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China's Emergence as a Global Recycling Hub – What Does it Mean for Circular Economy Approaches Elsewhere?

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Abbreviations

APSRG	Associate Parliamentary Sustainable Resource Group
AQSIQ	General Administration of Quality Supervision, Inspection and Quarantine
BIS	Department for Business, Innovation and Skills
BMU	Bundesministerium für Umwelt [Federal Environment Ministry]
CREED	Collaborative Research in the Economics of Environment and Development
CRISIL	Credit Rating Information Services of India Limited
DEFRA	Department for Environment, Food & Rural Affairs
EEA	European Environment Agency
EIA	Environmental Investigation Agency
EU	European Union
GDP	gross domestic product
ISO	International Organization for Standardization
JETRO	Japan External Trade Organization
LAPFF	Local Authority Pension Fund Forum
Mt	million tonnes
PET	polyethylene terephthalate
UK	United Kingdom
UN	United Nations
US	United States
VAT	value added tax
WRAP	Waste & Resources Action Programme

Abstract

This Evidence Report investigates how China's rise as a global recycling hub affects other countries' prospects for moving towards a circular economy. This question has received little, if any, attention in the burgeoning literature on sustainability. There is substantial literature on global resource depletion, on the need to overcome the throwaway economy and on national and local attempts to move towards a circular economy. There is, however, little analysis of how the global trade in recycled materials, which is increasingly dominated by China, affects other countries' attempts to build a circular economy.

The report fills this gap by first showing that China's rise in importing waste and exporting new products feed on each other, thus underlining the well-known proposition that waste can be turned into a strategic resource. Second, it examines the implications for other countries by unpacking the effects. It distinguishes between effects that come from the sheer rise in quantity of China-bound trade in recycled materials and effects that come from China raising the quality standards for importing recycled materials. These effects are then examined for developed and developing countries of different types. This differentiated analysis shows that the prospects for building a circular economy can only be understood by incorporating the China-dominated global trade in the analysis. Riding on the growth of recycled materials, countries or regions can build circular domestic loops and create business and employment opportunities, but these are influenced by the configuration of their recycled material trade with China. These influences are not just economic. The constellation of actors seeking to promote – or slow down – transitions to a circular economy are also influenced by the trading opportunities with China. The report cannot trace all of these economic and political connections. Its purpose is to open up this topic, put forward propositions and indicate corridors for future research.

1 Introduction

China's rise as a manufacturing hub and exporter of manufactured goods is widely known and documented. From electronics to toys to solar panels, China is the global leader in multiple product categories and exports these products around the world. But what does it import from other countries? The largest import of China from the largest economy in the world, the United States (US), is scrap and waste (United Nations Statistics Division 2012). China is the world's largest importer of recyclable waste materials such as paper, plastic, steel and copper. The United Kingdom (UK) exports approximately 70 per cent of domestic plastic waste. Nearly 90 per cent of these exports end up in China. During the past decade, imports of recyclable waste materials from the UK by China have increased more than ten times (APSRG 2014).

There are both economic and environmental imperatives that drive this flow of recyclable waste materials to China. The economic imperatives stem from the lower cost of recyclable waste materials as compared to primary mining. It is well known that resources embedded in recyclable waste materials are much more economical and efficient to use in the production process as compared to primary mining. These recyclables can be used in the manufacturing process in China at a fraction of the cost of materials obtained through primary mining. The rapid expansion of the manufacturing sector in China has created the demand for raw materials, some of which can be efficiently met by the imports of recyclable waste materials. Another source of economic advantage stems from the Chinese dominance in global trade and exports of manufactured goods. The rise in Chinese exports has meant ever-more ships loaded to full capacity travelling to ports around the world. However, the ships returning to China, referred to as reverse haulage, are usually empty because most of the countries are net importers of goods in relation to China. The effect is that the shipping costs to China are substantially lower in comparison to the shipping costs from China (Velis 2014). For instance, in the case of the US, the shipping costs to China are one quarter of the shipping costs from China to the US (Minter 2013). In the market for recyclable waste materials, where prices are determined through international competitions between companies all around the world, the favourable prices for reverse haulage provide Chinese importers of recyclable waste materials significant advantages. In fact, reverse haulage is one of the critical reasons for the dominance of Chinese companies in the recyclable waste materials market as compared to competitors such as India.

At the same time, there are significant environmental imperatives for utilising recyclable waste materials. These imperatives are gaining salience with the growing awareness in China of the environmental damages caused by the rapidly expanding manufacturing sector. Over the past five years, there has been significant domestic pressure on the Chinese authorities to reduce environmental damages. A key indicator has been the rising number of protests by residents surrounding manufacturing hubs and mining areas. The environmental damages from the manufacturing sector stem from the backward linkages to the raw material sector. With an expansion in the manufacturing sector, the demand for raw materials has also expanded. By utilising recyclable waste materials, China has been able to reduce its dependence on domestic raw materials and the polluting mining sector. The second source of environmental damage stems from the effluents generated by the manufacturing industry.

From the perspective of the Chinese authorities, the rationale for facilitating the trade in recyclable waste materials is straightforward. Through such trading, China is securing the raw materials required to sustain its large and growing manufacturing sector. Along with facilitating trade in recyclable waste materials, the Chinese government is also creating an

enabling environment for domestic industries to make the transition to a circular economy. China's Circular Economy Law came into force in 2009 and the principles of a circular economy are now embedded in the official development goals (Government of China 2008).

Our discussion thus far is indicative of the trans-boundary implications of Chinese dominance in the secondary resource market. The trans-boundary implications emerge because of two reasons. The first consequence of Chinese dominance is that waste management systems globally are reliant on China for recycling their waste. This could create opportunities for collaboration between businesses involved in pre-processing the waste in their home country before it is exported to China for recycling. The second implication stems from the competitive advantages to Chinese businesses due to the enhanced access to cheaper raw material embedded in waste. Access to cheaper raw material enhances pressures on competing businesses in other countries. In sum, there are complex trans-boundary implications of the rise of China on countries around the world. These implications create opportunities for both collaboration and competition between businesses in both developed and emerging markets. Moreover, such possibilities for cooperation and competition are influenced by domestic policy initiatives in China and beyond.

In this report, we explore the impact of the rise of China as a global recycling hub on circular economy approaches in both developed (UK and Germany) and developing (India) countries. It is likely that this impact has changed and will change over time partly due to changes within China. We will therefore also seek to understand the (evolving) organisation of the circular economy within China, paying attention to the role of governments as well as businesses. We specifically ask the following question:

How does the rise of China as a global recycling hub affect the opportunities and barriers for the development of circular economy approaches in other countries?

We develop an analytical framework that extends models of circular economy across borders. We will use the framework to establish impacts of trade in recyclable waste materials across borders. Using this framework, we will investigate the impact of Chinese policies and the rise of Chinese businesses on the opportunities and barriers for the development of circular economy approaches in India, the UK and Germany.

The research is based on a secondary literature review and data available from the United Nations database on Commodity Trade (UN Statistics Division 2012). We bring several different strands of literature together to answer our research question. The insights from the literature on circular economy and waste management are used to extend the circular economy framework to include impacts across borders and the resulting implications for secondary resource policy. We draw on insights from literature on the Asian drivers as a framework for assessing this impact from China. This framework is then used to examine the impact on developed countries (UK and Germany) that are concerned about the rising exports of recyclable waste materials to China. We also use the framework to examine the impact on emerging economies such as India, who would not only like to secure raw materials for their expanding manufacturing industry but also compete with China as a destination for recyclable waste materials for their recycling industry.

The value added of this report lies in bringing together disparate materials and ideas. There is some literature on the recycling industry in China but it is largely descriptive. There is some analytical material on the circular economy but it is underdeveloped with regard to cross-border dimensions. There is some material on the application of circular economy ideas in countries such as Germany, the UK and India, but there is little systematic analysis of how the China connection affects the functioning of the circular economy in these countries. This report investigates how China's rise as a global recycling hub affects other

countries' prospects for moving towards a circular economy. This question has received little, if any, attention in the burgeoning literature on sustainability. There is substantial literature on global resource depletion, on the need to overcome the throwaway economy and on national and local attempts to move towards a circular economy. There is, however, little analysis of how the global trade in recycled materials, which is increasingly dominated by China, affects other countries' attempts to build a circular economy.

The report fills this gap by first showing that China's rise in importing waste and exporting new products feed on each other, thus underlining the well-known proposition that waste can be turned into a strategic resource. Second, it examines the implications for other countries by unpacking the effects. It distinguishes between effects that come from the sheer rise in quantity of China-bound trade in recycled materials and effects that come from China raising the quality standards for importing recycled materials. These effects are then examined for developed and developing countries of different types. This differentiated analysis shows that the prospects for building a circular economy can only be understood by incorporating the China-dominated global trade in the analysis. Riding on the growth of recycled materials, countries or regions can build circular domestic loops and create business and employment opportunities, but these are influenced by the configuration of their recycled material trade with China. These influences are not just economic. The constellation of actors seeking to promote – or slow down – transitions to a circular economy are also influenced by trading opportunities with China. The report cannot trace all of these economic and political connections. Its purpose is to open up this topic, put forward propositions and indicate corridors for future research.

In what follows, Section 2 establishes the links between domestic actions on circular economy and their potential impacts on trans-boundary movements of recyclable waste materials. We contend that closing the loop of material flows in a globalised economy is possible only across borders. Section 3 provides evidence on the rise of China as a global recycling hub. We focus on flows of two materials, paper and plastics, as they constitute nearly 45 per cent by weight of the waste generated in developed countries (the next largest flow is organic waste which does not have substantive trans-boundary flows) and are largely exported to developing and emerging markets. In Section 4, we develop the analytical framework for assessing the impact of China on the development of circular economy approaches in the UK, Germany and India, while Section 5 uses the analytical framework to assess the impact in the three cases. Section 6 concludes and proposes a future research agenda.

