantly different from zero at the critical level of 5%. The reason why the parameter for the period dummy is not significant can be explained by table 5, which shows the DEA estimates for the financial performance of each year. The table shows that there are significant differences in the financial performance among the years, but 2012 has a relative high financial performance

and is grouped with the years 2009, 2010 and 2011, which have a relative lower financial performance. The results of the bootstrap-truncated regression with a confidence interval of 90%, shows that the period dummy is significantly different from zero at the critical level of 10%. The results of the bootstrap truncated regression model with a confidence interval of 99% and 90% can be found in the Annex. The dummy variables for the regions shows that the Southern-model have a significant positive relation with the financial performance inefficiency and the Eastern-model has a significant negative relation on the financial performance inefficiency compared with the Anglo-Saxon model, which functions as the baseline. A possible explanation for the differences in the financial performance of companies within a specific capitalism model, can be the result of the differences in the social-economic factors which influence the competitiveness of a region (Farkas, 2011). Finally, table 7 shows the results in the difference in change in financial performance inefficiency scores for a company that is active in the sector energy (which functions as the baseline) compared with companies in other sectors. The findings show the 95% confidence intervals for all the sector parameters and most are significantly different from zero at the critical 5% level. For most of the sectors applies that there is a negative effect on the financial performance compared with the energy sector.

Table 7: Results of the bootstrap-truncated regression.

			95% Confidence Interval	
		Coefficient	Lower Bound	Upper Bound
$\beta 0$	Intercept	-0.0788718	-0.1547755	-0.0078085
$\beta 1$	Financial Performance Inefficiency	0.1411542	-0.0452864	0.3204778
$\beta 2$	(Financial Performance Inefficiency)^2	-0.2125002	-0.5750991	0.1461435
$\beta 3$	LN (total assets)	0.0359025	0.0296753	0.0422762
$\beta 4$	Age	-0.0000656	-0.0002004	0.0000696
Region				
$\beta 5$	Dummy (YEAR)	-0.026963	-0.0570041	0.0010471
$\beta 6$	Dummy(Nordic Model)	-0.0003253	-0.0303109	0.0283521
$\beta 7$	Dummy(Centre-Model)	0.0161902	-0.0072693	0.0395802
$\beta 8$	Dummy(Southern Model)	0.1167124	0.0909609	0.1435718
$\beta 9$	Dummy(Eastern Model)	-0.0902272	-0.1590821	-0.0244553
Sectors				
$\beta 10$	Dummy(Materials)	0.1171202	0.0774139	0.1567515
$\beta 11$	Dummy(Industrials)	0.1528817	0.1142064	0.1905611
$\beta 12$	Dummy(Consumer Staples)	0.0348021	-0.0256914	0.0955789
$\beta 13$	Dummy(Health Care)	0.0822584	0.0399423	0.1267787
$\beta 14$	Dummy(Information Technology)	0.1100828	0.0664684	0.1550395
$\beta 15$	Dummy(Telecommunication Services)	0.1452317	0.1032863	0.186945
$\beta 16$	Dummy(Utilities)	0.2374552	0.1981849	0.27773

Table 8, provides the results of the second bootstrap-truncated regression of the circular performance on the financial performance plus the control variables. The marginal effect of the financial performance inefficiency on the circular performance inefficiency can be calculated on the same way as in function 6.2. The marginal effect can be calculated by taking first derivative of the function;

$$\text{CPI} = 0{,}4388062 + 0{,}0317109FPI - 0{,}1068296FPI^2 \qquad (6.3)$$

The marginal effect of the financial performance on the circular performance is;

$$\frac{\partial CPI}{\partial FPI} = 0{,}0317109 - 0{,}2136592FPI \qquad (6.4)$$

