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Resource efficiency and the circular economy

Concepts, economic benefits, barriers, and policies

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Executive summary

Resource efficiency and the circular economy play an important role in environmental and economic policy. This paper defines these concepts and discusses potential economic benefits, barriers to achieving a resource efficient circular economy, and public policies for overcoming these barriers. Resource efficiency and the circular economy are normative concepts which suggest the maximization of wealth and wellbeing through increased material circulation and minimization of losses whilst staying within the limits of the natural environment.

An efficient use of resources benefits society and the economy in the long term by protecting the world we live in and reduces dependency on natural resources the economy depends on. Ecosystems provide society with food, materials, clean air and water, aesthetic and recreational pleasure and assimilate air emissions and wastes. Resource efficiency helps avoid depletion, degradation, or a collapse of ecosystems. It can also bring immediate economic benefits through reduced input costs and less dependence on volatile commodity prices.

Waste and resource management should aim for a sustainable yield of renewable resources, substitution of finite resources by renewable resources, and absolute limits to environmental impacts. A perfectly circular economy cannot exist due to limited availability of materials for circulation, growing or changing material demand, and inherent process losses. Circular use of materials requires energy and causes environmental impacts. A more efficient use of materials can also create a rebound when cost savings on raw material inputs lead to lower prices and increase consumption.

Evidence reviewed in this paper suggests increased resource efficiency can lead to private cost-savings and economic growth. However, these potential gains are likely to be unequally distributed across the economy: raw material exporting countries and the extraction industries are likely to suffer unless they adapt. Care should be taken when interpreting this evidence because the size and distribution of economic impacts depend on model design and assumptions. Circular economy jobs should address structural mismatch in order to lower unemployment.

Public policies to support a more resource efficient and circular economy should aim to address market, system, and transition failures. This requires strategic leadership, support for technological innovation, and specific measures to improve social outcomes. Public policy could stimulate resource efficiency by shaping waste management, the business environment, and education and training. Policy makers should consider the global impacts of production and consumption and the potential trade-offs between environmental and economic gains.

1. Introduction

Resource efficiency and the circular economy are increasingly influential concepts in environmental and economic policy. Resource efficiency is promoted by for example the United Nations (UN) and the Organization for Economic Co-operation and Development (OECD) (OECD 2004; UN 2017). The European Union (EU) launched the Roadmap to a Resource-efficient Europe (EC 2011) and the Circular Economy Action Plan (EC 2015). Several countries including Japan, Germany, and China have already implemented circular economy legislation (Bocken et al. 2017).

Policy interest in these two concepts is rising, driven in part by volatile commodity prices, accessibility of critical raw materials, concerns over climate change and environmental pollution, and a focus on jobs and growth (UNEP 2016). Much of the buzz is generated by coalitions of businesses, trade associations, charities, and think tanks. A prominent advocate of the circular economy is the UK-based Ellen MacArthur Foundation (EMF), a charity founded in 2010 which brings together governments, businesses, universities, and NGOs (Ellen MacArthur Foundation 2012).

Resource efficiency and the circular economy build on a long history of thinking about waste and resource management. Hardin's (1968) seminal paper *A tragedy of the Commons* theorised the overexploitation of common resources and Ayres & Kneese (1969) established the importance of materials in economic thinking. The Club of Rome report *Limits to Growth* (Meadows et al. 1972) showed population growth, industrialisation, and resource consumption are mutually reinforcing and result in rapid depletion of natural resources with potentially disastrous consequences for the population.

The 1980s saw the rise of more optimistic thinking on the relationship between environment and economy. The ideas of *Ecological Modernisation* hold that the economy benefits from greater environmental protection and resource conservation (Revell 2005). A prime example is the book *Factor Four Doubling wealth, Halving Resource use* by Von Weizsäcker, Lovins, & Lovins (1997) in which the authors maintain that economic growth and a reduction in resource use are possible through a shift in focus from labour productivity to resource productivity. They envision an economy with less resource use, higher employment, and greater economic output.

The purpose of this paper is to explore the role of public policy in resource efficiency and the circular economy. The paper does not seek to recommend or develop new policies. Instead, it presents key concepts and challenges related to resource efficiency and the circular economy. The following four questions are discussed in this paper.