2 Closing the loop in an open system

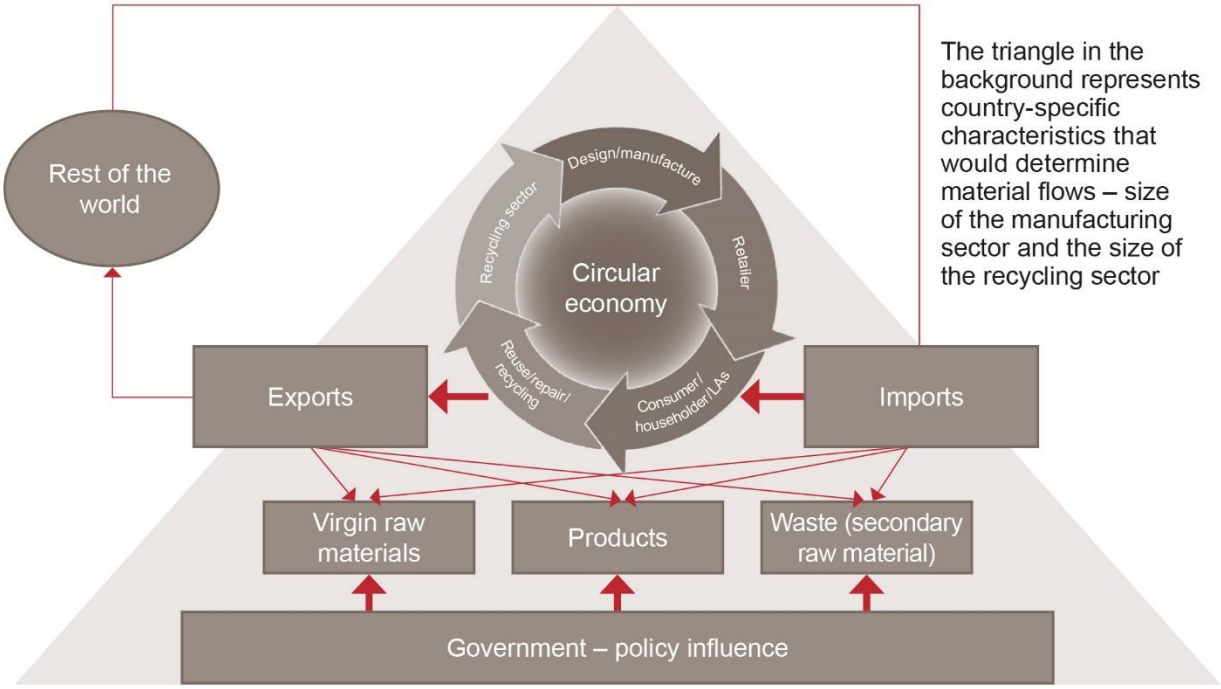
According to a joint report of the Ellen MacArthur Foundation and the World Economic Forum:

> A circular economy is an industrial system that is restorative or regenerative by intention and design. It replaces the end-of-life concept with restoration, shifts towards the use of renewable energy, eliminates the use of toxic chemicals, which impair reuse and return to the biosphere, and aims for the elimination of waste through the superior design of materials, products, systems and business models. (World Economic Forum 2014: 15)

A key element of circular economy is bringing resources embedded in products back into the production process through repair, reuse and recycling. The ultimate aim is to have a circular system that eliminates waste and brings the embedded resources and energy in end-of-life products back into production and consumption processes.

Circular economy approaches envisage a fundamental re-thinking of the current models of production and consumption. Overcoming traditional linear models of make-use-throw involves changes in the organisation of production and consumption systems at various levels – within a firm, within a cluster of firms, within a country and across borders. It has implications for the actors involved at these different levels, from the mining of raw materials, production of components, assembly of final products, consumption of the assembled products and disposal of post-consumption waste. Working through the implications becomes more complex once we take into account an increasingly globalised world in which products and services seamlessly cross national boundaries. Modern economies are characterised by large inflows and outflows of materials across national boundaries. Material flows – in the form of raw materials, products and waste – cross national boundaries through imports and exports. With increasing globalisation, these material flows have increased and become much more complex (World Economic Forum 2014). The increase is largely because of the rise in trade flows between countries. Production and value chains have become increasingly globalised with increased specialisation within and at different stages of the value chain. The flows have become much more complex because of the increasing complexity of products. Products now contain multiple raw materials and components that are sourced from countries around the world (World Economic Forum 2014). Due to these inflows and outflows of materials (embedded in raw materials, products and waste), modern economies are open systems in a material sense. Circular economy approaches are focused on closing the loop of these material flows. As modern economies are open systems in a material sense, closing the loop of material flows will necessarily need to happen across national borders. Figure 2.1 illustrates the cross-border dimensions of a circular economy.

Figure 2.1 Circular economy across borders



Source: Authors' own, based on WRAP (2015). Reproduced with permission from WRAP.
Note: LA: local authority

The cross-border closing of material cycles, depicted in Figure 2.1, has several implications. First, the figure shows that due to the imports and exports of virgin raw materials, products and waste, material cycles cannot be closed within national boundaries. Second, a country's ability to absorb recyclable waste materials depends on the size of the domestic recycling industry and the domestic manufacturing base.[1] The capacity of the domestic recycling industry would determine how much waste (domestically generated waste + imported waste) can be recycled within the country and how much would have to be exported. The size of the manufacturing sector would determine the demand for raw materials which can be recovered from recyclable waste materials. Third, the flows of raw materials, products and recyclable waste materials to and from any country are affected by government policies and standards. As virgin raw materials are relatively more expensive as compared to resources embedded in recyclable waste material, in our subsequent analysis we focus on government policies that influence trade in products and recyclable waste materials.

In order to unpack the cross-border effects of a circular economy, consider the following example. Imagine that a product is consumed in country A and is manufactured in country B using raw materials from country C. Table 2.1 summarises the potential impacts of circular economy policies in country A on countries B and C.

[1] The availability of raw materials within the country is not a determinant of the demand for recyclable waste materials because virgin mining is almost always more expensive as compared to recovering resources from recyclable waste materials.

Table 2.1 Potential impacts of material flows across borders due to adoption of circular economy approaches

	Country A (consumer)	Country B (manufacturer)	Country C (raw material supplier)
Maintenance	Reduced demand for new products Increased demand for maintenance/servicing	Reduced supply for new products Reduced demand for raw materials	Reduced supply of raw materials
Reuse	Reduced demand for new products Increased demand for services that promote reuse	Reduced demand for raw materials	Reduced supply of raw materials
Refurbish/ remanufacture	Reduced demand for new products Increased demand for refurbishment and remanufacturing	Reduced demand for raw materials Enhanced opportunities for developing refurbishment and remanufacturing	Reduced supply of raw materials
Recycle	Enhanced access to raw materials domestically – which can be exported back to country B or used in domestic industries	Additional potential source of raw material from country A	Reduced supply of raw materials

Table 2.1 suggests that the adoption of circular economy approaches in country A will have multiple implications for businesses operating in all three countries. The businesses in country C would be hit hardest because the demand for raw materials would decrease. The manufacturers in country B would also face reduced demand for new products. However, due to the prevalence of manufacturing capacities, adoption of circular economy approaches in country A would be associated with a restructuring within B from making new to refurbished products. In country A, the retailers of new products would suffer but there would be incentives to set up businesses for refurbishment, remanufacturing and recycling. In the short run, the reliance on country B's manufacturing capacity would continue and if country A is not able to restructure the manufacturing sector, the major gains from the adoption of circular economy approaches would be exported abroad to country B. This stylised example also indicates that from a global environmental perspective, there are enormous gains to be made by the adoption of circular economy approaches in country A. However, from a national economic point of view, there would be losses in country C while the distribution of the gains between A and B would depend on each country's ability to restructure its manufacturing sector.

The example above confirms that domestic policies directed towards closing the loop in an open system would have trans-boundary implications. In sum, we contend that in a globalised world, material flows can only be closed across national borders. The transformation from a linear model to a circular model would be impossible within national boundaries until a country decides to close itself from international flows of materials. As a corollary to the proposition, we suggest that national initiatives and policies on promoting the circular economy would necessarily have impacts across borders. Attempts at promoting

circular economy approaches within national boundaries would have impacts on circular economy approaches of trading partners. This insight is critical especially in the context of emerging national policy initiatives as well as the rising awareness of policymakers on the potential benefits of a circular economy. Armed with this insight, we now develop an analytical framework to examine the cross-border impacts of China on circular economy approaches in the UK, Germany and India.

3 Assessing the impact of China

In this section we provide an analytical framework to assess the impact of China on the globalised circular economy. The framework we propose draws from the Asian driver literature. The Asian driver literature has focused on the impact of the rise of China on opportunities and threats for the rest of the world. We use the categorisation of Asian drivers in Schmitz (2006) and adapt it to the context of a circular economy.

Asian driver 1: The first driver is concerned with changes in the sheer quantity of trade due to the rapid growth and competitiveness of China. In the context of recycling markets, the rise of China as the global production powerhouse has been critical for the creation of a domestic recycling industry. The recycling of waste from countries such as the US and UK has provided the much-needed raw materials for the expansion of the domestic manufacturing industry in China that is making products which are being sold globally. In fact, the rise of China as a global production powerhouse is the main factor that has enabled it to establish itself as the global leader in the recycling market. Rising production has created a rising demand for raw materials. Raw materials embedded in waste are much cheaper to mine in comparison to virgin mining from primary sources.[2] Paper and plastics, which constitute almost 45 per cent (by weight) of recyclables in developed countries, have contributed to the development of China as a recycling hub. Access to these recyclable waste materials has also enabled the development of Chinese industries that use plastics and paper as raw materials. In Section 4, we use data from the United Nations (UN) Comtrade to show how China has become the most favoured destination for waste paper and plastics. The impact of Asian driver 1 on the UK, Germany and India is analysed in Section 5.

At the same time, with rising per capita and disposable income, there is now increasing amounts of domestically generated waste within China. With time, this waste is rapidly overtaking the amount of imported waste from the rest of the world. Especially in the case of electrical and electronic products, domestically generated waste in China is much higher in comparison to the imported waste from the rest of the world. This second source of waste provides China with an additional avenue to sustain a globally competitive recycling industry, and also secures it from the vagaries of international flows of waste, thereby making its industrial sector more resilient.

