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Factors affecting circular business practices

Examining the sectors of electric and electronic equipment and fast-moving consumer goods in the European Union and China.

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Project Report

1. Introduction

The topic of the circular economy has developed quickly in recent years. In the European Union, a multitude of companies have started changing their business practices towards becoming more circular. In 2015, the EU developed a framework to further promote the circular economy (CE), which is the European Commission's 'Action Plan for a Circular Economy' (European Commission, 2015). China has developed in this area, as well, and in some parts of their economy moved towards a more circular economy. For example, recently China has highly restricted the imports of European plastic waste in order to enable better management of their own waste (Brooks, Wang, Jambeck, 2018).

These policy directions are only two examples chosen from the wide range of action plans, private cooperation and regulations that have developed over the last years. Further development in this area is very likely with circular economy practices being appealing to governments, companies and customers alike. When looking deeper into the structures of the circular economy in both the EU and in China, it can be found that governments play a key role. When comparing the two different approaches taken by China and the EU, the following main research question and sub-questions have been formed:

What factors and policies are promoting private sector circular economy practices in the sectors of consumer electric and electronic equipment (EEE) and Fast Moving Consumer Goods (FMCGs) in Europe and China?

A. What policies are in place to promote the circular economy (CE) in Europe and China?

B. Based on the literature, what factors (country and market specific) contribute most to the promotion of private circular initiatives?

C. What are the effects of factors and policies on the circularity of companies in China and Europe?

D. What policies should be implemented to encourage private circular initiatives in the sectors of EEE and FMCG's in Europe and China?

This report aims to give advice to policy makers on how to best deal with this topic and effectively further develop their approaches. To limit the scope of the research, the EU and China and the industries of electrical and electronic equipment (EEE) and fast moving consumer goods (FMCG) in both countries have been focused on.

To begin with, a definition will be given of key concepts used in the report. Subsequently, the current context of the electrical and electronic equipment and fast moving consumer goods sectors will be described. Then, an overview of barriers to circularity for China and Europe will be presented. Consequently, the policies in place for both sectors and both regions will be mentioned. Once these are outlined, the differences between them will be discussed. Afterwards, in the methodology section the process of making the questionnaire, data collection, and the QCA tool used for the data analysis are explained. Subsequently, the results are shown and then discussed in detail. Based on these results policy recommendations are given. Finally, a conclusion restates the most important findings.

2. Literature Review

The following section covers key concepts of the research topic, barriers to circularity in the context of China and the EU, and an overview of the current policies that China and the EU have implemented to promote circularity.

2.1 Defining Key Concepts

According to the United Nations, the total amount of raw materials that have been extracted from the earth has tripled in the last forty years due to increased consumption by the rapidly growing middle class worldwide (UNEP IRP, 2017). This dramatic increase in extraction of global materials is visualized in Figure 1 (Krausmann et al., 2009). This shows the dramatic measures that need to be taken in order to curb the use of raw materials. The circular economy seems to be a solution which allows for sustained economic growth without compromising the future of the planet.

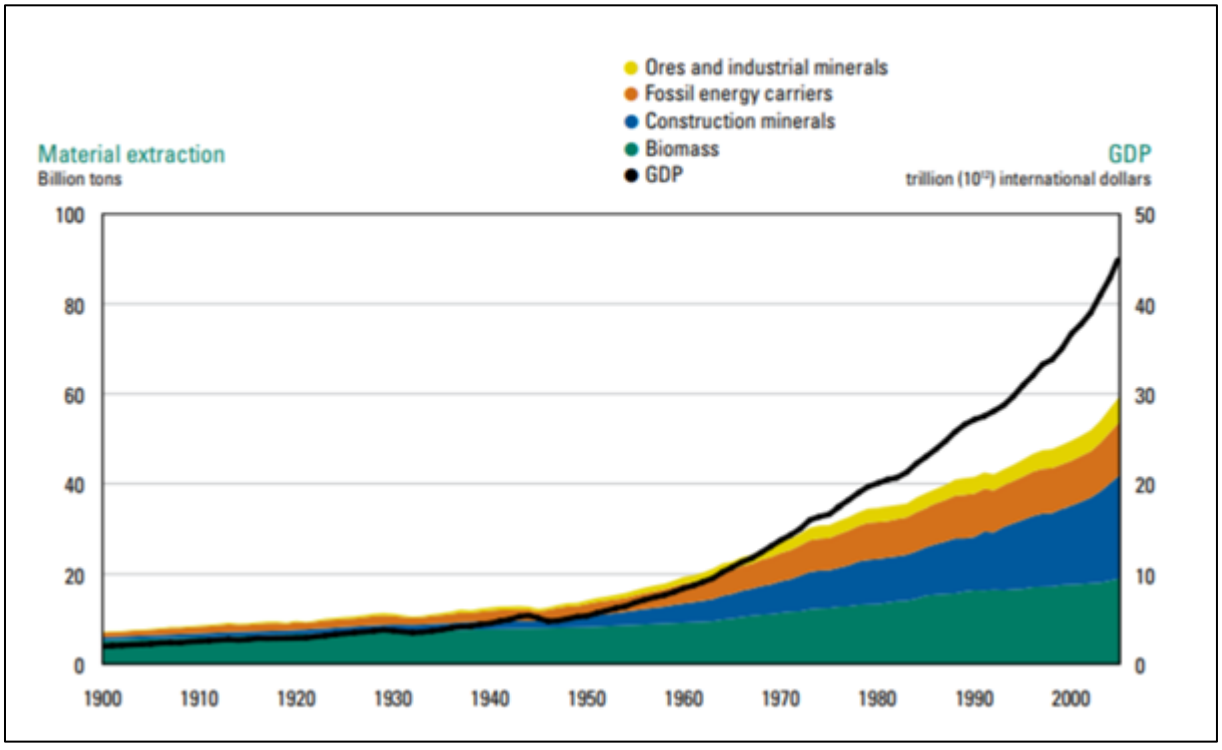

Figure 1: Global material extraction in billion tons from 1900 until 2005 (Krausmann et al., 2009)

2.1.1 The Circular Economy

In 2015, the United Nations (UN) released the Sustainable Development Goals (SDG's) in an effort to combat global problems. These goals included the promotion of sustainable

industrialization, innovation, resource efficiency, sustainable infrastructure and sustainable consumption (United Nations, 2018). In order to meet these goals, the current, mostly linear, economic model has to shift to a more circular one, i.e. to shift towards a regenerative system in which as few new raw materials as possible are used. There is no broadly accepted, definition of the circular economy (CE) as Mayer et al. (2018) stated. However, for the sake of this report we will define CE as a concept revolving around the following three principles: phase out waste and pollution through design, keep products and materials in use, and regenerate natural systems (Ellen MacArthur Foundation, 2018). For the purpose of conciseness, we decided to focus on the industries of electrical and electronic equipment (EEE) and fast moving consumer goods (FMCG).

2.1.2 Electrical and Electronic Equipment

When trying to reduce the linearity of the economy, electronic waste is a key issue to address (Achillas et al. 2010). This is due to the high value, high volume, scarce, critical, and sometimes hazardous contents of waste electrical and electronic equipment (WEEE). WEEE is a complex waste stream that consists of a multitude of materials ranging from plastics to precious metals, providing challenges on how to manage, recycle, and dispose them (Baldé et al., 2015). Technological developments and a decrease in price are driving an increase in purchases of EEE in Europe (EEA, 2014). Consumers also tend to discard EEE before the end of their useful life since they have become ‘status’ items (Mansfield, 2003). As a result, discarded EEE are among the fastest growing waste streams in the world (EEA, 2014). It is especially interesting to look at the WEEE stream between China and Europe given the huge flow of raw materials and electronics going from China towards Europe. In fact, about 90% of the raw materials deemed critical for Europe are imported, primarily from China (European Commision, 2010).

Circular practices would also reduce the dependency of a country on foreign raw materials. For example, McMahon et al. (2018) specifically looked at repurposing end of life notebook computers to thin client computers. Indeed, notebooks contain many valuable raw materials such as cobalt, neodymium, indium and europium. These materials are used to make lithium-ion batteries, hard disk drives, and liquid crystal displays. Such resources primarily come from a handful of countries around the world, including China (see Figure 2). This clearly shows how dependent Europe is on other countries for its critical raw materials. The relevance of CE therefore goes beyond WEEE reduction, which further highlights the importance of circular practices in this sector.

Kissling et al. (2013) have studied what barriers prevent reusing a large percentage of WEEE and which success factors increase reuse. These barriers and success factors for reuse are ranked by importance in Table 1. Among other factors, they conclude that early sorting of WEEE and value-saving logistics play an important role in attaining a high reuse ratio. Especially since previous research has found that many of the negative environmental effects associated with WEEE arise from suboptimal gathering and treatment (Magalini et al., 2014).

Table 2
Generic barriers and success factors for reuse ranked according to importance (Kissling et al., 2013: 24).