- What are resource efficiency and the circular economy?
- What are their potential short term economic benefits?
- What are the barriers to achieving a resource efficient circular economy?
- What is the role of public policy in overcoming these barriers?

The questions are answered on an abstract and conceptual level based on the academic and grey literature and with insights from consultation with Defra officials and academics.

The paper is structured as follows. Chapter 2 reflects on different definitions and conceptualizations of resource efficiency and the circular economy. Chapter 3 discusses the potential short term economic benefits of resource efficiency and Chapter 4 deals with the barriers that may prevent a shift towards it. Chapter 5 discusses the role of public policy in stimulating a resource efficient circular economy. Chapter 6 concludes.

2. Resource efficiency and the circular economy

Resource efficiency and the circular economy focus on the economic and environmental significance of the extraction, conversion, use, and disposal of material resources. The emphasis may be on businesses, households, or national and local governance. This chapter discusses the similarities between different interpretations of the two concepts and identifies six core elements. It also identifies key principles for sustainable use of resources and discusses the practical limitations of a resource efficient circular economy.

2.1. Definition and elements

Resource efficiency is described by the European Commission as “improving economic performance while reducing pressure on natural resources through efficient use of them” (EC 2011). The UN defines it as “reducing the environmental impact from the consumption and production of products over their full life cycles by ensuring that natural resources are produced, processed, and consumed in a more sustainable way” and adds that “by producing more wellbeing with less material consumption, resource efficiency enhances the means to meet human needs while respecting the ecological carrying capacity of the earth” (UN 2010).

The circular economy is “restorative and regenerative by design, and aims to keep products, components, and materials at their highest utility and value at all times” (Ellen MacArthur Foundation 2016). It is opposed to the “linear economy” in which materials are quickly disposed. The EU action plan for the circular economy describes it as a system “where the value of products, materials, and resources is maintained in the economy for as long as possible, and the generation of waste is minimised”. It is considered essential to achieving a “sustainable, low carbon, resource efficient and competitive economy” (EC 2015).

The power of the two concepts is in their appeal to a range of audiences but different interpretations may be incommensurable. In particular, environmental and economic interpretations can be at odds, and some may focus on long term benefits whereas others are solely concerned with short term benefits. This working paper recognises the basic similarities between different perspectives and adopts a broad understanding of resource efficiency and the circular economy. It also reflects on the tensions between long term and short term benefits (Chapter 3) and environment-economic trade-offs (Section 5.3).

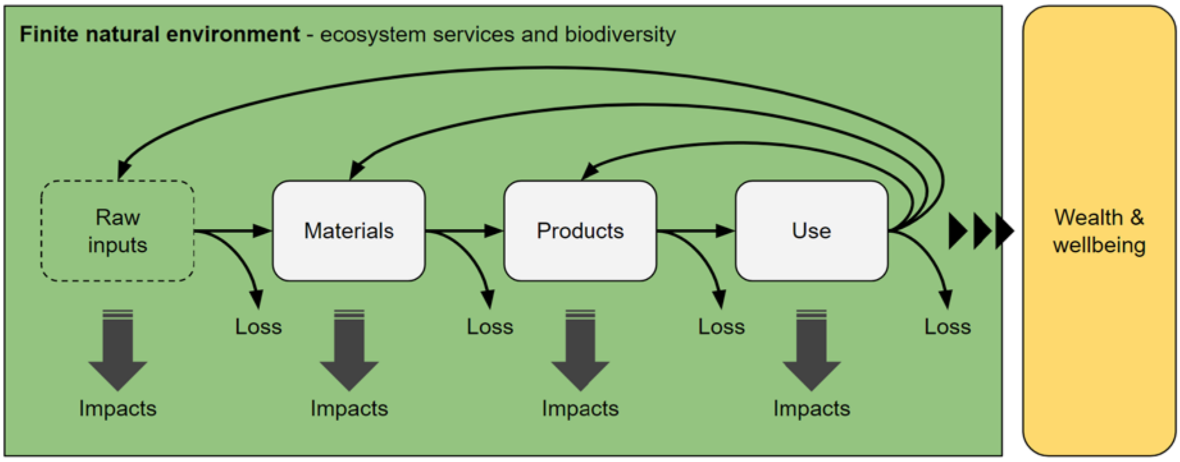

Figure 1 – Resource efficiency and the circular economy (Van Ewijk 2018).