Asian driver 2: The second driver is concerned with the governance of global value chains, especially through coordination of global value chains as well as the influencing of standards. While little information on the coordination of the global recycling chains is available in the secondary literature, the influence of China on global standards has been manifest recently through the implementation of the Green Fence in 2013. The Green Fence, announced by China in February 2013, stipulated the acceptable levels of contamination in shipments of waste. By raising its standards through reduced levels of contamination acceptable in international shipments of waste, China was able to wield significant influence on the global recycling industry. The impact of the Green Fence was felt in countries that relied on China for disposal of their waste. Shipments of waste from the US and UK were turned back because they violated the standards stipulated under the Green Fence. The ripple effects of the Green Fence were also felt in countries that are competing with China in the global market of waste. For instance, countries such as Indonesia and India benefited from the implementation of the Green Fence as they became favoured

[2] That they happen to be less environmentally damaging and provide many low-paying jobs is at best a co-benefit. At the same time, there is also a cost associated with unregulated recycling of these materials leading to substantial pollution in Chinese cities. However, these costs have to be evaluated against the costs associated with primary mining.

destinations for the shipments of waste that were turned back by China. The net effect of the Chinese Green Fence is difficult to establish because it was in force for a relatively short period of time. The fence was removed in November 2013 after being in force for just ten months. However, it provides a nice experiment for the analysis of potential impacts on both countries that are reliant on China for the disposal of their waste as well as on countries that might benefit from the rising standards of waste acceptable for recycling in China. In Section 5, we examine the impact of the Green Fence on the UK, Germany and India.

Asian driver 3: According to Schmitz (2006: 56), Asian driver 3 suggests that:

> *The accumulation of innovation capability in China, India and other Asian countries has ramifications for the rest of the world*. The hypotheses are first, the main losers are the developed countries. Second, the developing world will gain: new technology sourced from the East will be more accessible than technology from the West. Third, new *production* spaces will open up as the Asian drivers are devoting more attention to *innovation* activities.

There is limited secondary literature on innovation capacity in China and its impact on the developed countries that have been traditionally leading the development of innovations in the recycling sector. However, there are clear parallels to other industries where Chinese industries have benefited from interaction with their counterparts in the US and Europe and have adapted the technologies to suit their environment. Through joint ventures, Chinese companies now have access to the best available technologies from around the world. For instance, in 2012, a leading German company that is one of the world's largest recycling, environmental services and raw materials trading groups, ALBA Group, set up one of the largest automobile recycling plants in the world in China. In 2013, ALBA Group signed agreements with Chinese companies to implement projects under the broad ambit of a Sino-German cooperation initiative to set up a Metal Eco-City in Guangdong Province promoting the implementation of a circular economy in China.[3]

Experience from other sectors suggests that access to technologies from global lead firms through partnership agreements, supported by thriving domestic industrial capabilities, creates the conditions that enable the transition from a knowledge-using to a knowledge-creating industry in China. Such a transition is likely to benefit from the changing focus of the Chinese government through investments in promoting a circular economy. For instance, over the past decade, the Chinese government has taken multiple steps to promote the recycling industry by setting up eco-industrial parks focused on recycling. The Circular Economy Law that came into force in 2009 and the 12th Five-Year Plan focus on developing local capacities for closing the loop. Exploring Asian driver 3 in detail would, however, require primary research and in-depth interactions with Chinese and European businesses. This would indeed be an interesting area of future research. Due to lack of secondary sources in this area, we do not focus on Asian driver 3 but come back to it in the concluding section of the report where we outline a future agenda for research.

[3] A brief description of the Sino-German Metal Eco-City project is available at: http://china.ahk.de/market-info/investment-zones/sino-german-metal-eco-city/; a press release from ALBA is available at: www.alba.info/en/alba-group/press/press-information/press-releases/german-chinese-lighthouse-project-sino-german-metal-eco-city-alba-group-plans-construction-of-first-green-coal-plant-in-china-29032014.html (accessed 8 July 2015).

4 The rise of China as a global recycling hub

In order to assess the potential impact of China on circular economy approaches, in this section we establish the extent of China's dominance in the global market of recyclable waste materials using the framework of Asian drivers discussed above. Then in Section 5, we examine the effects on other countries.

We operationalise Asian driver 1 by focusing on the quantity of trade flows in recyclable waste paper and plastic and China's emergence as a leading destination of waste exports. For operationalising Asian driver 2, we focus on the quality of trade flows by analysis of the impact of the evolving standards for recycling in China, especially focusing on the Green Fence that was announced in February 2013.

4.1 Quantity of trade

Global waste trade is estimated to be worth *at least* US$1tn, and is rapidly growing (APSRG 2014), especially as competing raw materials become increasingly scarce and expensive. This trade involves virtually every country in the world, trading dozens of different types of scrap materials. Over the past two decades, though, China has risen to a dominant position in this global market. China's capacity and demand for materials in the form of recyclable waste materials is largely based on its position as a leading consumer of raw materials, and leading exporter of manufactured products. It should be obvious that countries whose industries most utilise a material, recycled or not, would have more demand for the material. Mikelis (2013), for example, notes that the biggest steel scrap importers in the world are among the biggest steel producers.

Accounting for trade flows to China is not straightforward. The flows are complicated by the fact that Hong Kong acts as an intermediary port of entry for much of the scrap entering China. In 2005, 99 per cent of re-exports from Hong Kong went to China (Yoshida and Kojima 2005a). Because of the Hong Kong relationship, calculations of waste imports and exports are not simple. We follow Velis (2014) in treating China and Hong Kong as one in calculations of imports using UN Comtrade data.

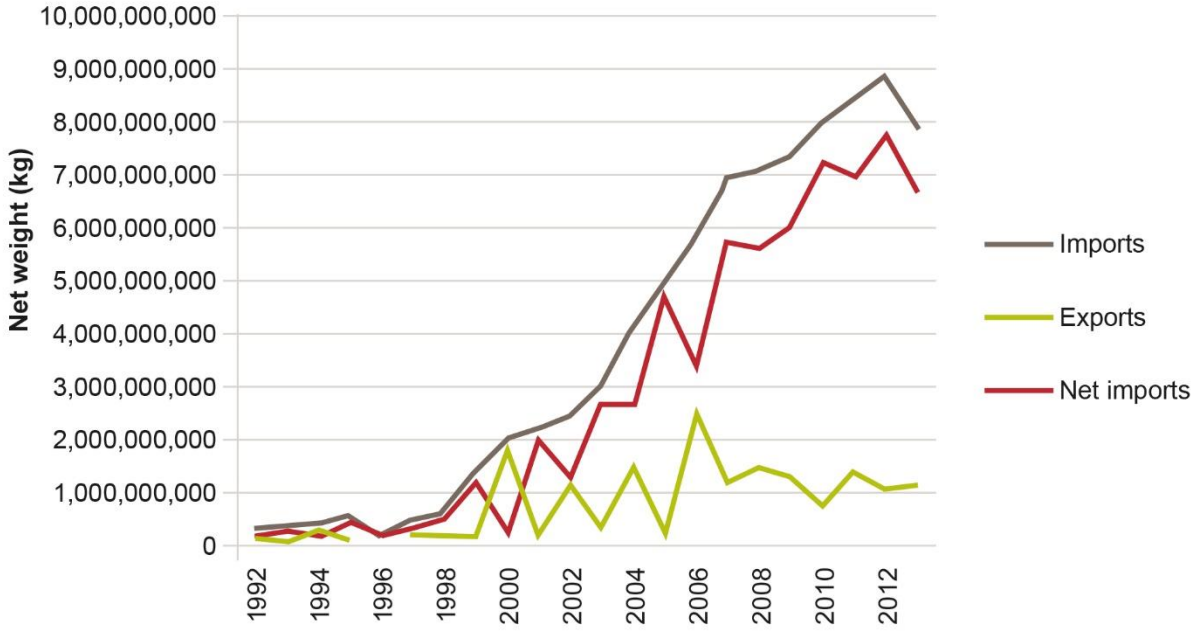
4.1.1 Plastic

Approximately 40 per cent of plastics production is now in Asia, with 20 per cent each in North America and Europe. Over the past decade, the majority of new plastic recycling facilities have been built in Asia and the Middle East (Velis 2014). China produces roughly a quarter of global plastics (Velis 2014), more than any other country. While Chinese economic growth has ranged from around 10 per cent per year since the 1990s (WRAP 2011), the plastics industry in China has grown at a rate of 15 per cent annually during the same time (CRISIL and Indian Centre for Plastics in the Environment 2006).

This rapid growth of the plastics industry has created a large demand for raw materials, and imported plastic waste has provided an additional source of raw materials. Globally, 56 per cent of the world's waste plastics exports go to China (by weight), and 87 per cent of exports from EU-27 countries go to China (contrasted with just 1.2 per cent of plastics products exported from the European Union (EU) going to China) (Velis 2014). Just in the period 2006–12, plastics imports to China rose from 5.9 million tonnes (Mt) to 8.9Mt (Velis 2014). The US remains the largest source of waste to China, making up 21 per cent, followed by Japan (18 per cent), Germany (12 per cent), the UK (9 per cent) and Thailand (2 per cent) (Velis 2014). However, an increasing number of Southeast Asian and African

countries are exporting plastic waste to China, most likely after pre-processing the material domestically.

Figure 4.1 China's trade in plastic scrap



Source: Authors' own, based on data from United Nations Statistics Division (2012).

According to UN Comtrade data, in 1993, China declared imports of scrap plastics from 37 countries with a value of US$87,545,769. In 2003, China imported a global total of US$774,509,827 from 81 countries, and mainly from Japan. In 2013, China imported a total of US$6,048,937,873 from 136 countries, and its imports from just one country – Japan – totalled more than its global imports ten years previous at US$857,416,662. This is a tenfold increase per decade (see Figure 4.1).