Where $\partial \mathrm{CPI}/\partial \mathrm{FPI}$, indicates the marginal change in the circular performance inefficiency by changing the financial performance inefficiency. Based on the first derivative of function 6.3 it is possible to calculate the marginal function for each FPI value. The outcome of FPI value in function 6.3 indicates the slope of the tangent at that point. When multiple values between 0 and 1 are filled in the function of 6.4, the outcomes show that there is in the first place a seemingly positive relation, then the line reaches an inflection point where the relation changes into a negative relation. This specific inflection point can be calculated by using the equation of 6.4 and set the first derivative equal to zero and solve for "FPI" to find the inflection point. The solution for this equation is FPI = -0,0317109/-0,2136592 = 0,148418135. This value indicates that when the FPI of a company is 0,148 the circular performance inefficiency is at its maximum.

The confidence intervals for both financial performance inefficiencies show that there is no significant relationship between financial performance and the circular performance. The logarithm of the total assets has a negative relation on the circular performance inefficiency, which means that larger firms have a higher circular performance. A possible explanation for this is that larger firms receive a higher level of attention from the public and face a greater pressure to operate in social responsible way (Stanwick & Stanwick, 1998). However, the value for the coefficient is not significantly different from zero, so it is not possible to conclude that larger firms are more circular. Another interesting finding is the outcome of the period dummy, because the table shows that the variable is not significantly different from zero, which basically means that there is no significant difference in the circular performance of companies in the period 2009 to 2012 compared with the companies in the period 2013 to 2016. This is an interesting result, because there is an increasing pressure from the European Union towards companies to operate in a sustainable way and shift from a linear system towards circular system, and on the same time there is increase in customer awareness resulting in a higher demand for sustainable products over time (Blokpoel, 2016); (Commission, 2014). The findings also reveal that the Centre-, Eastern & Southern model has a negative relation on the circular performance compared with the Anglo-Saxon model, although the coefficients are not significant different from zero at the critical level of 5%. The Nordic model is significantly different from the Anglo-saxon model at the critical level of 5%. A possible explanation could be found in the literature, were (Sánchez-Ballesta & García-Meca, 2007) shows that the corporate governance mechanisms in a country influence the corporate behaviour of firms and (Aguilera & Cuervo-Cazurra, 2004) noted that differences in sustainable practices can be associated with the differences in corporate governance system. Another interesting finding from table 8 is that the circular performance differ across sectors, as most coefficients for the dummy variables are significantly different from zero based on an interval of 95%. The table shows a positive significant coefficient for the sectors Health Care, Telecommunication Services and Utilities. This means that those sectors have a significantly (at 5%) higher circular performance inefficiency compared with the energy sector. Meanwhile the Consumer Staples sector has a significant negative relation on the circular performance inefficiency compared with the energy sector. The differences in circular performance across sectors could be the result of the different barriers that a sector face for the implementation of the concept circular economy (Technopolis, 2016) and it is likely that the applicability for the implementation of circular economy differs depending on the product characteristics, technologies and markets that are relevant for the sector (Linder & Williander, 2015).

Table 8: Results of the bootstrap-truncated regression.

			95% Confidence Interval	
		Coefficient	Lower Bound	Upper Bound
$\beta 0$	Intercept	0.438806	0.294646	0.577302
$\beta 1$	Financial Performance Inefficiency	0.031711	-0.315993	0.381044
$\beta 2$	(Financial Performance Inefficiency)^2	-0.106830	-0.522570	0.304179
$\beta 3$	LN (total assets)	-0.007071	-0.018010	0.003553
$\beta 4$	Age	0.000008	-0.000217	0.000224
$\beta 5$	Dummy (YEAR)	0.002947	-0.040135	0.045485
Region				
$\beta 6$	Dummy(Nordic Model)	-0.053226	-0.105265	-0.004801
$\beta 7$	Dummy(Centre-Model	0.011071	-0.026253	0.049609
$\beta 8$	Dummy(Southern Model)	0.000284	-0.041988	0.045385
$\beta 9$	Dummy(Eastern Model	0.058813	-0.048238	0.159027
Sectors				
$\beta 10$	Dummy(Materials)	0.056195	-0.008765	0.128105
$\beta 11$	Dummy(Industrials)	0.058166	-0.007701	0.128727
$\beta 12$	Dummy(Consumer Staples)	-0.116354	-0.233346	-0.005593
$\beta 13$	Dummy(Health Care)	0.117302	0.042010	0.192350
$\beta 14$	Dummy(Information Technology)	0.041636	-0.038844	0.120184
$\beta 15$	Dummy(Telecommunication Services)	0.193020	0.117476	0.267836
$\beta 16$	Dummy(Utilities)	0.106912	0.033097	0.183876