Rank	Barriers	Success factors
1	Lack of legislation that sets financial incentives for reuse and enfoeces reuse	Quality and reliability of products distributed for reuse
2	Access to a sufficient volume of used equipment of good quality and at low cost	Control of product and process quality during preparation for reuse
3	Bad reuse practice ("shame reuse") leads to the reluctance towards reuse	Access to high-quality used equipment (local or imported)
4	Competition from informal sector and from unlicensed recyclers	Secure user data sanitation and/or OEM brand protection
5	Public- and industry-organised collection and recycling schemes do not consider reuse in their design	Ability to offer attractive sustainable and socially responsible services and/or products to suppliers and/or recipients Stakeholder relationship management
6	Some OEMs do not approve of the sale of used products because they fear that these products compete with OEM-branded new products Unpredictability in supply and demand	Transparency and track-and-trace capability from collection to preparation for reuse to re-distribution (and to recycling and disposal if relevant) of used products
7	Societal discussion on the soundness of reuse Complex legal and regulatory situation	Securing of a proper recycling solution for the equipment, which is distributed for reuse
8	Competition with recyclers for supply of used equipment	"One-stop-solution" (ability to offer the suppliers a single contact for collection, preparation for reuse and recycling of used products)
9	No consideration of reuse in product designs	Turnover rate (short storage duration given a fast deterioration of asset value)
10	Variety of different standards and lack of global reuse standard with clear definitions	Throughput volumes
11	Market for products: prices of new EEE decrease, approaching the level of refurbishing costs. Demand for used EEE decreases	Value conserving logistics
12	Logistics costs	Low pricing of products distributed for reuse
13	Labour costs	

Table 1: Barriers and success factor for reuse ranked by importance (Kissling et al., 2013)

Similarly, McMahon et al. (2017) studied success factors regarding preparation for reuse (PfR) in several European countries. These success factors include a good relationship between PfR organisations and compliance schemes (from the producers) as well as heavy involvement of social enterprises in reuse activities. However, interviews with several actors in the WEEE management system in Denmark highlighted issues with the current PfR system (Zacho, Bundgaard, Mosgaard, 2018). A main issue is that reuse is not considered during collection. Indeed, WEEE is often (partly) destroyed during transport and storage. Additionally, PrF actors often lack access to WEEE in the first place, with these products immediately going to a waste recycling centre. Likewise, interviews with similar companies in the UK lead to conclusion that the governmental system in place is focused on waste management, not on reuse (Cole, Gnanapragasam, & Cooper, 2017). Most companies are of the opinion that the government should leave logistics of WEEE to private companies (to minimize damage during transport), while playing a more active role in making the public aware of different reuse routes. It is also stated that consumer acceptance plays a key role in the amount of WEEE that is reused. For example, the Netherlands tends to normalise using second hand products, while this is more often associated with lower socioeconomic status in the UK (Cole et al., 2017). Here again, lies

a role for the government to promote the social acceptability of reuse. The obstacles to reuse discussed above partially suggest that adequate policies could increase circular practices in the EEE sector.

Figure 2: Production concentration of critical mineral materials (European Commision, 2010)

2.1.3 Fast Moving Consumer Goods

Similar to WEEE, fast moving consumer goods (FMCG) provide a challenge in increasing the circularity of the economy. These goods cover a range of products (typically found in the local supermarket) from food and beverages to personal care and household items. This industry is often characterized by huge sales volume combined with relatively low prices (Ellen MacArthur Foundation, 2013). This can make it difficult to shift towards circular principles, especially given the short average lifespan of a FMCG. However, it is crucial that FMCG are included in shifting towards a circular economy since they make up 75% of municipal solid waste generation (Ellen MacArthur Foundation, 2013). The Waste and Resource Action Program (WRAP) in the UK found that citizens disposed of 7 million tonnes of food and drink waste in 2012, or 20% of the total weight of food and drinks that were originally brought home (Waste and Resources Action Programme, 2012).

There are however a lot of opportunities for the FMCG sector in the circular economy. Resources lose value during processing, distribution, design and in the end of life stage. For example, between 8 and 12% of food outputs are currently lost in the processing stage

(Gustavsson, Cederberg, Sonesson, Otterdijk, & Meybeck, 2011). The end of life value is often negative since extra costs are needed to dispose of packaging materials. A more circular economic model could add significant value for all parties involved: producers have to use less raw materials and consumers benefit from the reduced waste and emission (The Ellen MacArthur Foundation, 2018). Companies and start-ups alike have started incorporating circular practices in their business models. However, there remain barriers to the widespread diffusion of CE. An overview of obstacles challenging the Chinese and European markets from implementing circular practices will be provided in the following section.

2.2 Overview of barriers to CE in China and Europe

2.2.1 China

Geng and Doberstein (2008) list several barriers and challenges to efforts towards the implementation of circular economy efforts in China. They classify those obstacles in three sections: policy, technology and public participation. Policy is related to shortcomings of current policy in China – such as low levels of resource taxes, low fees for harmful discharges, lack of enforcement of regulation, limited consumption taxes, and inadequate simulative policies for scavenger and decomposer companies. Regarding technology, the authors mention the lack of demand for environmentally advanced technologies, in addition to lacking the ability and resources to make use of such. Furthermore, they point out the lack of systemic information systems which are needed for companies to plan and manage their resources in an environmentally beneficial way. Lastly, Geng and Doberstein (2008) discuss the lack of close cooperation between different agencies, such as environmental protection and economic development, in circular economy efforts. Concerning public participation obstacles, the authors point out the lack of broad public involvement towards circularity in China and the lack of capacity to encourage such, due to limitations in environmental management programs and facilities in Chinese academic institutions.

Moreover, formal e-waste treatment companies have a hard time collecting WEEE as informal collectors enjoy their advantage of a flexible network and provide immediate cash payment as well as higher prices than the formal collectors (Kojima, Yoshida, & Sasaki, 2009). This points towards one of the barriers mentioned by Kissing et al. (2013), namely the barrier of competition from the formal sector and the unlicensed recyclers. The most pressing obstacles, however, are the major lack of public participation and enforcement. Most consumers do not have a full understanding of the electronic waste cycle and the e-waste treatment companies are for the most part only educated on the production and output activities, missing

crucial knowledge on the value of a circular economy. Furthermore, no public groups or NGOs are involved in the policymaking process which hinders the formulation of inclusive and efficient regulations.

2.2.2 Europe

In the EU, a joint-study between Deloitte and University Utrecht (Kirchherr, Hekkert, Bour, Huibrechtse-Truijens, Kostense-Smit and Muller,2017) identified four categories of obstacles to circularity: culture, regulation, market and technology. The research interviewed 153 companies and 55 government officials working in the EU in relation with CE and ranked obstacles from most to least pressing (as shown in Figure 3). Culture seems to play the most important role to transition to the CE as the linear economy is culturally ingrained in our industrial models. Consumer and corporate cultures alike hinder the move towards circular business models. This shift will need to happen within the society as well if we want to effectively attain our circular objectives. Although not identified as a pressing obstacle by Kirchherr et al. (2017), Clay (2017) suggests that technology is a crucial condition for the transition to a circular economy. His research shows a strong correlation between the use of innovative technologies such as mobile technology, trade and return systems, 3D-printing, and advanced recycling technology and the circularity of firms. Moreover, Clay (2017) found that start-ups and SMEs as well as public enterprises have a higher business level circularity despite lower financing options. The financial structure and size of companies therefore seem to have an impact on firm circularity. The market and regulatory obstacles seem to hint at the need for governmental intervention, which will be further discussed in this literature review. In recent years, national policies have been drafted and put in place to encourage circular practices. China and the EU alike have tackled some of the aforementioned barriers as will be discussed in the next section.

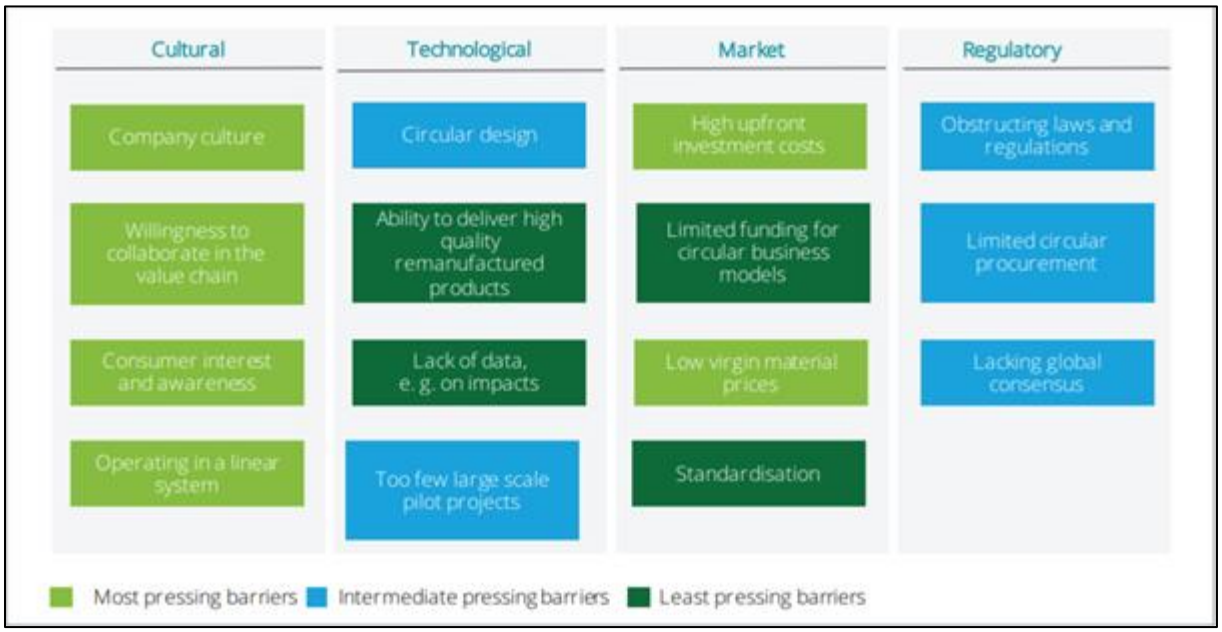

Figure 3: Heatmap of Circular Economy Barriers (Kirchherr et al., 2017)

2.3 Overview of CE policies in China and the EU

China and Europe have come together to work on improving resource efficiency and to gain greater mutual understanding of each other's CE practices (McDowall et al., 2017). They have done so by signing a Memorandum of Understanding on Circular Economy Cooperation on the 16th of July 2018 (European Commission; National Development and Reform Commission of the People's Republic of China, 2018). The main point of the agreement is to establish a high-level policy dialogue – referred to as "The Dialogue", on circular economy. It is stated that this should be led by high-level officials and contact points should be established. The document lists several forms of cooperation – bilateral and multilateral meetings with stakeholders, information exchange on research, capacity building, and activities related to training and improvement of personnel. The memorandum acknowledges the importance of CE for sustainable growth on a global level and that both China and the EU face common challenges in developing resource efficient policies. Furthermore, it is stated that the dialogue should contribute to the several agendas regarding cooperation and sustainable development in 2020 and 2030.

Both parties in the memorandum have come up with suggested fields of cooperation. There is mention of the collaboration in design, planning, and implementation of relevant

efforts in areas of mutual interest. Two other fields are strategic exchanges on management systems and policy tools, and such exchanges on best practices of CE in crucial topics such as chemicals, plastics, waste. Lastly, exchanges on financing and investments of CE are mentioned. However, it should be mentioned that the memorandum explicitly states that no financial or legal obligations are created through it. Regarding validity, cooperation according to this agreement is stated to last for five years, continuing if no party terminates it. (European Commission; National Development and Reform Commission of the People's Republic of China, 2018).