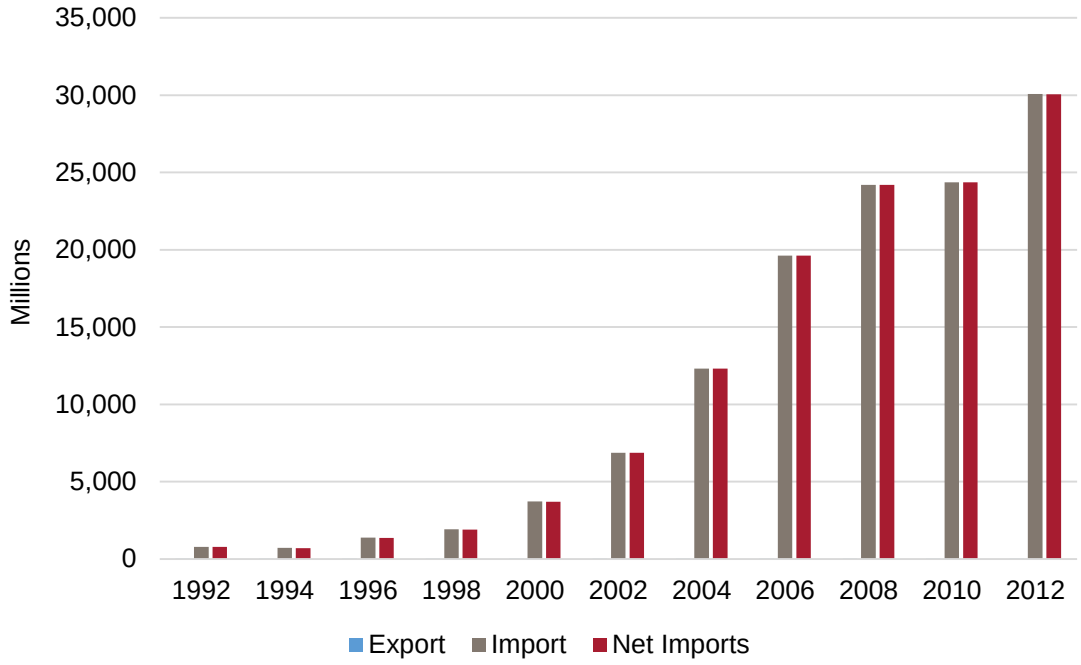
The Chinese government has given a high priority to the development of a domestic plastic industry. The 11th Five-Year Plan (2006–11) for China focused on the promotion of plastics over steel and wood (Meng and Yoshida 2012). The government encouraged plastic processing with subsidised land and energy costs, and created an enabling environment promoting the use of plastics in national industries such as construction (CRISIL and Indian Centre for Plastics in the Environment 2006). In 2008, the government introduced an obligation of 100 per cent of waste plastic use, and gave tax concessions of 10 per cent on value added tax (VAT) to companies achieving this target (Meng and Yoshida 2012). These tax concessions were combined with state-supported investments in the development of infrastructure and industrial parks focused on manufacturing and recycling plastics. For instance, Minter (2013) cites the example of Wen'an, south of Beijing, which has come to be what he describes as China's great plastic scrapyard.

4.1.2 Paper

China's exports of wood products have rapidly expanded in the past two decades, with furniture being the largest, followed by paper. In 2009, China overtook the US as the world's biggest producer of paperboard as well as the biggest importer of paper for recycling (WRAP 2011). In 2011, 62 per cent of paper and board production in China came from recycled sources, and just under half of this recovered material came from domestic sources (WRAP 2011).

Using the Comtrade data for the Harmonized System code 4707 ‘waste or scrap of paper or paperboard’, China has shown a dramatic increase in imports since 1992. In 1993, China reported import value of US$74,756,027. This grew to US$170,837,440 by 1998; US$1,231,243,197 in 2003; US$5,556,925,599 in 2008, and was US$5,930,237,692 in 2013. Over two decades, this growth represents an eightyfold increase.

Figure 4.2 China’s trade in paper scrap



Source: Authors’ own, based on data from United Nations Statistics Division (2012).

Figure 4.2 shows that the trade over the past ten years has increased fourfold in terms of the weight of material traded. While China continues to rely on recycled paper imports, this is slowing down. Paper consumption is on a larger downward trend in the developed world (WRAP 2011). However, paper consumption in China is increasing rapidly. In 2011, China and the US were using about the same amount of paper, but with a large gap in per capita consumption. At the same time, the recycling rate of paper in China has increased from 24 per cent in 2006 to 40 per cent in 2009 (WRAP 2011). If China continues increasing both domestic consumption and recovery, it could satisfy nearly three-quarters of demand from domestic materials by 2020 (WRAP 2011).

4.2 Quality of trade

In 2004, China imposed a ban on imports of plastic scrap from Japan because the waste consignment arriving at Chinese ports was contaminated with lower grade municipal solid waste. This was the first incident of China banning entry of waste originating from a particular country for environmental considerations. The main driver for the ban was, however, the domestic outrage at the environmental violations in the recycling industry within China. Yoshida (2005) interviewed recycling companies in China and found that they felt a direct hit from this ban, with some companies becoming unprofitable. Japan also suffered; in 2003, some 300 companies exported waste to China, with a turnover of yen ¥30bn. Some in Japan are arguing to ban exports of plastics to China now, in order to maintain materials within the Japanese economy (Velis 2014). Would such a ban have a similar impact on China today? China’s increasing regulation on imports of plastics seems to indicate that it holds more power in the market than it did a decade ago.

Regulation on import of waste is not new to China. It became evident in the 1990s that a large proportion of recyclable waste materials imported into China were in fact not recyclable and contributed significantly to environmental and human health hazards (Yoshida 2013). As a result, there have been significant developments over the past two decades on regulating imports of waste. Table 4.1 shows a timeline of Chinese regulations on trans-boundary movements of recyclable waste materials.

Table 4.1 Chinese regulation regarding reclaimed materials imports

1991	'Notice of Strict Regulations Governing Transboundary Movements of Hazardous Waste Destined for China'.
1993–96	China sent back several ships of contaminated waste (Yoshida 2005).
1994	'Interim Regulation Concerning the Strict Control of Waste Imports from the European Commission'.
1995	'Law on the Prevention and Control of Environmental Pollution by Solid Waste'.
1996	'Interim Provision on the Administration of Environmental Protection in the Importation of Waste Materials'.
	China imports 639 tonnes of medical waste labelled as paper, from the US. The Chinese government temporarily banned imports for recycling (Yoshida and Kojima 2005a).
	The above move inspired the creation of the business lobby group the Hong Kong Plastics Recycling Association; imports were allowed again, with regulation. China enacted the Law of the People's Republic of China on the Prevention and Control of Environmental Pollution by Solid Waste. Since that time, China has also had an import licensing system which requires pre-shipping inspections with issued guidance (Yoshida 2005). Under this solid waste law, any import or transport of hazardous waste is illegal.
2003	China gave a two-year prison sentence to a captain who imported an illegal shipment of 1,000 used monitors. This was the first such prison sentence (Meng and Yoshida 2012).
	The Chinese government promulgated the 'Temporary Registration Measure for Overseas Companies Exporting Recyclable Wastes to Mainland China' (AQSIQ Announcement No.115 – this was designed to screen out the companies that had sent substandard shipments. They looked for something like ISO 14000 status, but also they weeded out small-scale exporters (Yoshida 2005).
2004	Ban on Japanese exports of recyclable materials. This was in response to an import of 6,000 tonnes of plastic scrap of which 4,000 tonnes was contaminated municipal solid waste (this was one of many documented cases where a thin layer of reported material was placed over a larger amount of another waste product) (Yoshida 2005).
2005	The solid waste law was amended to include a responsibility for the shipper if the country of origin could not be identified (Yoshida 2005).
2008	China banned imports of certain types of plastics (WRAP 2011).

(Cont'd.)

Table 4.1 (Cont'd.)

2009	Increased requirements under the General Administration of Quality Supervision Inspection and Quarantine (the certificate that allows someone to sell scrap materials to China) (WRAP 2011).
	China announced the Circular Economy Promotion Law of the People's Republic of China (Meng and Yoshida 2012).
2010	China lifted the ban on import of polyethylene terephthalate (PET) plastic bottles (Meng and Yoshida 2012).
2011	China removed its standing VAT rebate for domestically reclaimed paper and plastics, which affected the costs of internal demand and drove demand for exports (WRAP 2011).

Note: AQSIQ: The General Administration of Quality Supervision, Inspection and Quarantine.

4.2.1 Operation Green Fence

From February to November 2013, Chinese customs officials enforced the campaign 'Operation Green Fence', which was aimed at decreasing the quantity of contaminated recyclable material entering the country. However, the levels of contamination stipulated under the Green Fence were already in force in China as early as 2009 (Velis 2014). It should also be noted that this was also in step with other national laws; for example, the enforced amount for contamination was the same as the standards set by the UK government for export quality (APSRG 2014). More than 0.8Mt of illegal waste shipments were stopped in the first five months (Velis 2014). Containers were returned to countries of origin at high costs. The impact on exporting countries included: more strict export inspections, stockpiling of materials, local processing, and exporting to other countries.

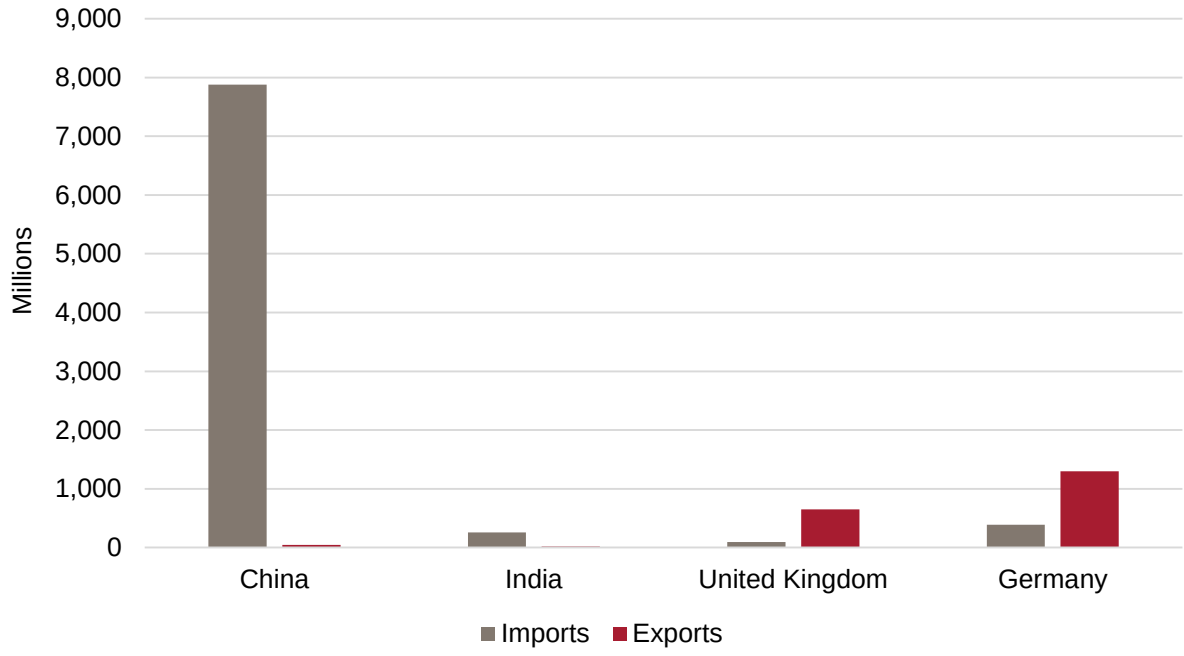
China's Green Fence had an impact not only on plastic trade, but on the types and qualities of wastes traded. According to a report prepared for the American Chemistry Council (Moore Recycling Associates 2013), the Green Fence had the impact in America of reducing the recycling of lower grades of plastic films by £77m. However, during the same period, the recycling of higher grades of plastic films increased by £190m. This clearly reflects China's increased discernment regarding the grades of plastic films it would import. With limited alternatives, the US continued to export the higher grade plastics and was forced to explore alternative markets for those grades that China would no longer absorb.