7. Discussion, Conclusion & Recommendations

This study examined the relationship between the circular performance and the financial performance of European companies. The study can be separated into four parts. The first part of the study contains the literature study about the working of the circular economy and to gain insights in the pros and cons of companies with a circular business model compared with a linear business model. The second part includes the conceptual framework, which describes the particular variables that are used in the study and how they are connected with each other and is based on the theoretical background. The third part contains the operationalization part of the study, where the DEA-model and the bootstrap-truncated regression model are elaborated and the KPI's are selected to measure the financial performance and the circular performance of a company. Finally, part four contains the results of the DEA models and the bootstrap truncated regression model.

7.1 Discussion

The data that is used in the study can contain a potential measurement bias, because the sample selection is based on data availability for both the circular performance data as the financial performance data. The main problem of data availability that occurs for the financial performance indicator, is due to the Tobin's Q which is a market based indicator and used to measure the financial performance of a company (Hillier, Ross, Jaffe, & Jordan, 2013). The result of using this indicator is that all the companies in the dataset Sustainalytics that weren't stock listed, are excluded from the study. Although this implies that only a few companies had to be deleted, because the majority of the companies in Sustainalytics are stock listed. The majority of the deleted companies consisted of publicly owned companies. This implies that the results of the study are not generalizable for other European companies that are not stock listed or public owned companies. Another measurement bias that occurs due to data availability, is in the scope of the observations in the database Sustainalytics. Paragraph 4.3 already mentioned that selecting the circular performance indicators was a trade-off between sample size, the scope of the observations and the quality of the indicator and how it expresses the circular performance. The result is that the sample contains mainly observations in the years 2009, 2010, and 2011. Therefore, the study is not mainly based on recent data, which could bias the results, because there is a growing awareness among companies to make shift towards a circular in the past recent years and one of the main goals of the European Union (Commission, 2014); (UNEP, 2016).

After making the financial performance and the circular performance measurable, it was necessary to determine a benchmarking technique to compare the firm's performance relative to the other firms in the sample. DEA is used as a benchmarking technique for both the circular performance and the financial performance and the initial idea was to use the bootstrap algorithm of (Simar & Wilson, 1998) to analyze the sensitivity of the obtained efficiency scores, construct a 95% confidence interval for the efficiency scores and obtain the unbiased performance estimates. The bootstrap procedure was applied to determine the unbiased financial performance estimates, but this approach was not possible for the circular performance estimates. The reason for this is that Sustainalytics assigns scores between 0 and 100 with relatively little variation on each circular performance indicator based on a format. This format describes the indicator description, the answer category description and the score that can be assigned to the category in which the company scores. The disadvantage of using DEA as a benchmarking technique is that most of the firms in the dataset have the maximum score on one of the circular performance indicators, resulting in a high number of companies that are identified as fully efficient by DEA. The result of this is that there is less variation in the data which makes conducting the bootstrap algorithm of (Simar & Wilson, 1998) not possible. Therefore it was necessary to use effiency scores that could be sensitive for the sampling

variations of the estimated frontier, which could bias the results of the bootstrap-truncated regession model (Simar & Wilson, 1998).