Figure 1 visualizes the broadly agreed logic in a single diagram. At the core is the product life cycle in which raw inputs are converted into products that provide wealth and wellbeing to society. The diagram contains six important elements that are common to both resource efficiency and the circular economy.

- *Raw inputs* into the economy. These usually include raw materials and may also include land and water.
- *Wealth or wellbeing* are the results of the exploitation of natural resources, often measured through economic output metrics.
- *Environmental impacts* range from toxic air emissions and water pollution to forest degradation and climate change.
- *Finite natural environment* describes ecosystems and their limited capacity to deliver their services under increasing pressures.
- *Inefficiencies (losses)* occur between raw inputs and economic outputs across the value chain and lead to waste.
- *Loops* between inputs and outputs reflect circulation of materials back into the value chain or, for some organic materials, back to their origin instead of being lost as waste.

Resource efficiency and the circular economy are normative concepts that prescribe a reduction in the use of raw inputs through increased material circulation and minimization of losses. The concepts also suggest maximizing wealth and wellbeing but without exceeding the limits of the natural environment. Different interpretations of resource efficiency and the circular economy may categorized by which of the six elements above they emphasize. For example, some interpretations emphasize the impacts on wealth and do not explicitly cover environmental limits.

2.2. Principles and limitations

The resource efficient circular economy aims to respect the finite character of the natural environment through circulation and efficient use of materials. *Efficient* resource use implies the minimization of losses and *circular* resource use entails the return of used materials to an earlier stage in the same product life cycle or to another product life cycle. Resource management should adhere to the following basic principles of a resource efficient circular economy.

- Sustainable yield of renewable resources: harvest should not exceed the reproduction rate of resources such as timber and fish.
- Substitution of non-renewable resources: the loss of non-renewable stocks should be compensated for by growing renewable stocks.
- Absolute limits to impacts: throughputs and associated impacts cannot grow forever but need to respect ecosystem limitations.

Efficient use of resources and circulation of materials could help adhere to the above principles. For instance, the use of recycled material reduces the consumption of non-renewable resources and limits the problem of depletion.

The third principle requires total impacts to be limited at absolute levels to preserve regulatory and supporting functions of ecosystems. The actual acceptable levels are very difficult to assess. Steffen et al. (2015) formulated some limits for the global level with the planetary boundaries framework. However, absolute limits are also relevant at the local and regional level or at the level of biomes and basins. The desirable limits are not known for every level, nor is their regional distribution, nor are the precise implications for material flows and environmental impacts.

The three principles have an important implication: if wealth and wellbeing are to grow in the future, but the use of resources has to respect certain limits, it is necessary to *decouple* wealth creation from resource use and environmental impacts. Such decoupling can be relative (resource use or impacts grow slower than the economy) or absolute (resource use or impacts level off or decrease with continued economic growth). The desired strategy may depend on the type of resource. Given the uncertainties around the actual limits of the environment, a precautionary approach is recommended.

A perfectly circular economy with a 100% efficient use of materials cannot exist because of physical and practical limitations regarding the processing of materials (Van Ewijk 2018).

– Material circulation requires energy inputs and leads to environmental impacts. These impacts may sometimes exceed those of virgin production. In either case, the impacts of energy use should stay within environmental limits.
– Materials may be unavailable for recycling or reuse during an extended period of time. For example, steel in buildings cannot be used again for many years. Material demand can therefore not be met with secondary inputs only.
– For most products, demand grows with economic growth. Even perfect circulation of materials is insufficient to meet growing demand. Additional virgin extraction is required.
– Material circulation involves inherent processing losses. Materials may also lose quality or become contaminated. Even at stable demand, additional material inputs are needed.

- The supply of recycled inputs does not follow demand. Technological change or a lack thereof may direct preferences towards materials that are available only through virgin extraction.

These limitations imply that a narrow focus on recycling and processing efficiency is not sufficient to achieve sustainable yield, avoid depletion of non-renewable stocks, and respect absolute limits of the environment. Instead, it will be necessary to shift towards renewable materials and fuels which can be cycled indefinitely. Even then, it is not possible to escape the finite character of the natural environment: the production of renewable resources requires space of which only a limited amount is available.