5 Effects on other countries

Global trade in recyclable waste materials is a massive industry and involves players in virtually every country in the world. China has risen to dominate this market. Below is an attempt to examine the relationships that three different countries have with China in terms of plastic and paper scrap trade, including how their trade flows with China affect their prospects of developing circular economy approaches domestically. The three countries are the UK, Germany and India. Germany and the UK are both developed EU countries, with more stringent domestic environmental regulations. Germany has a larger manufacturing base as compared to the UK, however, and has a more mature recycling industry. India is a rapidly developing economy but relatively small in comparison to China, both in terms of the size of its manufacturing base as well as the scale of its recycling infrastructure.

Figure 5.1 shows the stark difference between the trade volumes across the four countries. China is by far the largest importer of plastic scrap. It is interesting to note that it exports very little of its plastic scrap abroad suggesting the capabilities of the domestic industry to absorb domestically generated scrap. Both Germany and the UK are net exporters of plastic scrap. India, in contrast, is a net importer of plastic scrap but its trade volumes are much smaller than China.

Figure 5.1 Trade in plastic scrap



Source: Authors' own, based on data from United Nations Statistics Division (2012).

Both Germany and the UK send the vast majority of their plastic scrap exports to China. However, their share in China's overall imports is relatively small. As a result, their dependence on the Chinese market is disproportionately larger than Chinese dependence on their recyclable waste materials.

The UK, Germany and India are all in a similar position with China in terms of trade in paper waste as they are in plastics. However, the paper market has a different dynamic in

comparison to the plastics market. This different dynamic is due to the continuously declining demand for paper in the developed economies, the rising quality of paper being manufactured in countries such as India, and the increasing ability of China to reclaim a larger share of its rising domestic material stream. As a result, Chinese dominance is not as absolute in the recyclable waste paper market when compared to the waste plastic market.

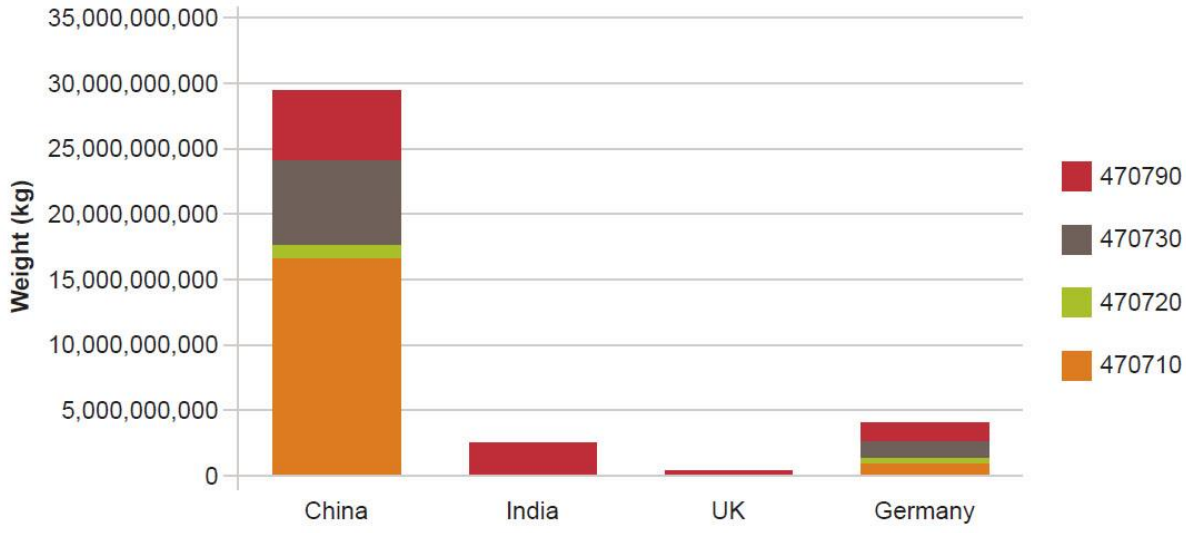
The data on trade flows confirm this difference. We use data from UN Comtrade on 'recovered (waste and scrap) paper or paperboard'. Under this code, there are four subcodes:

- 470710: unbleached kraft paper or paperboard or corrugated paper or paperboard
- 470720: other paper or paperboard made mainly of bleached chemical pulp, not coloured in the mass
- 470730: paper or paperboard made mainly of mechanical pulp (for example, newspapers, journals and similar printed matter)
- 470790: other, including unsorted waste and scrap.

It is evident from Figure 5.2 that China's trading volumes are much larger in comparison to the other three countries. Also, note in Figure 5.3 that both China and India exported scrap paper during 2013, but the amount does not appear on this scale. Further, India imported waste of each type, but it does not appear at this scale.

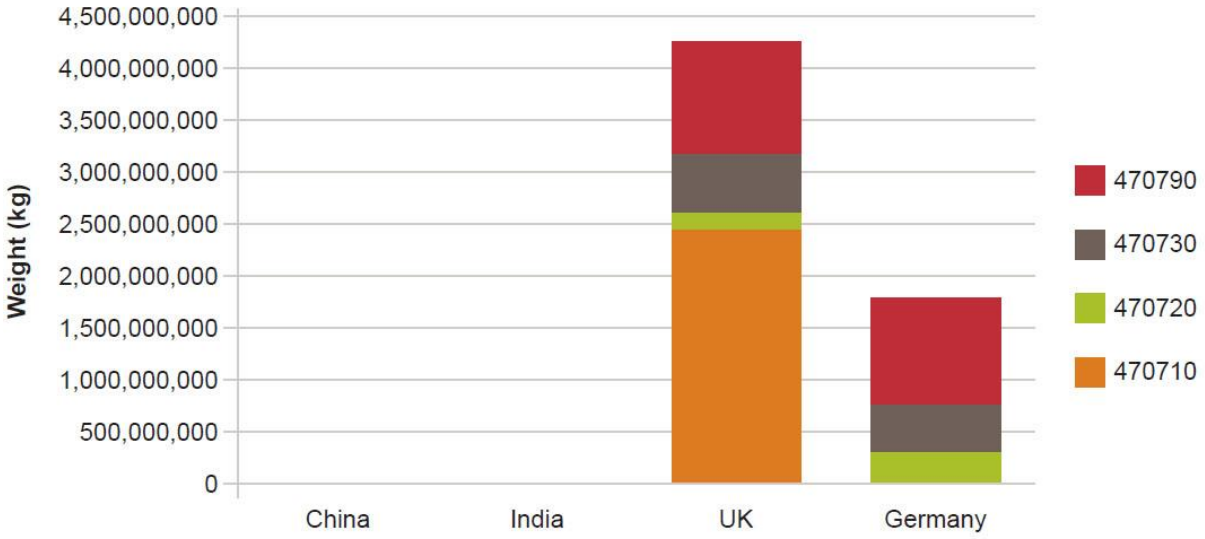
The disaggregation into the subcodes of the classification leads to other observations. The category 'unbleached kraft paper or paperboard or corrugated paper or paperboard' (code 470710) is a higher grade waste as compared to 'other, including unsorted waste and scrap' (code 470790). Figure 5.2 shows that China is already importing higher grades of recyclable waste paper as compared to India. It also shows that Germany exports relatively small amounts of the high-quality paper waste. In fact, it imports the relatively high grade of paper scrap from abroad to meet the domestic demand. At the same time, it exports a relatively low grade of material (code 470790) that ends up in China or India. We return to issues on quality competition when we examine the impact of China on the other three countries in the subsections below.

Figure 5.2 Imports – reclaimed paper by type, 2013



Source: Authors' own, based on data from United Nations Statistics Division (2012).

Figure 5.3 Exports – reclaimed paper by type, 2013



Source: Authors' own, based on data from United Nations Statistics Division (2012).

The above was an overview of the relative magnitude of the trade flows in plastic and paper scrap between China and the UK, Germany and India. We now turn to assess the impact of China on each of the three countries in turn. Each of the country cases is structured in the following manner: we first examine the impact of Asian driver 1, which is concerned with the production and market power of China, on the potential of developing circular economy approaches in each country. We then examine the impact of Asian driver 2, concerned with evolving environmental standards in China, on the development of circular economy approaches. While analysing the impact of Asian driver 2, we focus on the implementation of Operation Green Fence as a comparative event examining its differing impact on Germany, the UK and India. We end each case study with an assessment of how the impact of China is likely to evolve over time partly due to changes within China. This will also provide us with an enhanced understanding of the (evolving) organisation of the circular economy within China.

5.1 India

5.1.1 Quantity of trade effects

Like China, the demand for raw materials in India is expanding rapidly to meet the consumption needs of the growing middle class. China and India are both developing economies with increasing demands for raw materials, and have been shown to compete for raw materials, including recyclables such as metal scrap, for example (Rudolf 2010). India also aspires to expand its manufacturing sector, which has grown sluggishly over the past two decades. The most prominent example of this renewed focus on the manufacturing sector is the recent articulation by the Indian prime minister, Narendra Modi, of the Make in India campaign.

However, the speed and growth of the Chinese manufacturing sector has shrunk the operating space for Indian manufacturing. As a result of its manufacturing prowess, China has a distinct competitive edge over India in global markets for both finished products and raw materials. Manufacturing based on paper and plastics as primary raw materials are a case in point. China is the leading exporter of finished paper and plastic commodities all across the globe (UN Comtrade Database). For instance, China has a global monopoly in

plastic export whereas in the exports of paper products, China has the largest share and India is in a distant second position (UN Statistics Division 2012). Further, Chinese dominance in the market for finished products is the primary reason for its dominance in both paper and plastic scrap trade.