The results of the first bootstrap-truncated regession shows that there is not a significant relationship between circular performance and financial performance. This result is not in line with the majority of the empirical evidence that is found in studies that measure the relationship between environmental performance and financial performance. The majority found a positive link between environmental performance with financial performance (Albertini, 2013); (Horváthová, 2010), although the results of the current research landscape are in general contradictory, because there is still a huge body of existing literature that mention a negative or none relationship (Albertini, 2013); (Horváthová, 2010). Those differences in outcome can partly be explained by the differences in measuring financial performance and environmental performance of companies. Furthermore, empirical evidence showed that it is more likely to find a positive relationship between financial performance and environmental performance when accounting based indicators are used instead of market based indicators for measuring the financial performance (Albertini, 2013). The same applies when environmental ratings are used instead of measuring the environmental performance by using quantitative indicators (amount of waste generated) (Horváthová, 2010). This study measures circular performance based on qualitative indicators from Sustainalytics, which is not in line with other common practices to measure the circular performance (Park & Chertow, 2014); (Ellen MacArthur Foundation, 2015); (Di Maio & Rem, 2015); (Franklin-Johnson, Figge, & Canning, 2016). Other possible explanation between the outcomes in the empirical evidence could be a result of the differences in sector, time and geographical location that is examined (Molina-Azorín et al, 2009). When we compare the results with other empirical evidence in the field of circular economy, then the results are in line with a study conducted by (Blokpoel, 2016), who concluded that there was not a significant difference in business performance between Dutch SME's with a circular business model and SME's with a linear business model.

7.2 Conclusion

The purpose of this research is to examine the relationship between the circular performance and the financial performance of European companies. The circular performance analysis includes the identification of suitable key performance indicators that express the circular performance and the same applies for the financial performance analysis. In order to access the companies circular and financial performance, the study used DEA supplemented with bootstrapping to obtain the unbiased performance estimate. The bootstrapping approach was not possible for the circular performance indicators, because there was not enough variation in the data of the sample. The first bootstrap-truncated regression model regresses the financial performance estimates with the circular performance estimates and the control variables to examine the relationship. The contradictory results in the current literature and the pros and cons of circular economy suggested that the relationship between circular performance and financial performance was more complex than only a positive or a negative relationship. Therefore, the first hypothesis was based on the research line of the too-much-of-a-good-thing effect, which implies that seemingly positive relation reaches a specific inflection point after which the relation changes asymptotic and often in a negative relation (Pierce & Aguinis, 2013). The first hypothesis assumed that there is an inverted U-shaped relationship between circular performance and financial performance and was formulated as follows;

H_0: *There is not a relationship between the circular performance and the financial performance*

H_a: *There is a non-linear relationship between the circular performance and the financial performance*

The results of the first bootstrap-truncated regression model showed that the circular performance coefficients of the regression model weren't significantly different from zero at the critical level of 5%. Therefore, it is not possible to reject the null-hypothesis and is the conclusion that there is no significant relationship between circular performance and the financial performance.

The second hypothesis was based on the increasing pressure from the European Union towards companies to operate in a sustainable way, and the increasing customer awareness resulting in a higher demand of sustainable products over time (Blokpoel, 2016) (Commission, 2014). This research assumes that those developments in the external environment of the European private sector force companies to make the shift towards a circular economy over time. Therefore, the second hypothesis assumes that the circular performance of companies changed over time;

H_0: *The circular performance of companies did not increase over time.*

H_a: *The circular performance of companies increased over time.*

The second bootstrap-truncated regression model regressed the circular performance with the explanatory variables including the period dummy. The outcomes of the regression model indicated that the parameter for the period dummy is not significantly different from zero at the critical level of 5%. Based on those results it is possible to conclude that the circular performance of European companies did not change over time.