3. Economic benefits of resource efficiency

A resource efficient circular economy benefits society by protecting the natural resources which support economic activity. Measures to increase resource efficiency and protect the environment may impede economic growth but many industries could actually reduce costs of production through more efficient use of their material inputs. These "win-win" opportunities may ease a transition towards a resource efficient circular economy. Such a transition will not benefit everybody: there may be winners and losers within the economy and within industries.

3.1. The "win-win" logic

To understand the "win-win" logic, it is important to distinguish between short and long term benefits of the resource efficient circular economy. In the long term, the entire economy can only benefit from safeguarding the natural resources it critically depends on. In the short term, business benefits of the circular economy derive from savings on material input costs: the more resource efficient a company is, the less it needs to pay for material inputs per unit of output. This increases productivity and competitiveness and reduces exposure to volatile resource prices.

Increased resource efficiency does not always save costs in the short term. Individual businesses may benefit from inefficiency, overexploitation, and pollution because they do not bear the environmental cost. It may be necessary to increase to cost of resource inputs in order to reduce their consumption. Such as shift in prices may make the economy more efficient overall through better allocation of the environmental costs of resource extraction and processing. The short term losses of inefficient businesses may be offset by the short term gains of other industries leading to aggregate economic growth.

Higher resource efficiency can benefit several companies at the same time. For instance, sparing use of fertilizer by farmers can reduce their input costs and also decrease treatment costs for water companies. Most importantly, extending the life cycle of materials enables more value creation. Reuse of materials can be beneficial for the company that generates the waste (for example from revenue from selling the waste and avoidance of landfill fees) and the company that uses the waste (if recycled substitutes have a lower cost than virgin inputs).

A study commissioned by Defra (Oakdene Hollins 2017) estimates the potential cost savings for UK businesses due to no or low cost opportunities related to energy efficiency, waste reduction, and water savings at £5.7-7.2 billion. The study provides only basic estimates for a limited number of sectors due to a lack of data. Dobbs et al. (2011) analyse more efficient use of energy, food, water, and materials at the global level and estimate 2.9 $trillion private sector savings. It should be noted that resource prices have declined since which implies a proportional reduction in savings.

3.2. Achieving growth

The macroeconomic impacts of resource efficiency depend on the complex interactions between companies, industries, and sectors. The main tool for understanding these dynamics is economy-wide modelling. Three widely cited modelling outcomes are discussed here, which illustrate the links between resource efficiency and economic growth. First, IEA (2012) assesses energy efficiency policies using a Computable General Equilibrium (CGE) model and finds a 0.4% percent point change in global GDP by 2035. Growth is distributed unevenly across the globe with energy exporters suffering from lower energy demand and lower prices.

Second, the Ellen MacArthur Foundation (2015a) presents the potential benefits of a circular economy in Europe based on another CGE model. The study includes savings in mobility, food, and the built environment and finds that GDP could grow by an additional 12 percentage points by 2050. In the model, growth is driven by technical change but the cost of achieving technological change is excluded. A complete assessment of the economic impacts requires incorporation of investment in research, training, and production technology.

Third, CE & BioIS (2014) use a macro-econometric model to assess the impacts of reducing raw material consumption in the EU28 through public investment, private investment, and tax reform. The results suggest that annual improvements of 2.0-2.5% in resource productivity can yield net positive impacts on GDP. Beyond this threshold the costs of resource efficiency measures do not outweigh the benefits. The impacts on GDP are much smaller or negative when environmental taxes are not reinvested in the economy. In other words, environmental tax reform (ETR) with tax revenue recycling is the main driver of growth.

In summary, modelling results suggest economy-wide benefits from resource efficiency. The findings should be carefully interpreted since the model design and assumptions reveal how growth really comes about. For example, a model that predicts economic growth through ETR does not show that resource efficiency has unequivocal positive impacts on the economy. The results only suggest positive consequences of ETR. In addition, sectoral structure and trade patterns affect the outcomes, with resource exporting countries, sectors, or companies often being worse off than importers.