The processing of waste to meet the demands of the manufacturing sector has enabled the development of a thriving waste management industry in China. Although initially developed to transform imported waste into usable raw materials for the manufacturing sector, the expansion of the recycling industry has also meant that it can cater to the rising quantities of waste generated within China. We therefore contend that the rise of the Chinese manufacturing sector has triggered the development of a widespread and increasingly technologically advanced, recycling sector in China. The recycling sector is now a critical element driving the move from a throwaway to a circular economy.

Due to the dominance of Chinese businesses, Indian recycling companies interested in global trade in waste are unable to make inroads into the world's largest scrap markets – the US and the EU. They are less competitive as compared to China for the reasons described above – there is relatively less demand for the raw materials because the manufacturing sector is not as large. For instance, China's manufacturing sector contributes 32 per cent of the gross value added to the gross domestic product (GDP) while the Indian manufacturing sector contributes 15 per cent. As mentioned previously, Chinese businesses have a further advantage due to the differences in costs of reverse haulage. Minter (2013) gives examples of Indian businesses trying to enter the US market for scrap without much success because of these factors.

The overall impact of Asian driver 1 on the expansion of the recycling industry in India is negative. Due to China's dominant manufacturing sector and the consequent recycling infrastructure as well as reverse haulage prices, recycling businesses in India are constrained to expand existing operations or set up new businesses as compared to their Chinese counterparts. With rapidly depleting global supplies of virgin raw materials, China's example shows that sustainable models of rapid industrialisation would have to be based on developing circular economy approaches that aim to bring embedded resources in waste back into the manufacturing process.

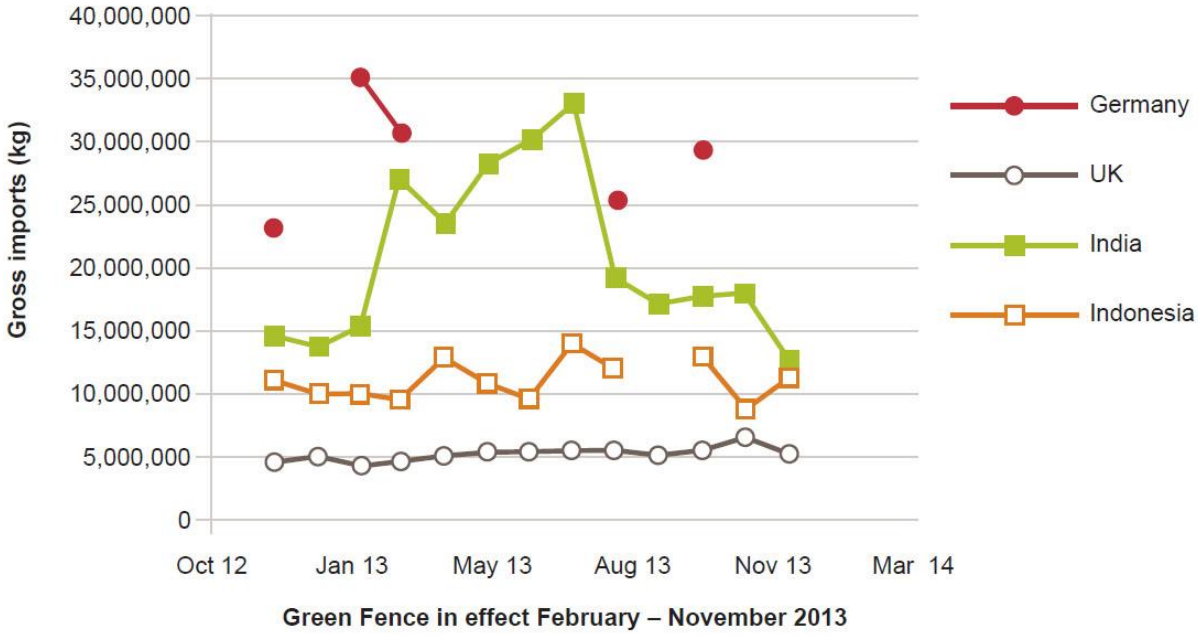
5.1.2 Quality of trade effects

With growing domestic and international pressures to promote environmental protection, China has announced a series of policy initiatives. The focus on sustainable development as a national development goal is largely driven by the rising awareness within China, as well as beyond, of the environmental damages caused by rapid industrialisation. Although the development of the recycling industry was driven by the need for raw materials for the expanding manufacturing sector, the co-benefits have been the development of the necessary building blocks for the transition to a circular economy in China. However, even within the recycling sector there have been significant environmental violations which are well documented. As a result, the Chinese government has taken steps to regulate trans-boundary movement of waste. As mentioned previously, the Green Fence is one such initiative. It provides us with a natural experiment to evaluate the impact of the changing environmental standards in China on access of recyclables to India. We use the implementation of the Green Fence as a proxy for assessing the impact of Asian driver 2.

Figure 5.4 shows India's plastic scrap imports during the Green Fence period. It appears that the Indian recycling industry was able to access substantially higher amounts of waste during the initial months of the implementation of the Green Fence. The spike in imports can also be confirmed through the rise in imports to India during the period of the Green Fence from countries such as the UK. The graph clearly shows that the Indian market is quite

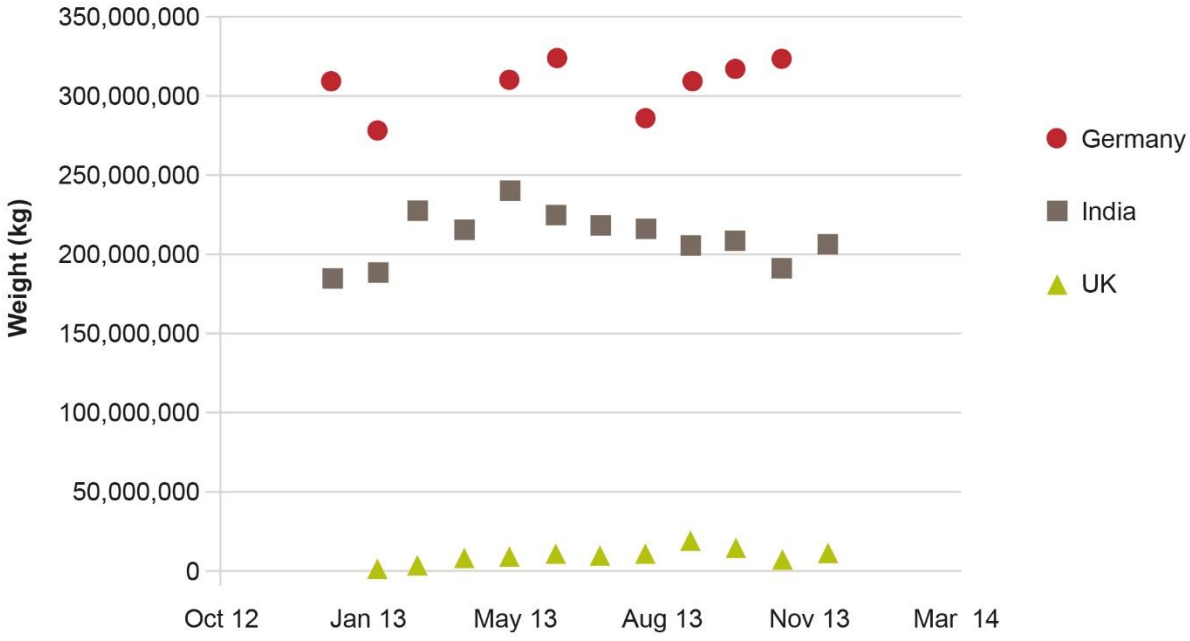
sensitive to the environmental standards in China and is a competing destination for waste from developed countries.

Figure 5.4 India's gross plastic scrap imports during the Green Fence period



Source: Authors' own, based on data from United Nations Statistics Division (2012).

Figure 5.5 India's imports of paper scrap during the Green Fence period



Source: Authors' own, based on data from United Nations Statistics Division (2012).

We observe a similar trend in the case of paper waste. Figure 5.5 shows the impact on India's imports of paper scrap during the implementation period of the Green Fence. The imports to India are higher during the Green Fence period. This trend is also confirmed through bilateral trade data. For instance, during the implementation of the Green Fence, the UK exports of paper waste to India increased by 40 per cent. However, as compared to plastic waste, the market for paper waste was less responsive and India's imports were not as drastically affected.

The enhanced access to waste during the Green Fence suggests that India is seen as a competing destination to China for exports of waste from the US and EU. With enhanced access to imports, our analysis is indicative of the fact that rising standards in China will divert the waste from China to other countries and Indian recycling businesses might benefit in the short run. This would imply that the overall impact of Asian driver 2 for the development of infrastructure that supports the transition to the circular economy in India would be positive.

However, the enhanced flow of recyclable waste materials to India during the Green Fence period also suggests that Indian businesses are willing to compromise on quality standards in order to access markets in the EU and US. For instance, in 2013, India's global average reported import price for plastic scrap was US$0.61/kg as compared to US$0.77/kg in China. Indian businesses paid less for the plastic waste they imported. This is another indication of the likely differential in quality of products which are being imported in China as compared to India.

The impact of rising environmental standards in China would provide enhanced access to recyclable waste materials by Indian businesses in the short run. However, with China's global dominance in the recycling sector and the resulting ability to influence global standards, a potential implication might be that India will have to compete with other developing markets for low-quality imports while China creates a niche in high-quality recyclables that are relatively less contaminated.

5.1.3 Evolution of China's impact over time

Our analysis suggests that the impact of Asian driver 1 on the development of a circular economy in India is negative while the impact of Asian driver 2 is a 'weak' positive. Recent developments in China provide certain opportunities for Indian businesses as they might lead to a relative reduction in Chinese production and market power as compared to India, thereby influencing Asian driver 1. The speed with which China has grown and been able to enhance the living standard of its large population has meant that the fraction of domestic waste is also rising rapidly. As a result, its reliance on international waste is declining and expected to decline further in the future. For several materials, China's demand may have peaked or be near peaking. The steel industry, for example, expects a slump in demand from China as it makes its first 'scrap cycle' – the end of life of domestically consumed appliances, cars and other products containing steel (Miller 2014). China is reaching a stage where domestic waste might be sufficient to meet the raw material demands of its domestic industry.