China and the EU have both made efforts to transition towards CE, and they can learn from each other by having a dialogue and focusing on best practices in the other region. The following section will discuss the main CE policies that the EU and China have respectively implemented, specifically targeting the EEE and the FMCG.

2.3.1 China

Geng and Doberstein (2008) discuss the need for China to adopt a new sustainable development method which can deal with issues of resource supply and waste and keep up with the country's rapid economic growth. The authors state that the concept of circular economy has been formally adopted by the Chinese government in 2002, which can be realized by three so-called "circles". Geng and Doberstein define those circles as being on micro-, meso-, and macro-level. Micro-level circular economy implementation deals with firm-level initiatives such as waste minimization, eco design, and environmental management systems. Meso-level or inter-firm level is concerned with the use of eco-industrial parks which serve the purpose of improved trading of industrial by-products and supporting green supply management. Finally, the authors discuss the third circle, which is on the macro- or social level. Activities there are targeted at the development of eco-cities and provinces, which aim to simultaneously target production and consumption issues. Examples of such efforts include preferential financial policies for 'scavenger' companies and the termination of environmentally unfriendly products production.

Geng and Doberstein mention current initiatives and future plans for CE development. They discuss the unbalanced regional development in the country, which calls for selective implementation of CE efforts in different regions and cities. The authors mention the first CE work plan drafted in 2005 which state that a number of companies have been chosen as pilot enterprises for such implementation, which has the objectives of establishing suitable development models; identifying key technologies and investment fields; examining potential connections among sectors related to the building of industrial cooperation clusters;

establishing indicators for corporate eco-efficiency; preparing policies to boost reduction, reuse, and recycling. Furthermore, a part of those pilots targets specific topics, which aim to put into place and improve resource recovery networks, determine adequate treatment methods, examine producers' responsibility extension and lastly, develop suitable policies.

Circular EEE Policies in China

Over the years China has undergone rapid economic development and urbanization and has benefitted from substantial technical innovation which has led to an increasing amount of electric and electronic waste to manage. China has started tackling this problem back in the early 2000s when it banned the import of e-waste (Lu et al., 2015). Thereupon many rules and regulations have been introduced directed toward the minimization of pollution and environmental impacts in this industry. Lu et al. (2015) collected and analysed multiple policies that have been introduced over the last 18 years tackling different parts of the life cycle of electronics. The most notable laws are the "Circular Economy Promotion Law", "Solid Waste Pollution Control Law", and "Clean Production Promotion Law" (Lu et al., 2015). These aim to improve design and production of electronics in order to achieve a higher efficiency rate in reuse and recycling. As a result, formal e-waste treatment plants have to receive a license from a local environmental protection agency to assure safe handling of hazardous and toxic materials. There is also a "Collection and Treatment Decree" in place, seen as the Chinese counterpart to the EU WEEE Directive, that requires all e-wastes to be taken back, recycled, and disposed of properly (Lu et al., 2015). However, the policy fails to mention any requirements about collection channels and measures.

Several government agencies are to some extent involved in e-waste management and have published administrative regulations to improve resource efficiency and reduce environmental pollution caused during the process of dismantling and disposal of e-waste. For instance, the "Pollution Control and Management of IT Products" regulation of 2006 is similar to the EU ROHS (Restriction of Hazardous Substances) directive in terms of types and quantity of substances restricted for production, sales and import of IT products (Lu et al., 2015). However, not all parts of the e-waste life cycle are covered, and China severely lacks proper guidelines on electronic waste collection. Regulations need to be urgently improved in order to facilitate the transition towards CE.

Circular FMCG Policies in China

The different nature of FMCG means that different policies should be implemented to facilitate their circularity. The life time of such products being much shorter means that companies have little incentive to reuse and increase the life of their products. Since the circularity of FMCG products themselves are more difficult to improve, the role of packaging, waste reduction and transport are therefore key. Some of the circular policies mentioned above thus also apply to FMCG. For instance, the 'Cleaner Production Promotion Law' introduced in 2003 encourages companies to reduce their environmental externalities and their energy intensity by more efficiently using their resources at all stages of the production process (Su, Heshmati, & Geng, 2013).

In 2009, the 'Circular Economy Promotion Law' was passed to promote CE. This law also has important implications for FMCG because it aimed to stimulate the waste trade market and increase the productivity and economic benefit of waste utilization (Su et al., 2013). Moreover, it puts the responsibility on producers to set up a waste management system and reduce their consumption. The law also stipulates that enterprises producing certain products and packages are obliged to recycled, while others need to be made harmless if they are not fit for reutilisation (Jintao, 2009). In the last two decades, the Chinese government has increasingly regulated the FMCG sector to force companies to improve their resource efficiency, recycle waste and safely discard what cannot be reutilized. Similar policies have been implemented in the EU, which will be discussed below.

2.3.2 EU

The EU's transition strategy to CE generally follows what it outlined in the European Commission's' Action Plan for a Circular Economy in 2015. The plan is to tackle production, consumption, waste management and the reuse market in the ways described below. The production strategy is to revise legislation to promote products that are designed to be easily repaired, upgraded, recycled and remanufactured (Government of the Netherlands, 2016). It also plans on improving resource efficiency by providing guidance and clarifying regulations. Regarding consumption, the Commission will provide new rules that will encourage reuse activities, it will tackle false green claims and planned obsolescence, and procuring funding for circular products (European Commission, 2015). Furthermore, the Commission will boost the reuse market by developing quality standards for secondary raw materials, facilitating water reuse, and support an EU-wide research on raw materials flows (European Commission, 2015). EU policies specifically targeted for WEEE and FMCG respectively will be outlined below.

Circular EEE Policies in Europe

The EU Waste Framework Directive (75/442/EC) sets the hierarchy of waste treatment methods. In this hierarchy, reuse and waste reduction are preferred to recycling, energy discovery and disposal. Nevertheless, only 2% of all collected WEEE in Europe is prepared for reuse, whereas 68% gets recycled (Parajuly and Wenzel, 2017). An EU legislative passed in 2012 pushes Member States to promote the separation of WEEE to prepare it for reuse. The legislative aimed to recover 75% of WEEE by 2018 (European Commission, 2012). The European Community WEEE Directive has been developed to incentivise take-backs and to further improve recycling and recovery of WEEE. This Directive dictates that producers should bear financial responsibility for the collection and treatment of WEEE. This is however a rarity in practice since the majority of WEEE is gathered by so-called waste managers who focus on recycling, not on reuse (Grunow and Gobbi, 2009). Similarly, the focus of reuse over recycling described in the EU Waste Directive does not seem to hold in practice since the aim of the current system is collecting and managing WEEE for recycling. This seems strange considering that, compared to the 2% reuse of collected EEE in Europe now, several European studies have concluded that approximately 20 to 30% of discarded EEE is suitable for reuse when delivered at waste and recycling centers (Agamuthu et al., 2012). When looking at small household WEEE in Spain, as much as 68% had potential for reuse (Bovea et al, 2016). These shortcomings clearly show that increased regulations and structural changes could enhance the reuse market.

Circular FMCG Policies in Europe

Once again, FMCG are mainly concerned with packaging and reducing waste. The EU is dedicated to improving waste management by setting long-term recycling targets for municipal and packaging waste, generating extending producer responsibility schemes, and harmonizing waste regulations in the EU (European Commission, 2015). The top priorities set by the EU that directly impact consumer goods are plastics and critical raw materials. Recyclability and recovery of the materials used are promoted through legislations, and best practices are be summarized for collective learning (European Commission, 2015). EU level policies are crucial to collectively transitioning the interdependent EU economies towards circularity.

Examples on the national level showcase the general European stance regarding CE. In the Netherlands, a waste disposal tax was implemented on the disposal and incineration of waste (Government of the Netherlands, 2016). The Dutch Cabinet wants to eliminate all subsidies at the EU and national levels that have a negative impact on the circular economy. Furthermore,

a joint-study with other EU members was initiated by the Netherlands to investigate cost-effective tax measures that would promote the market of circular products. Efficient market incentives are still to be designed but efforts are put towards halving the non-recyclable waste by 2020 (compared to 2012) through the promotion of circular business models. Circular improvements in the FMCG sector is key to transition towards a European circular economy in the future.

2.3.3 Key Differences of CE Policies in China and the EU

In both Europe and China governments have been working on promoting an environment supporting business developments that include circularity. However, McDowall et al. (2017) discuss that there are quite a few differences between European and Chinese policy making, partly resulting from different views on the general definition of circular economy. The Chinese defined the CE as part of their action plan for future development whereas in Europe, the CE focuses more on resource efficiency. In China, rapid economic growth has led to certain environmental problems which now aim to be solved by introducing circular practices in development. In Europe, the focus lies more specifically on certain parts of the linear business that want to be changed, such as design, resource efficiency, and waste (McDowall et al., 2017). China has been building their CE policies mostly on the so called "Circular Economy Promotion Law" which was published in 2009. The EU developed a plan called "Closing the Loop—An Action Plan for the Circular Economy" which was developed in 2015.

McDowall et al. (2017) argue that China's efforts pay greater attention to scale and place. That is achieved by multilevel experimentation through hierarchy. Furthermore, China focuses on environmental challenges – a result of rapid growth, by being more involved in tackling issues concerned with industrial production, pollution, and water. On the other hand, the authors state that Europe's approach focuses more towards boosting competitiveness by improving resource efficiency. In that sense, it is argued that the EU's approach is narrower in environmental scope, with larger focus on waste and resources, and with little mention of scale nor place. Due to those differences in context and governance systems, McDowall et al. (2017) argue that there should be restraint in making direct comparisons between China and Europe, and they suggest in order to improve collaboration, there is a need of mutual understanding.

Furthermore, the need to take country-specific differences into account when implementing policies is illustrated by the following example. Extended Product Responsibility (EPR) is a policy tool widely used in the developed world to promote the 3Rs (reduce, reuse and recycle). Under this approach, the producer is responsible for collecting expired and

discarded products, and either repairing, reusing or recycling them. However, Kojima, Yoshida and Sasaki (2009) discuss the difficulties arising with the EPR approach when exported in developing countries. The identification of producers is difficult as small producers, for instance, assembling products themselves can be hard to trace back, and companies going bankrupt cannot be accounted for. Moreover, smuggled and imitated goods cannot have their producers accounted for either. Such goods can make up a large part of the market in developing countries, representing up to 50% of goods in Indonesia (Kojima et al., 2009). In China, despite the availability of numerous formal recyclers, many companies end up selling their waste and e-waste to informal recyclers at higher prices. The latter do not invest in pollution control and labour protection and can thus have a competitive advantage. This requires large subsidies to keep formal recyclers competitive. The importance of the informal market in developing countries can compromise the effectiveness of certain policies proved successful in developed countries. This needs to be carefully considered when interpreting the results

3. Methodology

The following section will discuss the questionnaire used for data collection, the sampling method, and the tool used for analysis of data.