3.3. Securing employment

The potential economy-wide growth through higher resource efficiency could increase employment. Of the three economic models discussed above, only the model by CE & BioIS (2014) provides an estimate of employment benefits. The results suggest that employment can be stimulated by using environmental tax revenues to reduce labour taxes. In a scenario with 2% annual resource productivity gains there are around two million additional jobs by 2030. The model does not specify in which professions, sectors, or regions these jobs will be created.

An important opportunity for the resource efficient circular economy is a shift towards labour-intensive service sectors. At the same time, jobs in resource-intensive sectors like mining may be lost. Such jobs are often concentrated in particular regions and require attention from policy makers. There may also be distributional consequences of resource efficiency policies. Environmental tax revenues could be used to address these shifts in the labour market, for example by funding education and training programs to help workers find new jobs (OECD 2017).

A detailed analysis of employment impacts of five case studies by Walz (2011) reveals how increased resource efficiency may affect employment. First, net job increases are more likely when stimulating value chains with relatively low import shares. A high export share could imply new jobs in for example product repair are exported too. Second, employment gains are generally the result of a shift towards sectors with high employment intensity. There are substantial shifts between sectors, often from the secondary to the tertiary sector, and readjustment may require education and training.

A report on circular economy jobs in the UK by Morgan & Mitchell (2015) suggests recycling, reuse, and remanufacturing largely involve jobs in occupations with the highest current unemployment rates and could therefore help address structural mismatch. Unemployment also varies by region and is highest in former industrial areas. It should be noted that “circular economy” jobs like recycling are often considered “dirty” work, shunned by local labour, and done by itinerant and migrant workers (Gregson et al. 2016).

4. Barriers to resource efficiency

The discussion of the potential economic benefits of resource efficiency raises an important question: if such potentials exist, why have they not been exploited? This chapter discusses three approaches for understanding the barriers to change, focusing on markets, systems, and transitions. The approaches have different theoretical foundations but can all be expressed in the common language of *failures.* Failures constitute a lack of or inappropriate conditions for either well-functioning markets, productive innovation systems, or a successful transition towards a new socio-economic regime.

4.1. Market failures

The literature on barriers to resource efficiency and the circular economy typically identifies a set of market failures that inhibit change (Ellen MacArthur Foundation 2015b; Oakdene Hollins 2011; Ecorys 2011; BioIS & Amec 2013). A market failure indicates a situation in which markets do not deliver an efficient outcome to society. For example, if the cost of environmental pollution is not incorporated in the price of a good, its consumption will be higher than optimal. The identification and correcting of market failures is premised on the idea that efficient markets deliver the best social outcome.

Most literature and reports on resource efficiency and the environment focus on market failures. The following failures are commonly cited as barriers to resource efficiency (Ellen MacArthur Foundation 2015b; Oakdene Hollins 2011; BioIS & Amec 2013; Ecorys 2011).

- Externalities: goods (positive externalities) or bads (negative externalities) are not priced. For example air pollution may not be priced because it is impractical to charge polluters for using the atmosphere as a sink.
- Imperfect information: market actors lack the information to make optimal decisions. An example is a lack of business information on where and how to obtain secondary inputs.
- Missing markets: a desired good is not supplied because of high transaction costs or a lack of confidence. An example is a lack of waste utilization because of searching cost and the lack of confidence in a steady future supply.
- Public goods: goods that are not privately supplied because of the challenges in charging consumers for their use. An example are natural carbon sinks such as forests that carbon emitters do not pay for.
- Split incentives: the incentives of different actors are misaligned because one actor receives the benefits of higher efficiency but the other actor bears the costs. This can occur in complex value chains.

The identification of market failures is a common approach to policy but has important limitations: even well-functioning markets are blind to long term societal goals and the economic transformation required to achieve them. Most major breakthroughs – such as aerospace or biotechnology – were achieved not by fixing market failures but through concerted long term government efforts, which included dedicated research funding and build-up of infrastructure. Such efforts can hardly be explained through market failures analysis only (Mazzucato 2015).