This observation gains further salience due to the recent announcements by the Chinese government to slow down the blistering pace of growth (to achieve a 'new normal'). With increasing availability of secondary resources domestically and the reduced demand due to deliberate attempts to slow down the growth of the manufacturing sector, Indian businesses might be able to capture some of the gains in the recycling sector. However, they would face competition from other developing economies in Asia as well as Africa, but India would have the advantages over them akin to China's advantages over India. The recent slowing down of the Chinese economy as well as the increasing share of domestic waste in China to feed

the requirements of the recycling industry implies that Indian companies are also likely to have access to the largest scrap generators – the US and EU. This provides the opportunity for developing the infrastructure that will enable the transition to a circular economy in India.

As a relative latecomer, India can learn from Chinese experience. The most prominent learning area would be policy formulation promoting the transition to a circular economy. The Chinese policy on circular economy is embedded in the overall industrial policy. The Circular Economy Promotion Law is embedded in the larger context of sustainable development within the national development goals. In India, policy initiatives related to a circular economy are being implemented in silos and industrial policy still has limited focus on closing the loop of material cycles. The recent emphasis on Clean India is another example where the focus is on narrow end-of-pipe solutions for managing waste rather than on systemic approaches like a circular economy. Such disjointed initiatives reflect limited coordination within policymaking in articulating an overall national goal on the transition from a linear to a circular economy. While this might be a reflection of the current priorities of the government, the Chinese experience would suggest that promoting the transition to a circular economy would require significant policy guidance from the government. This would require the development of a coordinated approach of promoting manufacturing and, at the same time, promoting development of infrastructure that facilitates the transition to a circular economy.

5.2 The UK

5.2.1 Quantity of trade effects

As mentioned above, the size of the manufacturing sector is a key factor influencing the development of circular economy approaches. The UK's manufacturing sector contributes 10 per cent of the gross value added to the GDP as compared to 32 per cent in China. China's rise as a global manufacturing hub has occurred at the same time as the relative decline of the UK's manufacturing power, especially in production for mass consumption goods. Paper and plastic are used as raw materials substantially for the production of such mass consumption goods. In the case of the UK, most of the demand for plastic and paper consumption is met by imports. China is one of the largest exporters of finished paper and plastic commodities to the UK (UN Statistics Division 2012). As compared to the Chinese plastic manufacturing sector, the British plastics sector is marginal (British Plastics Federation 2015).

This difference in consumption and production, as well as the relative size of the manufacturing sector in the two countries, has two implications. First, there is relatively little demand for raw materials in the domestic industry in the UK. As a result, the waste generated within the country cannot be absorbed by the local industry. According to 2014 data, the UK has the capacity to absorb all of the glass it recycles domestically. For other materials, including paper, plastics and metals, it can only absorb half of the domestically available recyclable waste (APSRG 2014). Second, as a consequence of the first implication, most of the recyclables are exported. Not surprisingly, China is a major destination for these recyclables.

The UK paper recycling industry is more mature in comparison to the plastic recycling industry (WRAP 2011). A market analysis conducted by WRAP in 2011 concluded that overall, the UK is much more reliant on China as an end market than China is on the UK as a supply market. In 2011, the UK was responsible for 11 per cent of China's paper imports (WRAP 2011). The UK recycles nearly 80 per cent of its paper, but half of that is exported, and 80 per cent of exports go to China (APSRG 2014). According to UN Comtrade data, in 2013, the UK exported 4,266,385,045kg of paper scrap, and imported 191,439,184kg; this is

up from 2012, where the UK exported 4,475,740,266kg and imported 143,211,090kg. The UK is by far a net exporter of its recyclable paper.

As a result of the gaps in the production and consumption of products, the recycling infrastructure in the UK is relatively less developed. In fact, even as late as 2001, almost 90 per cent of the waste in the UK was being landfilled (European Environment Agency 2013). However, there has been increasing pressure on the UK to promote recycling domestically. The EU imposed a target of 50 per cent material recycling on all member states, to be achieved by 2020. The UK response has been impressive. In an assessment by the EU in 2010, the UK had already reached a level of 43 per cent material recycling. However, the rapid rise in material recycling has been largely achieved through the export of recyclable waste materials to China. In the ten years leading to 2009, China's share of UK paper scrap exports rose from 10 per cent to more than 60 per cent; for plastic scrap, the figure reached 88 per cent (WRAP 2011).

The result of the lack of domestic demand for raw materials and the pressure of achieving the targets set by the EU has led to two kinds of infrastructure. The first kind, referred to as material recovery facilities, focuses largely on segregating high-quality recyclables which are then exported. As mentioned previously, for paper and plastics, China is the primary destination. The second kind of infrastructure, referred to as energy from waste, recovers energy from mixed household waste. However, due to the lack of raw material demand domestically, there are hardly any facilities in the UK that process waste paper and plastics into reusable raw materials. For such facilities, the UK is reliant on China and other export destinations.

A recent report highlights the potential foregone opportunities due to the export of recyclables from the UK (APSRG 2014). It is important to note, however, that there are clear limits to such opportunities unless there is a domestic demand for raw materials within the UK. As a result, the opportunities for transforming from a linear to a circular economy in the UK in the short run would be reliant to a substantial extent on China and other countries where raw material demand is expanding. In sum, the overall impact of Asian driver 1 on the development of a domestic circular loop is more difficult because domestic manufacturing capabilities are weak. China's rapidly expanding manufacturing sector provides an outlet in that recyclable material can be exported in significant quantities (instead of going to landfill or incinerators). As a result, there is a benefit for the planet. But China's dominance is also a problem because business opportunities that come from promoting a domestic circular economy are more difficult to achieve.

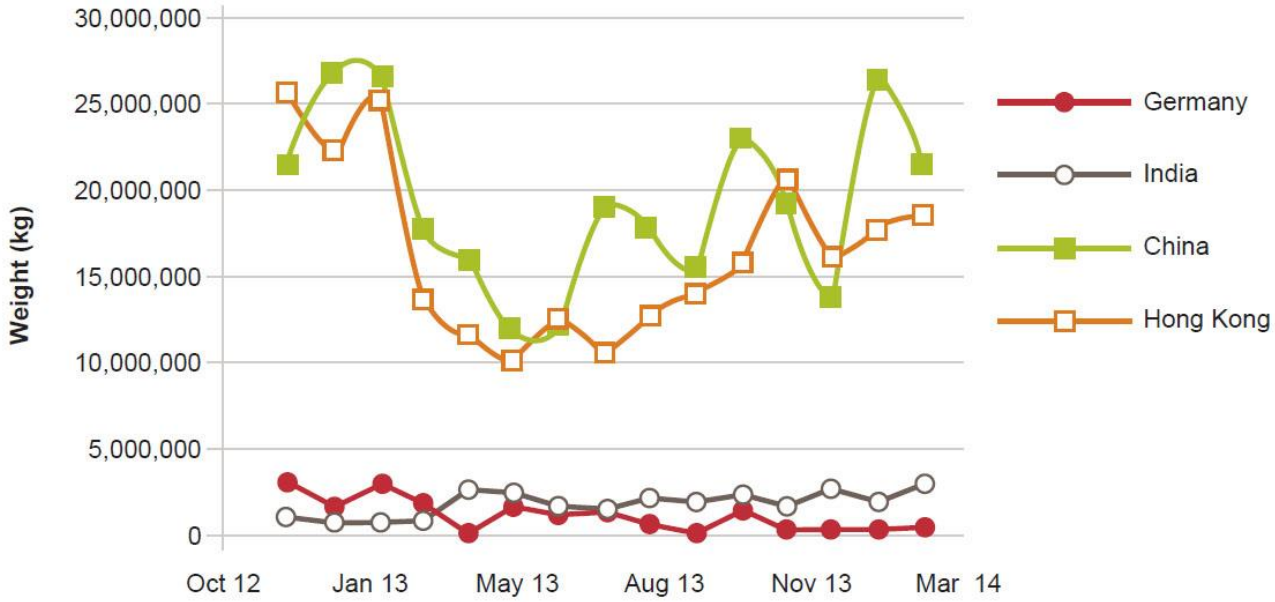
5.2.2 Quality of trade effects

Environmental standards and compliance norms for recycling infrastructure in China are still relatively weak as compared to the UK. The flow of waste from the UK to China is therefore viewed as an attempt by UK businesses and local governments to transfer their burden of waste management to China. Chinese businesses make substantial profits from this trade but at the same time cause widespread damage to the environment. With rising awareness of the resource value of waste in the UK and concerns about environmental pollution in China, there are increasing pressures in both countries to ensure that environmental standards are enhanced. The Green Fence was such a case. The impact on the UK was stark – shiploads of waste destined to China were stuck at ports in Hong Kong and China. Some of the shiploads were also turned back because they exceeded contamination levels. Plastic scrap exported to China from the UK dropped from 27,000 tonnes per month before Operation Green Fence to 17,000 tonnes per month during the operation (APSRG 2014). Due to the reliance on China and the lack of domestic infrastructure for recycling, during this time, exports increased to several other countries. Bangladesh and Vietnam, which both

held little trade with the UK in 2012, experienced a near tenfold increase in 2013. Indonesia and Thailand also experienced a surge.

British export standards for paper are the same as the Green Fence – 1.5 per cent contamination; however, shipments inspected during the Green Fence showed contamination levels of 11 per cent (APSRG 2014). In the first five months that the Green Fence was implemented, the UK declared an 8.5 per cent decrease in paper exports. At the same time, exports to Indonesia rose 4 per cent, and to India rose 40 per cent (APSRG 2014). It should be noted that these export figures were still substantially lower than exports to China.

Figure 5.6 UK gross exports (reported) of plastic scrap, by country, 2013



Source: Authors' own, based on data from United Nations Statistics Division (2012).

The Green Fence highlighted the vulnerability of the British recycling system to Chinese environmental standards and compliance norms. However, the flow of recyclables to other countries that did not impose contamination standards on the UK shipments shows that there is limited capacity to absorb domestic waste within the country. This would imply that the overall impact of Asian driver 2 would create the pressure for the development of domestic infrastructure that supports the transition to a circular economy in the UK.