In order to deliver quality policy recommendations to enhance circular economy practices in the consumer electronic and electronic equipment and fast moving consumer goods sector in Europe and China, the paper needs to be based on sound empirical research investigating the extent to which participating companies practice circularity. For the purpose of allowing for in-depth analysis and to strike a balance between qualitative and quantitative research the fuzzy set qualitative comparative analysis (fsQCA) method proved to be most fitting also considering the restrictive time limit.

The following four steps have been pursued for the fsQCA and will be elaborated on further:

1. Data collection (e.g. on FMCG and WEEE, or at national level (emerging markets))
2. Quantification of conditions
3. Applying fsQCA (in cooperation with supervisor)
4. Interpreting the results

3.1 Questionnaire and Variables Explanation

Based on in-depth research on potential push and pull factors affecting company's level of circularity resulting in the aforementioned literature review, the research question has been transposed into the following equation:

Level of circularity = Company Structure + Consumer + Industry + Regulation + Company Culture

The section outlines what each variable is measuring, why it was chosen for the model, as well as which questions of the survey contribute to which variable and why. This literature review has highlighted factors that hinder the proliferation of circular practices as well as factors facilitating the transition towards CE. For the purpose of this research, five factors have been identified as contributing most to CE. Namely, company structure, consumer demand, company culture, industry and regulations. It is important to note that this research investigates factors inducing circularity at the company level, not at the national level. Even if larger coordination

programmes or pilot projects might induce circularity it is not considered as a factor in this research as it does not directly affect individual companies.

Please see Appendix A for the questions on the questionnaire as they were presented to companies. In the questionnaire the questions are separated into groups corresponding to the variables, but in the final results analysis it was found that some questions were better suited to other variables. (NB if there is a '~' in front of a question number, the complement of the score was taken, eg 0.1 becomes 0.9). In each case, full non-membership is allocated a zero score, while full membership is a score of one. Consequently, it will be discussed in detail what the exact meaning is of the five independent and the one dependent variable and how they are constructed.

3.1.1 Company Structure

Questionnaire questions corresponding to the variable of company structure are Q4, Q5, and Q13.

The effect of company structure and size has not been covered by existing literature. It has been included in this study in an attempt to establish if it affects a company's circularity level, and if so, to what extent. If a company:

- Has more employees (Q4);
- Sells less standardised and more complicated products (Q5); and
- Implements an Environmental Management and Auditing System (Q13)

then the company is larger and more complex and will therefore have a higher score for this variable.

Q13 was used in this variable rather than in the circularity measure or culture. It may indicate that they are aware of their environmental impact, but it is not a direct indicator of their level of circularity. Having this auditing system in place does not imply they have a culture of circularity.

3.1.2 Consumer

Question Q14 from the questionnaire corresponds to the consumer variable.

Consumer demand plays an important role in inducing circularity as it has been observed that consumer culture can affect the demand for recycled or reused products. Moreover, a lack of awareness of circular products seems to be an issue, due to poor knowledge of what circularity is or a lack of information regarding companies' circular levels. This variable consists of only one question (Q14): what are the external consumer forces on the company's

circularity efforts? The higher the demand for circular products, the higher their score for this variable.

3.1.3 Company Culture

Questionnaire questions corresponding to the variable company culture are Q8, Q10, Q24, Q25, Q26, Q27.

The literature review clearly indicated that company culture is an important factor in a company's circularity. Intrinsic motivation to be circular for ethical and moral reasons seems to strongly induce circularity. If a company:

- Engages in circularity even when the costs exceed the economic benefits (Q8);
- Values making their products more circular over the coming three years (Q10);
- Values the circularity of its supply chain partners (Q24);
- Is committed to finding circularity economy solutions (Q25);
- Includes strengthening the employee's circular economy mindset as part of their training and skills development (Q26); and
- Has a 'product champion' (someone who takes charge at furthering the internal development and external promotion of a certain good or service) for circularity

then the company has a culture that is committed to circular economy practices and will therefore have a higher score for this variable.

These questions all intend to measure intent and what the companies value; how motivated is the company to implement circular practices. They do not measure the absolute level of circularity the companies have been able to achieve, this is left for the dependant variable.

3.1.4 Industry

Questionnaire questions corresponding to the industry variable are Q16, Q17, Q18.

Literature indicates that the environment in which companies operate has an effect on their circularity. If a company:

- Has low upfront investment costs associated with their products (Q16);
- Has independent firms that repair their products (Q17); and
- Is highly affected by high virgin material prices (Q18)

then the company is in an industry and operating environment that is conducive to circular practices and will therefore have a higher score for this variable.

A company with lower upfront investment costs associated with their products can more cheaply alter their operating practices to become more circular; there is lower barrier to altering their operations. If the company is manufacturing products that can be repaired by third parties, they could more easily implement a repair service, either through the already standing third parties, or independently. Companies who are highly affected by high virgin material prices will enjoy relatively significant benefits from increases in their circular practices.

3.1.5 Regulations

Questionnaire questions corresponding to the regulation variable are Q32, Q33, Q34, and Q35.

The literature attributes much importance to regulations as they have been observed to push companies into recycling more, improving their resource efficiency and enhancing the reuse trade market. The literature also suggests that a lack of enforcement or of regulations overall hinder the transition towards CE. Moreover, it is also suggested that regulations in place obstruct companies' transition towards circularity. If a company:

- Is incentivised by policies in place to improve their level of circularity (i.e. subsidies and waste policies) (Q32);
- Is required by law to increase their circularity (Q33);
- Is subject to regulations that make it easier for the company to design products for reuse, repair or recycling (Q34); and
- Is subject to clear regulations regarding circularity (Q35)

then the company is incentivised to become more circular by regulations and will therefore have a higher score for this variable.

The questions relate directly to the policies and regulations that have a bearing on a company's ability to make their operations more circular.

3.1.6 Circularity

Questionnaire questions corresponding to the variable of circularity are Q6, Q9, and Q23.
Circularity is the dependant variable and is designed to measure the extent to which a company is circular. If a company:

- Is involved in circularity in a variety of ways (Q6);
- Has made progress in making their products more circular over the past three years (Q9); and

- Sells products that have a longer lifetime compared to competitors in their country (Q23)

then the company is more circular and will therefore have a higher score for this variable.

The extent of the circular practices that they partake in, as well as the progress they have made in the past three years, and the lifetime of a company's products are all direct indicators of a company's level of circularity.

3.1.7 Omitted questions

Questions 11, 12, and 15 were omitted from the analysis as not receive enough responses were received.

Questions 19, 20, 21, and 22 were not answered by all participants. After generating responses through research and including them in the analysis, they decreased the coverage of the model, so they were therefore omitted.

Questions 28, 29, 30, and 31 would have been excellent contributions to the industry variable but were omitted in error when running the analysis.

Additionally, the aforementioned factors were thoroughly discussed with academics specialized in the field of circularity and resource efficiency.

3.2 Sampling method and data collection

The availability of current company data on circularity is limited and has been altering significantly over the last years due to the increasing interest of firms in becoming more circular. Therefore, new data has been collected for the purpose of this research through the use of a questionnaire which has been distributed online. Each of the factors of circularity - consumer, company structure, industry, regulation, and company culture, are measured with particular questions. For a complete overview of the individual questions, please refer to Appendix A. The questionnaire employs a mixture of closed and open-ended questions. The aim of the closed questions is to gather responses on quantitative data such as percentage of waste which is being recycled. The open-ended questions are used to provide information on topics which cannot be narrowly specified and are subject to more variety in responses. Examples for such are the main barriers that businesses experience in terms of circularity efforts. In total, there are 39 questions related to the topic of this research with three additional questions concerning whether respondents would like to be updated on the results and how they can be contacted.

For businesses based in Europe, “Google Forms” has been used to share the questionnaire, while for China-based organizations, “Survey Hero” has been used. For this research, a non-probability convenience sampling method has been employed, mainly due to the limitations in terms of time and budget. The sample of European producers has been mostly drawn through the use of trade platforms where a large number of companies’ listings are present, such as “EUROPAGES”; groups of interest in social media websites, such as “LinkedIn”; and also through the use of a street sampling method, represented by the authors of this paper visiting a variety of businesses in the Netherlands and Belgium and promoting the questionnaire. Regarding Chinese respondents, most responses have been gathered through use of existing personal and professional networks.

3.3 Qualitative Comparative Analysis (QCA)

3.3.1 Explanation of QCA

Charles Ragin, an American social scientist, was the first to use Qualitative Comparative Analysis (QCA) in 1987 in a book called “The Comparative Method, Moving Beyond Qualitative and Quantitative Strategies”, and later he expanded the method to include fuzzy sets (Ragin 2000; Ragin 2006).

QCA relies on data collected from case studies and aims to provide analysis of cases in their entirety. A main advantage of the QCA method is that it allows for a high degree of complexity in the data to be collected as it relies heavily on researchers in depth understanding of a topic, rather than raw data points. It aims to strike a balance between qualitative and quantitative research, which is especially fruitful for providing sensitive policy recommendations. Fuzzy set QCA allows for further granularity. Where QCA requires data points to take boolean values (one or zero) to demonstrate membership of a set. This would be too deterministic for the purpose of this research. In fuzzy set QCA (fsQCA), however, variables are calibrated to take on a value between zero and one indicating the extent to which the data point is a member of a set, which in the case of this paper is the extent to which a surveyed company engages in circular practices.

3.3.2 Quantification of Conditions & Applying fsQCA

Since fsQCA is a relatively recent method of analysis which requires a thorough understanding of the underlying processes for correct application, the data processing and analysis has been done under the oversight of qualified supervisors who are knowledgeable in this research method.