The third hypothesis is based on the differences in outcomes, between studies that measure the relationship between environmental performance and financial performance. A possible explanation for the contradictory results in the empirical evidence could be the result of differences in environmental performance across sectors. Therefore, this study assumes that there are differences in circular performance across sectors, especially since the applicability for the implementation of circular economy differs depending on the product characteristics, technologies and markets that are relevant for the sector (Linder & Williander, 2015). The third hypothesis that is examined in this study is as follows;

H_0: *There is no difference in the circular performance across sectors.*

H_a: *There is a difference in circular performance across sectors.*

The outcome of the second bootstrap-truncated regression model indicated that there is a significant difference in the circular performance for some of the sectors that are studied. The bootstrap-truncated regression model contains seven dummy variables to measure the differences in circular performance across sectors, with the energy sector as baseline. The outcome of the model indicated that there were four sectors that had a significant difference in circular performance compared with the energy sector. Those results make it possible to reject the null hypothesis and accept the alternative hypothesis, which implies that there are differences in circular performance across sectors.

7.3 Recommendations for further research

For further research, it would be interesting to examine the relationship between financial performance and circular performance, by using quantitative indicators for measuring the circular performance like the Reuse Potential Indicator developed by (Park & Chertow, 2014), Material Circularity Indicator defined by the Ellen MacArthur Foundation or the Circular Economy Index

longevity indicator proposed by (Franklin-Johnson, Figge, & Canning, 2016). The quantitative indicators have the advantage of measuring the circular performance in an objective way compared to environmental ratings. This study did not used quantitative indicators because of time limitations, and collecting the data for the quantitative indicators could be a time-consuming process. Calculating those quantitative indicators requires detailed information in the material flows of a company, the utilization of the materials or the product lifetime. The information that is necessary differs depending on the type of quantitative indicator that is used to measure the circular performance, but it can be noticed that this type of information requires a cooperative attitude of companies in providing the information, which is not always for granted. Therefore, it can be interesting to work together with NGO's that stimulate the transition towards the circular economy and use their networks to come in contact with companies that are willing to contribute to the study. Once a suitable sample size is collected, DEA can be used as a benchmark technique to access the circular and financial performance of firms relative to each other and it would be interesting to use a panel data truncated regression to examine if the influence of circular performance on financial performance increased over time.

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9. Annex

9.1 Results bootstrap-truncated regression model (Financial Performance dependent variable):

Stats	*Intercept*	*Circular Performance Inefficiency*	*Circular Performance Inefficiency^2*	*LN (Total assets)*	*Age*	*Year 2013, 2014, 2015, 2016. (Dummy)*	*Nordic model (Dummy)*	*Centre-model (Dummy)*	*Southern model (Dummy)*	*Eastern model (Dummy)*	*Materials (Dummy)*	*Industrials (Dummy)*	*Consumer Staples (Dummy)*	*Health Care (Dummy)*	*Information Technology (Dummy)*	*Telecommunication Services (Dummy)*	*Utilities (Dummy)*	*sigma*
mean	-0.07887	0.14115	-0.21250	0.03590	-0.00007	-0.02696	-0.00033	0.01619	0.11671	-0.09023	0.11712	0.15288	0.03480	0.08226	0.11008	0.14523	0.23746	0.12488
p1	-0.18598	-0.10122	-0.74496	0.02802	-0.00025	-0.06489	-0.04115	-0.01706	0.08126	-0.19136	0.06291	0.09703	-0.05568	0.01896	0.04051	0.08628	0.18272	0.11699
p99	0.01283	0.40829	0.24970	0.04500	0.00015	0.01255	0.03719	0.04733	0.15588	0.00464	0.17181	0.20876	0.11767	0.14405	0.17546	0.20847	0.29332	0.13255
mean	-0.07887	0.14115	-0.21250	0.03590	-0.00007	-0.02696	-0.00033	0.01619	0.11671	-0.09023	0.11712	0.15288	0.03480	0.08226	0.11008	0.14523	0.23746	0.12488
p5	-0.15478	-0.04529	-0.57510	0.02968	-0.00020	-0.05700	-0.03031	-0.00727	0.09096	-0.15908	0.07741	0.11421	-0.02569	0.03994	0.06647	0.10329	0.19818	0.11917
p95	-0.00781	0.32048	0.14614	0.04228	0.00007	0.00105	0.02835	0.03958	0.14357	-0.02446	0.15675	0.19056	0.09558	0.12678	0.15504	0.18695	0.27773	0.13060
mean	-0.07887	0.14115	-0.21250	0.03590	-0.00007	-0.02696	-0.00033	0.01619	0.11671	-0.09023	0.11712	0.15288	0.03480	0.08226	0.11008	0.14523	0.23746	0.12488
p10	-0.13975	-0.00671	-0.49093	0.03088	-0.00017	-0.05018	-0.02338	-0.00212	0.09657	-0.14351	0.08745	0.12223	-0.00982	0.04969	0.07380	0.11090	0.20644	0.12041
p90	-0.02133	0.28066	0.07186	0.04106	0.00004	-0.00502	0.02242	0.03492	0.13649	-0.03883	0.14685	0.18278	0.08072	0.11775	0.14609	0.17787	0.26831	0.12943