5.2.3 Evolution of China's impact over time

Our analysis suggests that the impact of China on the development of circular economy approaches within the UK is negative due to Asian driver 1 and positive due to Asian driver 2. Given the emerging scenario in China, the net impact of the two drivers might create the conditions for expanding circular economy infrastructure in the UK. Such expansion would be due to three related factors. First, the demand for raw materials within the Chinese economy is likely to fall due to the declining rate of growth in China. This will have the impact of reduced demand for waste originating from abroad, including the UK. Second, due to rapidly expanding consumption and rising disposable incomes, there is increasing availability of domestic waste in China. This factor will also reduce the demand for waste originating from the UK. Third, due to enhanced pressures for enforcing stringent environmental standards the Chinese demand for waste from the UK would decrease in the short run. These factors, in conjunction with increasing awareness among citizens as well as

policymakers within the UK, are likely to support the development of infrastructure and business models that facilitate the transition to a circular economy within the UK.

However, there are certain barriers that need to be overcome because of the global nature of the circular economy. First, a rise in Chinese standards might imply that UK businesses are able to export the same waste to other countries that are willing to accept lower quality waste. This was observed during the implementation of the Green Fence and might continue in the short to medium term, diluting pressures to transform to a circular economy within the UK. A second implication could be that rising Chinese standards force UK businesses to adapt and reduce the level of contamination in shipments of waste being exported to China. This would enhance access to higher-quality recyclables in China and potentially increase revenues for companies exporting waste from the UK – a win-win for businesses in both countries. However, efforts to promote a domestic circular economy would be diluted and the UK's reliance on China would continue.

The role of policy is critical for the future development of a domestic circular economy in the UK. Policy instruments would influence the relative costs and benefits to the UK economy of promoting circular economy approaches domestically as compared to the present scenario where it depends on its exporting partners. Our analysis confirms that there are indeed opportunities for developing infrastructure and business models that promote a circular economy approach within the UK. However, there are limits to these opportunities because of the global nature of a circular economy.

5.3 Germany

5.3.1 Quantity of trade effects

The manufacturing sector in Germany contributes 20 per cent to the GDP as compared to 32 per cent in China (recall that the corresponding figures for India and the UK are 15 per cent and 10 per cent respectively). This implies that Germany still has a substantial demand for raw materials to meet the needs of its domestic industry. In order to meet the demands of the domestic industry, Germany has continued to import scrap plastics. For these imports, Germany and China increasingly compete in the international market. However, this competition is for high-quality plastics. China has some clear advantages in the market due to the relatively low cost of reverse haulage. For example, Furniss (2015) reports that Egyptian businesses export high-quality plastics to China even for a lower market price, because of shipping costs – it is cheaper to ship from Egypt to China than it is to ship from Egypt to Germany. At the same time, especially in the case of plastics, Germany relies on China to recycle its plastic scrap. Exports of plastics from Germany have been on the rise, especially to China. In 2010, German exports constituted 8.3 per cent of China's imports of plastic scrap. This suggests an interesting pattern in the Sino-German trading relationship of plastic scrap. Germany exports low grade plastic scrap to China but competes with China for higher grade plastic scrap to meet the domestic requirements of its industries.

A similar trend can be observed in the trading of scrap paper. Germany is in a similar position to the UK in that it exports a large proportion of its recyclable paper waste to China. However, Germany has a larger domestic paper recycling industry as compared to the UK. This provides an additional fall-back option to German businesses to recycle their domestic waste, especially in situations where Chinese authorities decide to change their standards, like they did during the Green Fence.

Germany has one of the most comprehensive raw materials strategies in the world (BMU 2012). Over the past three decades, Germany has also developed a series of policy measures that have created an enabling environment for the development of a recycling

culture and the necessary recycling infrastructure to meet the needs of the country. As a result, recycling rates in Germany are among the highest within the EU and the world. For instance, Germany recycles more than 65 per cent of the waste generated domestically (European Environment Agency 2013).

The impact of the rise of China and the growing demand for raw materials has provided an additional avenue for closing the loop to German businesses. Plastics and paper waste which would have otherwise been incinerated for energy recovery can now be exported to meet the demand for raw materials in China. China is therefore supporting closing the loop of material cycles in Germany in a much more comprehensive manner than before. Since the 1990s, the export of recyclables from Germany to China has expanded rapidly. For instance, in 2002, China was recycling 80 per cent of PET bottles that Germany collected for recycling (Yoshida and Kojima 2005b).

In sum, the rise of China has enabled Germany to close the loop of its material cycles more extensively by moving up the waste management hierarchy from incineration to material recovery. This is especially true for lower grade plastics and paper that still have an extensive market in China.

5.3.2 Quality of trade effects

As mentioned above, Germany relies on China for recycling certain fractions of its recyclables. As a result, the Green Fence had substantial impacts on Germany. Germany's plastic scrap exports declined during the Green Fence period. In contrast to the UK, however, Germany was able to process more plastic scrap domestically (Velis 2014). The case of paper scrap suggests that Germany might have benefited from the implementation of the Green Fence. During 2013, when the Green Fence was in place, Germany imported 100,000 tonnes more than compared to 2012. At the same time, exports also decreased by 300,000 tonnes. This suggests that German companies compete with Chinese companies for paper scrap. Due to a robust domestic recycling industry which is more resilient to external shocks, Germany was better able to deal with the challenge posed by the Green Fence as compared to the UK.

The overall impact of Asian driver 2 therefore would be to weaken the closing of material cycles between Germany and China. The rationale is as follows. Due to rising standards in China, the domestic waste management sector in Germany would become more competitive and would have greater access to domestic waste. However, due to the higher costs associated with recycling (recovering energy) as compared to waste incineration (recovering energy), as well as the excess capacity of incinerators in Germany, it is likely that the overall impact of Asian driver 2 would lead to more energy recovery than material recovery from waste. This outcome, however, would be environmentally inferior in comparison to the outcome when the waste from Germany is recycled in China because material recycling ranks above incineration in the waste management hierarchy.

5.3.3 Evolution of China's impact over time

Our analysis suggests that while Asian driver 1 has a positive impact on the promotion of circular economy approaches in Germany, Asian driver 2 has the opposite impact. The overall impact of Asian drivers 1 and 2 is likely to promote energy recovery (incineration) rather than material recovery (recycling) from waste in Germany. However, Germany might also find trading partners in other developing countries which compete with China for the lower grade recyclables, allowing it to maintain the level of recycling in the economy. In sum, the limited reliance on the Chinese recycling industry, a strong domestic manufacturing sector and the presence of a vibrant recycling economy within Germany as well as rising global demand for recyclables make the China effect negligible on circular economy approaches in Germany. Germany's performance during the implementation of the Green

Fence attests this assertion. Further, given the emerging scenario in China (reduced growth rates, focus on developing circular economy domestically within the broader agenda of sustainable development, and enhanced reliance on domestic waste), we believe that the marginal China effect on German circular economy approaches is likely to decline further.

6 Conclusion

The transition from a linear to a circular economy is a global challenge. This is confirmed by our analysis which suggests that in an increasingly globalised world, in which raw materials, products and waste cross national boundaries, circular economy approaches have to be implemented across borders. It is impossible for a country, open to trade with the rest of the world, to close material cycles within national boundaries following principles of a circular economy. Armed with this insight, we examine the effect of China as a global recycling hub. We find that China is playing a critical role in closing the loop at a global level by recycling the waste that is being generated in developed countries and by putting competitive pressures on countries which are at similar levels of development.

The speed and extent of China's rise as a global recycling hub, in the context of closing material cycles across boundaries, has several implications for the development of circular economy approaches. We examined the impact of China on India, the UK and Germany. We find that the development of circular economy approaches in India and the UK is significantly affected by China's rise as a global recycling hub. In contrast, circular economy approaches in Germany are largely unaffected by China's rise as a global recycling hub. Our analysis suggests that this difference is largely driven by domestic industrial characteristics, especially the presence of a substantive domestic manufacturing and recycling sector. This provides the economies' local demand for raw materials and the ability to transform waste into a raw material, thereby enhancing options for closing the loop domestically. Availability of such options is critical for the domestic industry to be resilient to international pressures and shocks. Our analysis also has implications for countries with manufacturing capacity in only a few sectors. The circular economy for these countries can be national in these sectors but in other sectors they can only contribute to a global circular economy.

The role of domestic industrial policy is critical in creating such options. In China and Germany, industrial policy and national development goals give a high priority to the transition from a linear to a circular economy. However, Germany is more advanced in comparison to China in the implementation of these policies. In the UK, there is an increasing realisation of the importance of transitioning to a circular economy, but the overarching policy framework and the necessary infrastructure to enable such a transition is still at a nascent stage. In India, the transformation from a linear to a circular economy is not high on policymakers' agendas. Elements of an overall policy framework exist (waste management laws, the Make in India and Clean India campaigns). However, implementation of these diverse initiatives in a coordinated manner with an overall vision to close material cycles is still not present. We therefore conclude that although circular economy approaches can be implemented across borders, domestic industrial policy wields significant influence and can ensure the development of resilient businesses and infrastructure. Our analysis also confirms that the external effects of China's rise as a global recycling hub are evolving due to changes within the Chinese political economy. The external effects of the decisions by the Chinese government evolve largely due to the evolution of domestic decisions. For instance, our analysis suggests that the decision to slow down its rate of growth as well as the gradual strengthening of environmental standards within China are likely to create additional business opportunities for Indian businesses in both the manufacturing and recycling sectors.

Our research is based on secondary literature and, as a result, has certain limitations. We have relied on our own extensive knowledge of the recycling industry as well as on published sources to assess the impact of China on circular economy approaches in the UK, India and Germany. A more detailed and nuanced understanding of the cooperation and

competition possibilities between businesses in these countries can only be established through primary research.

The transformation from a throwaway to a circular economy would require innovations in existing models of production, consumption and waste management. Also, significant innovations are needed to develop new business models. Historically, such innovations have occurred in Europe and the US. There is emerging literature and case material on such innovations in the EU and US. With China's dominant global position, the transformation to a circular economy across the globe is likely to depend on developing such innovation capabilities within China. However, little is known about innovation capacities among Chinese businesses. Anecdotal evidence exists but there is little by way of analytical research on these innovative capacities within China that would drive the transformation to a circular economy. We believe that this is an important area for future research.

We have focused on the impact of China in this report and have found significant differences in the impacts on Germany, the UK and India. The differences in the impacts were largely caused by the varying domestic circumstances measured by the level of domestic manufacturing, the presence of recycling infrastructure as well as industrial policy focused on closing material cycles. However, in this report, we do not explore the causes of the variations in domestic circumstances in each of these countries. We believe that a deeper understanding of such variations as well as the actors (and alliances) who drive them is critical for enabling transformations from a linear to a circular economy, and is a critical element of our future research agenda.

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