According to a study conducted by Marx (2000) which outlines the threshold for the minimum amount of cases needed per number of independent variables in fsQCA, a minimum of 15 responses are required for an empirically significant analysis of five independent variables. The conducted survey resulted in 20 company responses from Chinese and European firms in the EEE and FMCG sector. The next step is to prepare the data table and either choose one questions per category to represent the independent variables (Singleton) or assign equal weights to each question and compound them into one value for every category (Equal Weighting). Since every question is to a similar level related to their respective category the paper applies the equal weighting method to take all possible factors into account.

The next step is to calibrate the Likert scale (1-5) used in the survey to a range of 0-1 through the use of thresholds. It is up to the researchers to carefully consider which thresholds are appropriate to determine if the independent variable should be considered 'full member' or 'fully out', as well as determining the 'cross-over point'. The full member and fully out scores were chosen based on the careful review of cases from the survey respondents. For each of the variables it was decided that all of the companies that scored above 0.8 exemplified the variable and should be assigned full member status. Likewise, those that scored below 0.2 were judged as not possessing the key qualities that the variable represented. The cross over score was chosen half way between full member and fully out scores because the variables are not at all skewed.

The threshold applied for all variables has been chosen as follows:

Full Member	Cross Over	Fully Out
>0.8	0.5	<0.2

Table 2: Full member, cross over and fully out thresholds that determine the level of calibration

4. Results

This section includes the detailed fsQCA results, a further discussion of their interpretation and limitations.

4.1. Results

In order to gain a full picture on which independent variables interact with one another to result in circularity, it is necessary to analyse the second output presented in Appendix B, the truth table. Once the data has been recoded into binary values, the truth table sorts it into the different combination of values on the causal conditions (i.e. the independent variables) leading to the output (i.e. circularity). Each row of the table is a logical combination of values on the causal conditions. Then every row is assigned an output value of circularity (score of 0 or 1) based on the score of the cases which share that combination. Only combinations resulting in a score of 1 for circularity (yc) are of interest for this research.

After running the truth table analysis presented in Appendix D, two solutions i.e. combinations are shown to lead to circularity. The solution coverage of 0.58 describes how many cases with the outcome are represented by a particular combination. In other words 58% of the cases can be explained with the resulting model. The solution consistency of 0.9 proves to be very close to 1 meaning that of those 58% of the cases 90% of them are consistent with the model. By replacing the acronyms with their respective variable names one can map out the relationships visually as such:

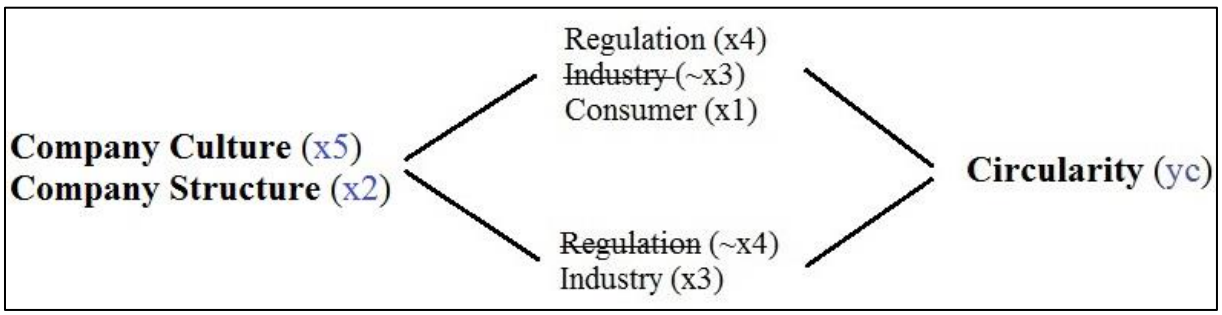

Figure 4: Circularity Model

Both paths require the presence of high levels in the company and culture variable from where circularity can be reached in two ways. The first is in an environment where companies score highly on the regulation and consumer variables, but poorly on the industry variable. The

second path represent companies that have a high score for the industry variable, but a low score for the regulation variable.

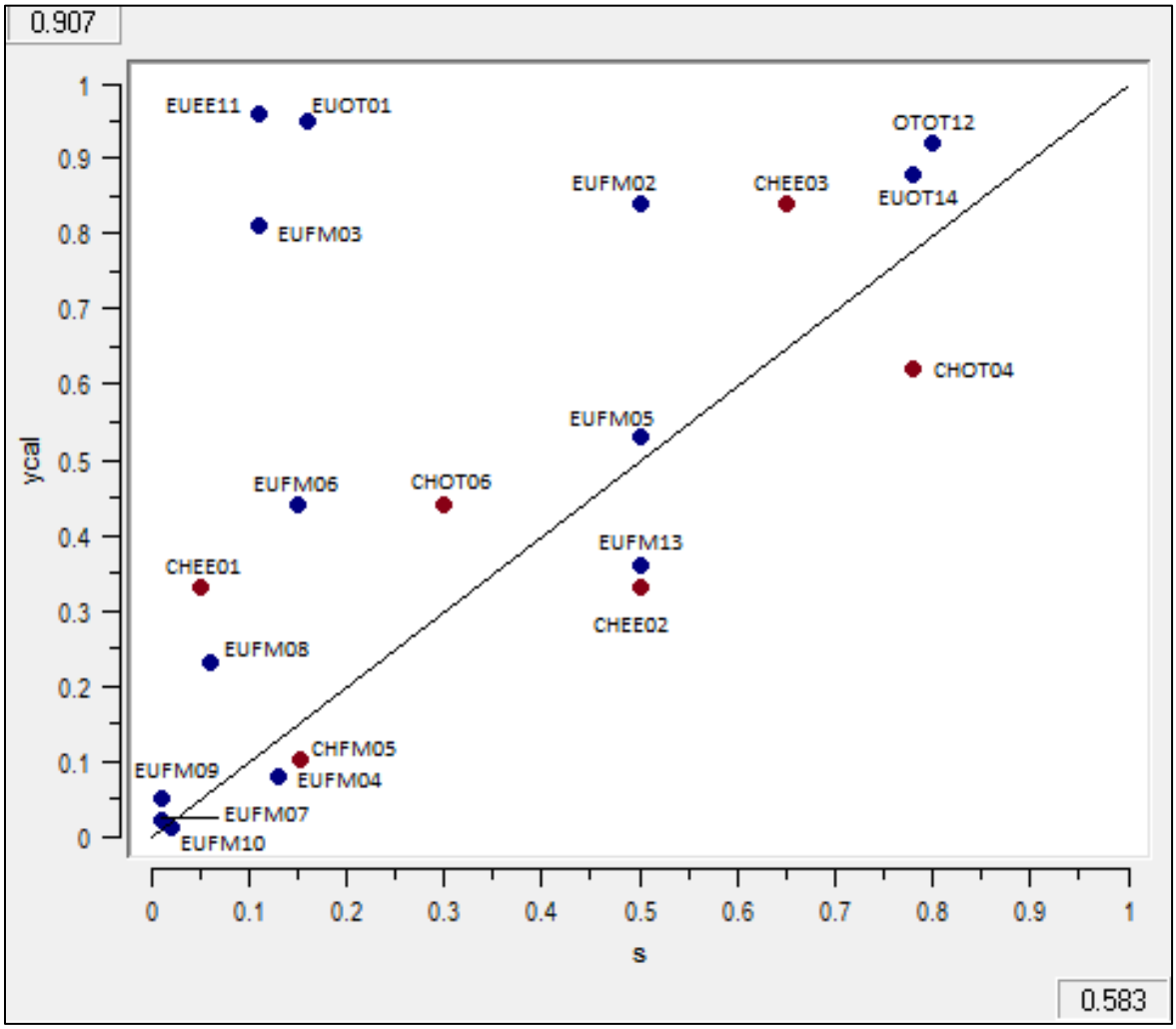

Figure 5: X/Y Plot fsQCA output

The data points are labelled with a six character string. The first two letters denote the region of the company, either EU (Europe), CH (China), or OT (other). The second two letters denote the sector of the company, either FM (fast moving consumer goods), EE (electric/electronic equipment), or OT (other). The last two characters identify which respondent the data point corresponds to.

The solution or s, resembles the circularity score that the different companies receive according to our model described above. The values range for 0 to 1 and it is plotted on the x-axis. The calibrated value of circularity is plotted on the y-axis. The 45 degree line running from (0,0) to (1,1) indicates a perfect match between our model measured level of circularity and the circularity level measured via the questionnaire. In reality, there is of course no perfect

fit. The solution coverage is about 0.583 while the consistency of the solution is 0.907. This means that our model matches the questionnaire results really well in almost 60% of the cases. It can be seen that the majority of the companies hover somewhere around the line, although there are some outliers.

The graph can be divided into four quadrants. The upper right quadrant are cases that fit the solution path and scored high on circularity. The bottom left quadrant represents cases that scored low on circularity and showed a low fit with the proposed solution. All cases present in the lower right quadrant would refute the research results as these would show low levels of circularity despite fitting the model. Finally, the upper left quadrant are outliers that scored high on circularity despite not fitting the model. This could be due to other variable that have not been included in the model or errors made in the weightings. As presented in Figure 5, no cases can be found in the lower right quadrant, however, three cases reside in the upper left quadrant. These European companies score highly on circularity regarding our survey while the fsQCA-solution dictates that their expected level of circularity is very low. In the discussion that follows, these cases shall be examined more closely as to what factors could explain their position in the graph.

4.2. Discussion of Results

The resulting model delivers some thought-provoking insights . Both paths include high scores for the culture and company variables. This suggests that companies that are larger and more complex, along with being motivated internally to find circular solutions, are more likely to achieve high levels of circularity. From there, the model provides two alternate paths to achieve high levels of circularity:

- Path one

When a company is operating in an industry that is not conducive to circular practices (low score for industry variable), they require strong regulations to incentivise circularity, as well as high demand from consumers for circular products (high scores for the regulation and consumer variables)

- Path two

When a company is operating in an industry that is conducive to circularity (high score for industry variable) it can achieve high levels of circularity in spite of low levels of regulation to incentivise their practices (low score for regulation variable). Consumers do not play a significant role in the circularity of companies in this scenario.

From these models the effect of changing one of the variables, through policy changes or otherwise, cannot be ascertained. In the instance of path two for example, those with a high industry score and low regulation score achieve a high level of circularity according to the model. It cannot be implied that if regulations on these high industry companies was increased, their level of circularity would decrease, this is beyond the scope of our model and additional analysis would have to be completed to test for this.