4.2. System failures

An alternative or complementary approach to the market failures perspective is provided by the innovation systems literature. Rather than focusing on the functioning of markets, this approach analyses how innovation and change comes about. It emphasises the *flows of information and technology between actors and institutions* in innovation processes (OECD 2008). Instead of reducing innovation to a matter of market (or government) failures, it focuses on the range of factors that influence innovation and includes both market and non-market actors as active contributors to change.

The systems perspective can be used to identify failures. The failures below partly overlap with market failures but also include distinct failures like the cultural norms and values of relevant actors (such as entrepreneurs and policy makers) and the level of interaction between them (Klein Woolthuis et al. 2005; Weber & Rohracher 2012; Jacobsson & Johnson 2000).

- Infrastructure: lack of for example waste collection and treatment infrastructure and information technology platforms that businesses require for the exchange of goods and information.
- Laws and regulations: failure of formal institutions includes regulatory barriers to resource efficiency and the wider legal environment that may impede for instance reuse of waste as a resource.
- Norms and values: actors' norms and values shape behaviour beyond what can be expected from direct incentives only. Traditions, routines, and culturally influenced practices may fail to adequately address emerging challenges.
- Interactions: the right level of interaction across the supply chain can prevent the perpetuation of current practices, stimulate higher efficiency, and the exchange of wastes as resources between companies (industrial symbiosis).
- Capabilities: actors may fail to respond to changing circumstances because they lack the knowledge, skills, or financial resources to change their ways of doing business and innovate their products.

Innovation systems can be identified at the national, regional, sectoral, or technological level. Technological innovation systems relate to individual technologies and national innovation systems describe an economy-wide capacity to foster any type of innovation. The innovation systems approach does not consider whether the overall direction of innovation is more or less environmentally desirable. For the purposes of this paper, it is necessary to not only understand the drivers of innovation but also the elements that steer innovation towards a resource efficient circular economy.

4.3. Transition failures

The transition perspective does just that by considering the overall direction of innovation. It emphasizes the role of *long term thinking*, *participation* of a wide range of actors, and *learning*. For example, the current linear economy – supported by vested interest and persistent routines – can be transformed by fostering alternative practices (e.g. sharing business models) in niche markets. These niche markets may be created and protected by strategic long term policy support. An incumbent regime is overturned when niche activities gain sufficient momentum to go mainstream (Geels 2002; Rotmans et al. 2001).

Transition failures go beyond system failures by judging a system for its capacity to innovate and change in a particular direction. A transition failure constitutes a lack of concerted efforts to guide innovation in a desired direction. The following transition failures can be formulated based on the literature (Weber & Rohracher 2012; Rotmans et al. 2001).

- Direction: a lack of a shared goal that steers a long term transition by inspiring and guiding policy makers and stakeholders. Intermediate objectives and targets support pathways towards the ultimate goal.
- Coordination: a failure to include and coordinate different actors, domains, and levels. Coordination is required between innovation policy and sectoral policy, between ministries and executive agencies, between different levels of government, and across time.
- Support: a lack of popular backing or market demand. A large system can only transition when there is sufficient support from stakeholders. New products and services must be stimulated through market demand.
- Learning: a lack of mechanisms to deal with uncertainty. Transition strategies should facilitate learning through experimentation and allow for adaptation of policies to changing circumstances.

Transitions should be seen at a long term time scale and may refer to the sectoral or economy-wide level. Examples of transitions are the shift from centralized fossil electricity supply to decentralized renewable electricity supply and from make-take-dispose consumption to product-service systems. These shifts involve fostering new technologies and practices (e.g. solar panels) and can be supported with public policy (e.g. feed-in tariffs). Such policy support requires long term thinking, participation of relevant actors, and constant evaluation and improvement (learning) of policy measures.

Failures analysis should be conducted with great attention for the linkages and overlaps between the different failures since policy problems usually result from multiple failures. Market, system, and transition failures analysis can be a useful tool to policy makers and overcoming all three types of failures will play an important role in achieving a resource efficient circular economy. The following chapter suggests how the three types of failures can be met and marries the potential responses in a single policy framework.

5. The role of public policy

The preceding chapters explained the concepts of resource efficiency and the circular economy, the potential short term economic benefits of pursuing them, and the market, system, and transition failures that inhibit change. This chapter builds on all these findings by presenting responses to the three types of failures and presenting an integrated policy framework that promotes a shift towards a resource efficient circular economy. The chapter also reflects on how public policy can balance the economic and environmental benefits of resource efficiency discussed in Chapter 2 and 3.