9.2 Results bootstrap-truncated regression model (Circular Performance dependent variable):

Stats	*Intercept*	*Financial Performance Inefficiency*	*Financial Performance Inefficiency^2*	*LN (Total assets)*	*Age*	*Year 2013, 2014, 2015, 2016. (Dummy)*	*Nordic model (Dummy)*	*Centre-model (Dummy)*	*Southern model (Dummy)*	*Eastern model (Dummy)*	*Materials (Dummy)*	*Industrials (Dummy)*	*Consumer Staples (Dummy)*	*Health Care (Dummy)*	*Information Technology (Dummy)*	*Telecommunication Services (Dummy)*	*Utilities (Dummy)*	*sigma*
mean	0.4388	0.0317	-0.1068	-0.0071	0.0000	0.0029	-0.0532	0.0111	0.0003	0.0588	0.0562	0.0582	-0.1164	0.1173	0.0416	0.1930	0.1069	0.2015
p1	0.2439	-0.4675	-0.6965	-0.0217	-0.0003	-0.0608	-0.1231	-0.0405	-0.0579	-0.0915	-0.0398	-0.0365	-0.2842	0.0136	-0.0677	0.0799	0.0029	0.1884
p99	0.6284	0.5062	0.4922	0.0076	0.0004	0.0598	0.0135	0.0654	0.0700	0.1911	0.1629	0.1638	0.0399	0.2205	0.1649	0.2984	0.2112	0.2169
mean	0.4388	0.0317	-0.1068	-0.0071	0.0000	0.0029	-0.0532	0.0111	0.0003	0.0588	0.0562	0.0582	-0.1164	0.1173	0.0416	0.1930	0.1069	0.2015
p5	0.2946	-0.3160	-0.5226	-0.0180	-0.0002	-0.0401	-0.1053	-0.0263	-0.0420	-0.0482	-0.0088	-0.0077	-0.2333	0.0420	-0.0388	0.1175	0.0331	0.1913
p95	0.5773	0.3810	0.3042	0.0036	0.0002	0.0455	-0.0048	0.0496	0.0454	0.1590	0.1281	0.1287	-0.0056	0.1923	0.1202	0.2678	0.1839	0.2118
mean	0.4388	0.0317	-0.1068	-0.0071	0.0000	0.0029	-0.0532	0.0111	0.0003	0.0588	0.0562	0.0582	-0.1164	0.1173	0.0416	0.1930	0.1069	0.2015
p10	0.3323	-0.2394	-0.4456	-0.0156	-0.0002	-0.0315	-0.0911	-0.0189	-0.0351	-0.0206	0.0040	0.0038	-0.2091	0.0582	-0.0165	0.1354	0.0473	0.1935
p90	0.5412	0.3084	0.2054	0.0012	0.0002	0.0376	-0.0157	0.0406	0.0322	0.1379	0.1122	0.1139	-0.0331	0.1787	0.1012	0.2546	0.1666	0.2092