The three company outliers in the upper left quadrant all operate in different sectors, the plastic sector, the electric electronic equipment sector and in the fast moving consumer goods sector. However, they have some similarities which leads to the fact that they do not fit well into the model generated by the fsQCA software. They either score poorly for the company structure variable, company culture variable, or both. With further development of our model, perhaps adjusting the weighting of the questions that contribute to the variables, we could develop more sophisticated variables that would account for these anomalies and hopefully better fit the data to the model.

Overall, European companies had an average score of approximately 2.6/5 when stating how much policies incentivized circular practices. Chinese companies scored about 3.2/5, meaning they indicated that the government tends to incentivize circularity more. All three companies also tend to have simpler products and indicate that the industry that they are in is not that conducive to circularity, which our model scores as being correlated with a low level of circularity.

More specifically, EUOT01 scored low on company structure due to the fact that the person answering the survey was not aware whether the company is subject to Environmental Management and Auditing Systems or not (Q13). If EUOT01 was subject to such auditing, their company complexity would have significantly increased. Moreover, EUOT01 scored three (on a five point scale) on the standardization question (Q5), selling products of an average level of standardisation. However, based on knowledge about this company the research team believes that the product is more complex than evaluated by the respondent. This question might be too subjective to capture the standardization level of the product concerned. Those changes would thus increase the company structure indicator, which would be more in line with our model.

EUEE11 is a Dutch company selling electric electronic goods. They state that consumers in their industry do not really care about the circularity of their products, but mostly about the price. Since the customer does not care that much there is also not that much of an internal company culture to improve circularity. Being internally motivated is deemed by our model to correlate positively with circularity. Also, they indicate that the government does not

incentivize or mandate them to be more circular. However, just because circularity is not a main concern does of course not mean that the company isn't circular at all. The CEO mentioned that customer support and customer service is key in their business, so they are determined to support their software for a really long time, making their products last longer than their competitors. They also recycle all their products, do waste prevention and do in-house repair. Lastly, they have also made quite some strides in becoming more circular in the last three years. Hence, they are in fact quite a circular company but this circularity is mainly driven by profits and by providing a great service towards their clients and not necessarily by internal or external motivation to become more circular in and of itself. That's why there is a discrepancy between the model outcome and the actual circularity level.

EUFM03 is in the fast moving consumer goods industry and primarily gets a low circularity score in our model because it is pretty small company and sells a simplistic product. Our model has determined that this correlates negatively with circularity. In practice however, being a small company that sells non-complex methods does of course not mean that a it cannot be circular. In this case, the company has a lot of circular practices but its size and complexity led to a low score in our model.

There are also companies which fit our model particularly well. As discussed earlier, there are two paths towards circularity in our model. Two companies, EUOT14 and CHEE03, fit the first path particularly well and appear in the upper right quadrant. The former is a large European company that operates in a multitude of industries, one of them being consumer electric electronic goods. The latter is a large Chinese company, operating in the electric electronic sector. They both score above average on industry and below average on regulation.

Two companies, OTOT12 and CHOT04, fit particularly well with the second path and again appear in the upper right quadrant of the scatter plot. This is somewhat unfortunate since this report primarily focuses on electric electronic goods section and fast moving consumer goods section. However, in this case a chemical company from India and a construction company from China match particularly well with the second path towards circularity. This could also be seen as positive, that our model might be applicable to more than just the two sectors we focused on. Both companies indicated in the survey that their industry is not very conducive towards circularity and that consumers really request circular products. They also gave above average scores to the regulation variable. This means that they both indicate that government has policies in place which either mandate or incentivize having circular practices in place.

4.3. Limitations

Our model could have been improved by increasing the number of respondents and soliciting more survey responses. A lot of questions could not be used as people were not familiar with roughly what percentage of their products they reuse and recycle. The minimum number of respondents necessary for a proper analysis with five independent variables is 15, this amount has been achieved. However, there are not sufficient results to run the analysis for Europe and China separately to get a better understanding of the differences between the two regions.

Food producing companies may receive a biased score on circularity due to the little reuse they can have (mainly recycling). There has been an effort made to balance this in the circularity measure but when this strategy was implemented insignificant results were obtained. It was therefore decided to use the same circularity standards for all industries. Bias could also occur in the circularity measure due to the following question: ‘‘how much progress have you made in recent years?” If the company was circular from the start and only maintains its level of circularity, then it would score low on this question despite its absolute level of circularity being quite high. Company culture is found to be an important factor, but this could be due to the fact that little regulations are in place to incentivize companies and that therefore companies need to be intrinsically motivated to engage in circular practices. This does not mean that if efficient regulations were in place, they would have little effect on businesses’ circularity.

Due to the use of convenience sampling, there might be issues regarding how representative the sample is of the population that is examined. Issues can arise from the specific regions where the data was mostly gathered from – Belgium and the Netherlands. Drawing inferences from this data for all businesses in the EU can be problematic, due to possible region-specific factors, which might have an effect. Furthermore, there could be an issue with the knowledge of respondents and the quality of data collected. It is often the case that the respondents to questionnaires are the first people who come in contact with it - in the case of street sampling it could be a shop clerk, in the case of e-mail surveys, it might be the person responsible for customer communication. It is highly possible that these types of respondents do not possess the necessary knowledge in order to provide sufficiently accurate information, which can lead to bias in the results.

5. Policy Recommendations

The policy recommendations drafted below are based on the open questions at the end of the questionnaire. These open questions inquired what the companies believed were barriers of entry and the role of governments in transitioning to CE, as well as any additional comments they had. The policy recommendations are divided into consumer demand, regulations and industry policies. These include general and specific recommendations for China and the EU as well as for FMCG and EEE.

5.1. Consumer Demand

According to the research findings, in the absence of industry, consumer demand and regulation together lead to company circularity. This first section covers policy recommendations to increase consumer demand. Amongst the many enablers and barriers of the transition towards a circular economy, public participation and awareness is one that requires special attention and care, especially when developing policies targeted to stimulate it. Beyond the much-needed regulations addressing corporate sustainability and responsibility, policymakers need to further consider the demand-side factors that are also integral in facilitating the transition. As evidenced by the preceding research, long-term promotion of CE can only be achieved when supply-side and demand-side initiatives work in tandem, especially in an environment where the industry pressure to transition is low, for example due to low virgin material prices. If policymakers wish to boost public engagement this requires reinforcing public awareness of the positive long-term impacts of CE and incentives to stimulate public participation. While consumer demand for circular products has been growing in Europe, China struggles in this aspect.

5.1.1 Labelling

Labelling has proven to be an effective way to make consumers more conscious of the environmental impact purchased goods have (European Commission, 2017). Many similar initiatives have been widely adopted in the EU such as the Marine Stewardship Council label certifying sustainable fishing, or the Better Life label implemented in the Netherlands ensuring animal welfare. Beyond food products the EU Commission proposed a labelling system for the energy performance of household items such as washing machines, heaters, and air conditioners (European Commission, 2018). What is clearly needed are labels more directed towards how circular a product is such as product durability, repairability, and recyclability. Indeed, one of our European respondents claimed that he was not recognized as being circular compared to his competitors and that therefore he did not have any advantage when selling on local markets. A circularity label would set him apart from competitors as he believes that consumer demand for

circular products is high in his industry. Beyond the local industry, however, worldwide labels would enable companies to know how circular their foreign providers are, which one of the respondents recommended.

This is an area where China is lacking behind as only few product labels exist and are fairly limited in their product range, such as Ecolabel. This is a critical issue considering the potential contribution China's 1.3 billion consumers can make. Since research on environmental and CE indicators have been gaining traction in recent years in China, this would be an ideal time to incorporate these measurements into creating suitable product labels. Beyond including CE measures into labels, it remains important to ensure proper auditing of the enforcement of these certifications to combat consumer confusion and lack of trust. Also the accuracy of the claims needs to be improved as some products are marked as recyclable or biodegradable even though they contain foreign material and therefore downgrade the recycled end product.

In this respect cooperating with the EU and learning from their product labelling requirements would be highly beneficial for China. Nonetheless policymakers need to keep in mind the different cultural tendencies of consumers from both regions as the impact might not have similar effects.

5.1.2. Campaigning

The choices of consumers are based on the information they are subjected to, hence the importance of persuasive campaigns. One of the European respondents believes that the public lacks knowledge on the concept of circularity and often mistakes it for waste management. However, CE goes much further as it aims to reduce waste rather than improve the efficiency with which waste is managed. Therefore, enhancing public awareness should go beyond simple informative campaigns and policymakers should strive to integrate CE thinking in schools and study in order to help future generations develop a sustainability culture. By making the circular economy concept an integral part of educational programs further research into this approach will be stimulated which would increase the chances to maximize the economic and social benefits that can be derived by it. This will heavily depend on the quality and amount of CE measures available for the effective communication of the principles of CE as well as on how well the information campaigns are adapted to reach the intended consumers.

Economic incentives go hand in hand with awareness campaigns. Successful initiatives implemented in the EU are for example manufacturers and retailers offering discounts on purchases with the return of old electronic devices and to some extent the use of taxation to

better reflect the environmental impact in the product price. These are examples policymakers in China could learn from and adapt to the local environment, especially because consumer price elasticity differs from country to country.

5.1.3. Market Research on Consumer Demand for Circular Products

A final point to address on the topic of public engagement is the simple matter to take into account consumer needs and preferences. One of our European respondent claimed they were badly informed on consumer demand and needs for circular products. Market-wide research is expensive, especially for SMEs but necessary to reach the consumers. Subsidies should be put in place for the purpose of facilitating this task for companies or government-led research supporting this topic should be made available. The public is also more likely to develop a circular mindset if every step of the CE model is made as convenient as possible for the consumer (Anttonen, 2018). This includes providing repair of electronic devices at reasonable prices and improve waste collection infrastructures to include curbside pickup of e-waste. One of the respondents complained that in the EEE industry Chinese manufacturers seek quick profits and change their hardware design very often which counteracts the wish of companies and consumers to use more durable products. A suggestion provided by a respondent is for the Chinese government to step up and incentivize electronics manufacturing companies to keep their product design the same for a longer time in exchange for subsidies to counteract the potentially resulting lower profits. Companies such as Fairphone, who make phone repair easy and affordable for consumers, are dependent on manufacturers producing for large firms. When these firms decide to change their phone design, the manufacturer adapts to their needs and Fairphone loses its long-term supply of consistent components. Especially large companies that have the necessary scale and capabilities should be incentivized to offer more durable products as they are the main influencers of consumer demand.

5.2 Circularity Regulations

As previously mentioned, the research findings suggest that regulations and consumer demand lead to company circularity. This section provides policy recommendations for the implementation of adequate regulations to promote circularity. Some topics which are discussed in the consumer demand and industry sections are also relevant for this section, however, they are not covered twice. Concluding from the research results, restrictive regulations inducing companies to engage in circular practices prove to be most effective in combination with high consumer demand for circular products. However, when the industry environment already strongly pressures companies to engage in circularity for cost reasons then

the need for regulations to be put in place is less essential. If the environment is pushing companies to be circular, then it is possible that existing regulation has little effect on their circularity, because they might have already done enough or more than required.

5.2.1 Improving and Adapting Existing Emissions, Waste and Recycling Regulations

Economic sanctions and restrictions are a possible measure that can improve companies' circularity efforts. Although there are existing regulations concerned with emissions, waste, and recycling in the European Union and in China, some respondents based in the EU indicated that such regulations are not strict enough or are not enforced properly. Regulations which can be stricter are taxation on greenhouse gas and harmful substances emissions, taxation on amount of generated solid waste, implementation of minimum percentage of recycled waste and imposing fines when there is no compliance. Furthermore, a few respondents have also indicated that food safety and health regulations in the EU are harmful to CE practices. This is mostly due to excessive use of packaging and limited ability to reuse certain products.

Having this in mind, it is suggested that current EU regulations should be examined and adapted to better facilitate CE practices. Furthermore, there should be more involvement of circular businesses with policy makers and regulators in the formulation and implementation of policies and regulations, which affect them.

5.2.2 Tackling Planned Obsolescence

Regulation can also be used to improve circularity efforts in terms of planned obsolescence of electronics. Due to the fact that intellectual property rights are stronger in the EU compared to China, it is harder for consumers and third parties to effectively tackle planned obsolescence of products. There are certain EU regulations in place, such as Directive 2012/19/EU, however, it is argued whether it goes far enough. Some possible directions of regulation facilitating circular practices in the electronics sector through planned obsolescence are based on increasing the availability of spare parts, providing consumers and third parties the right to repair and obliging companies to supply the necessary servicing documentation, and improving the accuracy of information electronics producers provide to customers in regard to their products' expected lifetime.

Availability of spare parts is a crucial limitation in the efforts to repair and thus increase the lifetime of certain electronics. Certain producers restrict the supply of original parts and use proprietary tools, which limits the repairability of their products. At the same time, they might prosecute parties which manufacture replacement parts and share servicing manuals without their consent. Even though such producers offer repair services, those are often overpriced and

are considered to be encouraging customers to rather buy a new product and throw away their old one. A possible solution to this is to oblige companies to provide repair parts for their products and the proprietary tools they use on the market.

Regulation can also be used to provide and enforce consumers and third parties the right to repair. Some producers do not share any servicing and repair documentation to their customers and third parties, which lowers the lifetime of their products and respectively increases electronics waste.

Lastly, it is possible to make it mandatory for electronics producers to provide accurate information about the expected lifetime of their products and stages of its life-cycle. Even if an electronic product might still be working after the guarantee period, it is possible that there is significant degradation in performance. Obliging companies to disclose information about product lifetime expectation and degradation over time will provide consumers and businesses with factual input they can use to make an informed decision towards their electronics product purchases.

5.3 Industry

The research results show another potential path to circularity where consumer demand is not relevant, and the regulation indicator negatively impacts circularity. In this scenario, only a strong industry indicator is conducive of circularity.

5.3.1 Financial incentives

Companies that have low upfront investment costs associated with their product tend to be more circular. Thus, circularity could be facilitated by providing financial help to companies with higher upfront investment cost. Three Chinese companies and a European one identified high cost as the most pressing barrier to improving their circular practices. One can imagine that circularity is not a top priority for companies, especially small ones with fewer financial and human resources. Therefore, providing financial incentives to innovate and develop circular solutions could help such companies on their path to circularity. For instance, providing investment-based incentives for companies willing to become more circular would reduce their risk associated with high upfront investment cost. This strategy was introduced in the Netherlands in 2006 to stimulate investment in renewable energy. The Dutch government provided companies investing in renewable energy with reduced taxable profit, low-interest loans and gave investors dividends that are free of income tax (Haas et al., 2011). A similar strategy would tackle the cost barrier outlined by the four respondents.

Moreover, five European companies and a Chinese one mentioned that a financial incentive should be put in place to recycle more. In Europe, recycling costs company's money because they have to pay a private company to pick up their recyclable waste. Even though a small subsidy is in place to partially reimburse companies, it costs them more than if they would throw recyclable waste away with general waste. This showcases the immense work that needs to be done regarding circularity. Recycling is supposed to be the last resort solution in CE as products should be initially designed to reduce waste and reuse and repair practices should be encouraged to reduce the amount of recyclable waste. Recycling incentives should therefore work together with repair, reuse and waste reduction incentives. Establishing quality standards for secondary materials and giving tax reductions on profits for the use of secondary materials could boost the reuse and repair trade market. The research findings suggest that proportionally more European companies than Chinese ones believe that recycling and reuse should be further encouraged. This indicates that the policies in place might be more effective in China than in Europe. Although both countries could benefit from such financial incentives, there seems to be a more urgent need in the EU than in China.

5.3.2 Research support

A lack of adequate technology does not seem to be a pressing issue to transition towards CE as European and Chinese companies respectively scored an average of 2.00 and 2.67 out of five on this question. However, a Chinese company specifically mentioned that relevant technology was not advanced enough for them to be more circular. The government could therefore coordinate and/or finance research on developing technology that would enable companies to become more circular. Further research should be done to find out what exact technologies are needed to transition towards CE.

Furthermore, five European respondents mentioned that hygiene and food regulations hinder circular improvements. For instance, the Agence Fédérale pour la Sécurité de la Chaîne Alimentaire (AFSCA) in Belgium requires food producers to use disposable paper towels to dry dishes in the kitchen. Also, packages for transportation and for sale cannot be reused which requires producers to dispose of plastic packages after every use. One could imagine that alternative solutions that fit the hygiene standards and that are more sustainable could be sought for. Governments could therefore invest resources to find such solutions.

5.3.3 Circularity training

The research results show that information asymmetry is an important barrier to circularity. Indeed, four European respondents mentioned that even though they are interested in becoming

more circular they do not have the time nor the resources to do so. However, companies mentioned that if free circularity training was given they would gladly improve their circularity. The government should therefore act as a circular educator or at least as a coordinator facilitating NGO's reach to companies. The spread of information is not the most resource-intensive activity that governments could engage in, but it would have an important impact of stimulating CE.

5.3.4 Public infrastructure improvement

Interestingly, the Chinese and European respondents respectively scored an average of 2.83 and 1.64 out of five on whether a lack of public infrastructure was impending their circularity efforts. This shows a clear difference in opinion between China and the EU which suggests that China should heavily invest in recycling and repairing centres, waste collection mechanisms and waste separation infrastructure. Since European companies seem to be rather content with existing public infrastructures, the Chinese government could cooperate with the EU to get insights into how they developed their strong public infrastructures.

5.3.5 International Cooperation

Furthermore, strong and transparent Sino-European cooperation was found to be important to maximize the effectiveness of policies in place. For instance, one of our European respondents identified Chinese regulations as hindering circularity because Chinese companies are required to take back electronic waste at the end of its life. However, the European company claims that it would be more efficient and sustainable if the product was disposed locally rather than having to be shipped back to China. International coordination would therefore improve the overall efficiency of the supply chain. In general, coordinated efforts between China and the EU would lead to more effective results as they would feed into each other and best-practices could be exchanged.

6. Conclusion

After analysing the current situation of the circular economy in both China and the EU, a questionnaire was designed to determine which factors affect companies' level of circularity. The companies in the dataset that were highly circular, for the most part, have a company culture that focuses on circularity and a high level of company complexity. Additionally, the model supports companies achieving circularity through one of two paths:

1) Having strong regulations in place to incentivise circularity and consumers that demand circularity, despite the industry the company operates in not being conducive to circular practices; or
2) The company operates in an industry environment that is conducive to circular efforts, despite there being a lack of regulation which incentivises circularity.

Industries that are not conducive to circular practices should be the focus of policy makers. Specific areas were identified where policies might be particularly useful, such as public and professional knowledge of the circular economy, labelling systems and international cooperation. Enhancing the public's education and awareness of circular economy concepts or assisting and encouraging companies to engage in circular activities by providing more access to knowledge, are both ways this could be achieved. Furthermore, providing economic incentives for companies could help them to further engage in circular practices. For some areas it is also important to examine and adapt existing regulations which are damaging the circular efforts of companies. A development desired by many companies is a common method of distinguishing between different businesses and products in terms of their circularity, which could be achieved by a standardized international labelling system.

An improved cooperation between domestic and international partners through initiatives such as standards and policy alignment, knowledge sharing, and supply chain improvements will make a significant positive difference in the further development of the circular economy.

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Appendices

Appendix A

Questionnaire:

Thank you for taking the time to partake in our survey, which will take less than 2 minutes. We are collecting data on circularity and its determinants. This is done as part of the SINCERE project (Sino-European Circular Economy and Resource Efficiency).
Circular refers to the term circular economy. In contrast to the linear economy (based on take-make-dispose), the circular economy aims to use as few raw materials as possible, with the help of product repair, reuse and recycling.

Your responses will be kept confidential. If some questions are not applicable to your company/product, please skip them.

感谢您腾出宝贵的2分钟参与有关“循环经济”的问卷。您填写的数据将为SINCERE项目（中欧循环经济和资源效率）提供价值，且完全保密。如果某些问题不适用于您的公司或产品，请略过。

与线性经济（购买-生产-处理）相比，循环经济尽可能少得使用原材料，而是进行产品维修、再利用和再循环。

---

0 What is your company name?
您的公司名称是什么？

1 What country do you operate in?

2 What is your position within the company?
您在公司内的职位是什么？

---

3 Which product line does your company mainly sell?

您公司的主要产品系列是什么？

4 How many employees does your company approximately have?

您的公司有多少员工？

5 How standardized are the products that your company sells? (1-5) Very simple, standardized - Very complicated, non-standardized

您公司销售的产品标准化程度如何？（1-5）**非常**简单，标准化 - **非常复**杂，非标准化

6 In which of the following ways is your company involved in circularity?

您的公司用以下哪种方式参与循环？

Waste prevention

废物预防

Reuse of waste

废物再利用

Design for recycling

回收设计

Design for repair and reuse

设计用于维修和重复使用

Remanufacturing

再制造

Own product repair

自己的产品维修

Use of reusable packaging

使用可重复使用的包装

None of the above

以上都不参与

7 Your company's circularity efforts are mostly motivated by:

您们公司的循环努力主要是由以下因素驱动：

Improved efficiency and cost reduction.

提高效率和降低成本。

Our strong ethical and environmental values.

我们强大的道德和环境价值观。

8 We engage in circularity even when the costs exceed the economic benefits:

即使成本超过经济利益，我们仍参与循环：

Yes

是

No

否

9 Within the last three years, how much progress have you made with regard to making your products more circular? (1-5) No progress - A lot of progress

在过去三年中，您在促使产品更加循环方面取得了多大进展？（1-5）没有进展 - 取得了很大进展

10 For the upcoming three years, how important is it for your company to make your products more circular? (1-5) Not important at all - Extremely important

在未来三年中，您公司让您的产品更加循环有多重要？（1-5）根本不重要 - 非常重要

11 Approximately, what percentage of sales is spent on research & development?

大约有多少销售额用于研发？

0-1 1-5 5-10 10-20 超过20% 我不知道

12 Approximately, what percentage of research and development expenditure is spent on circular efforts/products? 0-1; 1-5; 5-10; 10-20; 超过>20% 我不知道

大约有多少研发支出用于循环努力/产品？

13 Does your company make use of Environmental Management and Auditing Systems? Yes No Other:

您的公司是否使用环境管理和审计系统？ 是 否 其他：

---

14 To what extent do customers/consumers in your market actively ask for circular products?
To a very small extent
To a very large extent

您市场中的客户/消费者在多大程度上积极索要循环产品

在很小程度上

在很大程度上

15 What percentage of your customers do you estimate would move away from your product if the price increased 10%?

0-1; 1-5; 5-10; 10-20; 超过>20% 我不知道

如果价格上涨10%，您估计会有多少客户停止购买您的产品？

16 To what extent has your product required upfront investment costs?
Very little upfront investment (1)
Very large upfront investment (5)

您的产品在多大程度上需要前期投资成本？

前期投资很少 - 前期投资非常大

17 Are there independent firms who repair your product for commercial reasons?

有没有独立的公司因商业因素维修您的产品？

有 没有

18 To what extent is your company negatively affected by high virgin material prices? Not affected - Highly affected (1-5)

您的公司在多大程度上受到高原材料价格的负面影响？

不受影响 - 受到严重影响

---

19 Approximately what percentage of input is coming from recycled materials?

0-1, 1-5, 5-10, 10-20, 超过>20% 我不知道

大约有多少百分比的投入来自回收材料？

20 Approximately what percentage of input is coming from reused components?

0-1, 1-5, 5-10, 10-20, 超过>20% 我不知道

大约有多少百分比的投入来自重复使用的组件？

21 Approximately what percentage of a discarded product is collected for recycling?

0-1, 1-5, 5-10, 10-20, 超过>20% 我不知道

大约有多少百分比的废弃产品被回收？

22 Approximately what percentage of discarded product is collected for reuse?

0-1, 1-5, 5-10, 10-20, 超过>20% 我不知道

大约有多少百分比的废弃产品被收集再利用？

23 How does the lifetime of your product compare to that of competitors in your country? (1-5) Considerably shorter - Considerably longer

您的产品的使用寿命与您所在国家的竞争对手相比如何？

(1-5）**相当短 - 相当**长

24 To what extent is the circularity of your supply chain partners important to you?
(1-5) Not at all - Very important

您供应链合作伙伴的循环程度对您有多重要？

（1-5）**不重要 - 非常重要**

---

25 Would you say that your company is committed to finding circular economy solutions?
(1-5) Not at all - Very much so

您是否认为您的公司致力于寻找循环经济解决方案？

（1-5）**没有致力 - 非常致力**

26 Would you say that strengthening the employee's circular economy mindset is part of their training and skills development?
(1-5) Not at all - Very much so

您是否认为加强员工的循环经济思维是他们职业培训和技能发展的一部分？

不是很重要 - 很重要

27 Would you say that you have a product champion for circularity in your company?
(A product champion is someone who takes charge at furthering the internal development and external promotion of a certain good or service)
(1-5) Not at all - Very much so

您的公司有循环产品冠军吗？

（产品冠军是负责推进某种商品/**服**务内部开发、外部促销的人）

（1-5）**根本没有 - 有很多**

---

28 To what extent are circular processes widespread in your industry?
Not at all - Very much so

您的行业中循环流程发展的如何？

（1-5）行业根本没有 - 非常如此

29 To what extent are your products dismantled by other companies for recycling and re-use?
(1-5) Not at all - Very much so

您的产品在多大程度上被其他公司拆除以进行回收和再利用？

（1-5）很小的程度 - 很大程度上

30 To what extent does a lack of available technology impede your circular practices?
(1-5) Not at all - Very much so

缺乏可用技术在多大程度上阻碍了您的循环实践？

（1-5）不阻碍 - 非常阻碍

31 To what extent does a lack of available public infrastructure impede your circular practices?
(1-5) Not at all - Very much so

缺乏可用的公共基础设施会在多大程度上妨碍您的循环实践？

（1-5）不妨碍 - 非常妨碍

---

32 To what extent are you incentivized by policies in place to improve your level of circularity? (i.e. subsidies and waste policies)
(1-5) Not at all - Very much so

您在多大程度上受到政策的激励，以提高您的循环水平？（例如：补贴和废物政策）

（1-5）不提高 - 非常提高

33 To what extent are you required by law to improve your level of circularity?
(1-5) Not at all - Very much so

法律要求您在多大程度上提高您的循环水平？

（1-5）不要求 - 要求很高

34 To what extent do current regulations make it difficult for the company to design products for reuse, repair or recycling?

(1-5) Very difficult - Very easy

现行法规在多大程度上使公司难以设计产品以供再利用、维修或回收？

（1-5）非常困难 - 非常简单

35 To what extent are current regulations regarding circularity unclear and/or confusing?

(1-5) Not at all - Very much so

现行有关循环的规定在多大程度上不清楚或令人困惑？

（1-5）很清楚 - 非常不清楚

36 What barriers have you come across that make it difficult to improve your level of circularity?

您遇到哪些障碍，使得难以提高公司的循环水平？

37 What could your government do to promote circularity?

您认为政府怎样能更好的促进循环？

38 Do you have any additional comments regarding circularity that were not covered in our questionnaire?

您对我们的调查问卷中未涉及的循环问题有任何补充吗？

---

39 Would you like to receive an email with our policy recommendations?

Yes/No

您愿意收到包含我们政策建议的电子邮件吗？愿意/不愿意

40 Can we contact you to discuss your answers in more detail?

Yes/No

我们可以与您联系，更详细地讨论您的答案吗？

可以/不可以

41 If yes to either, what email address should we send it to?

如果愿意/可以， **您的**电子邮件地址是？

Appendix B

fsQCA Output: Necessary Conditions

```
compute: x1consumercal = calibrate(x1consumer,.8,.5,.2)
compute: x2consumercal = calibrate(x2company,.8,.5,.2)
compute: x3consumercal = calibrate(x3industry,.8,.5,.2)
delete variable: x2consumercal
delete variable: x3consumercal
compute: x2companycal = calibrate(x2company,.8,.5,.2)
compute: x3industrycal = calibrate(x3industry,.8,.5,.2)
compute: x4regulationcal = calibrate(x4regulation,.8,.5,.2)
compute: x5culturecal = calibrate(x5culture,.8,.5,.2)
compute: ycal = calibrate(ycircularity,.8,.5,.2)


Analysis of Necessary Conditions

Outcome variable: ycal

Conditions tested:
                     Consistency          Coverage
x1consumercal        0.654321             0.538071
x2companycal         0.695473             0.751111
x3industrycal        0.508230             0.656915
x4regulationcal      0.581276             0.647194
x5culturecal         0.826132             0.617692
```

Appendix C

fsQCA Output: Truth table

x1c	x2c	x3c	x4c	x5c	number	yc	raw consist.
0	1	1	0	1	1	1	0.880435
0	0	0	0	1	1	0	0.770833
1	1	1	0	1	1	0	0.766234
1	1	0	1	1	2	0	0.687912
1	0	0	0	1	2	0	0.598945
1	0	1	0	0	1	0	0.474419
0	0	1	0	0	2	0	0.444785
0	0	0	1	0	1	0	0.409524

Appendix D

fsQCA Output: Truth Table Analysis

```
*********************
*TRUTH TABLE ANALYSIS*
*********************

File:  C:/Users/Bas/Documents/final - main variables data - calibrated .8 .5 .2.csv
Model: ycal = f(x5culturecal, x4regulationcal, x3industrycal, x2companycal, x1consumercal)

 Rows:       3



 Algorithm: Quine-McCluskey
      True: 1
   0 Matrix: 0L
Don't Care: -

--- INTERMEDIATE SOLUTION ---
frequency cutoff: 1.000000
consistency cutoff: 0.879237
Assumptions:

                                                                    raw       unique
                                                                   coverage   coverage   consistency
                                                                   ---------- ---------- ----------
x5culturecal*~x4regulationcal*x3industrycal*x2companycal           0.330247   0.156379   0.996894
x5culturecal*x4regulationcal*~x3industrycal*x2companycal*x1consumercal  0.426955   0.253086   0.879237
solution coverage: 0.583333
solution consistency: 0.907200



Cases with greater than 0.5 membership in term x5culturecal*~x4regulationcal*x3industrycal*x2companycal: EUOT14 (0.78,0.88),
  CHEE03 (0.65,0.84)
Cases with greater than 0.5 membership in term x5culturecal*x4regulationcal*~x3industrycal*x2companycal*x1consumercal: OTOT12 (0.8,0.92),
  CHOT04 (0.78,0.62)
```