5.1. Policy responses

The role of public policy follows from the earlier identified barriers to resource efficiency. A narrow view limits public policy to addressing market failures. The innovation system perspective identifies public policies that may address system failures like norms and values. A transition perspective brings in a strategic role for public policy to guide innovation towards societally favourable outcomes. A transition strategy may include addressing market failures and strengthening innovation systems that support technologies consistent with resource efficiency and a circular economy.

Market failures are relatively clear-cut concepts for which a standard set of solutions exists. In practice though, such standard solutions may not work because of underlying more complex problems. One challenge with correcting market failures through public policy is the risk of introducing new distortions that also need correction. The following list indicates example policy responses to address the aforementioned types of market failures.

- Externalities – Cost internalization through pricing, trading of permits, or regulation of for example waste to landfill and air emissions.
- Imperfect information – Information supply through campaigns, product labels, and sharing platforms that support for example recycling.
- Missing markets – Ensuring supply of for instance waste as a resource through state involvement or incentives for the private sector
- Public goods – Government supply of these goods or regulation to ensure fair and sustainable use. Examples are regulation of fisheries and forestry.
- Split incentives – Correction of incentive structure to ensure for example waste reduction along the supply chain.

The role of public policy in addressing system failures is less clear than for the market failures approach. System failures should not be addressed in isolation but through a suite of interventions including those that address market failures. The following policy responses may be considered to deal with a set of system failures.

- Infrastructure – Public provision of infrastructures including support for IT platforms. An example infrastructure is a waste exchange.
- Laws and regulations – Regulatory reform to reduce unnecessary regulations and introduce supportive regulations. Examples are phasing out fossil fuel subsidies and supporting renewable electricity generation.
- Norms and values – Public debate on resource efficiency to gradually include all actors and build consensus. This shapes the environmental behaviour of firms, institutions, and consumers.
- Interactions –Stakeholder discussion platforms to support constructive collaboration and competition. The use of waste as resources, for example, depends on mutual trust between entrepreneurs.
- Capabilities – Provision of education, funds, and collaborative platforms to build knowledge and skills. Important skills are among others those needed for repair, recycling, remanufacturing, and eco-design.

Transition failures can be met through strategic coordination of the policy mix. Again, as for the systemic failures, none of the transition failures should be addressed in isolation. The following policy responses are worth considering.

- Directionality – Formulation of goals and intermediate targets. An example is the UK Climate Change Act which aims to reduce emissions up to 2050 by meeting intermediate carbon budgets.
- Coordination – Alignment of different policies across sectors and material life cycles. An example is the alignment of product regulation regarding recyclable content and waste infrastructure to collect recyclables.
- Learning – Inclusion of learning and adaptation opportunities to increase effectiveness of policies over time. Policies should be regularly evaluated and evolve with changing circumstances.

There are many overlaps and complementarities between the three perspectives, the associated failures, and the related policy solutions. The perspectives rely on different theoretical assumptions but also have important overlaps. The next section combines the three perspectives, the associated failures, and the responses to the failures, into a single policy framework.

5.2. Policy framework

Figure 2 shows a policy framework that marries the market, system, and transition perspectives and shows them in relation to the material life cycle in Figure 1. It displays three categories of policies which together address market failures and system failures. There are also some overlaps between the different categories.

- *Technology push policies* stimulate companies to offer more resource efficient materials and products. They address the market failures of externalities, public goods, and split incentives. They also address system failures regarding laws and regulations, company norms and values, and company capabilities.
- *Demand pull policies* stimulate market and industry demand for resource efficient materials and products. They address the market failure of imperfect information and address system failures of consumer norms and values, and consumer capabilities. They target demand for reuse, recovery, and recycling.
- *Context policies* do not directly affect companies but change the wider environment in which they operate. They address the market failures of missing markets and public goods. They also address system failures regarding infrastructure and the amount and type of interaction.

Transition failures are addressed at the level of strategic leadership. Strategic leadership coordinates the transition by imposing policy mixes that jointly steer the system in the desired direction.

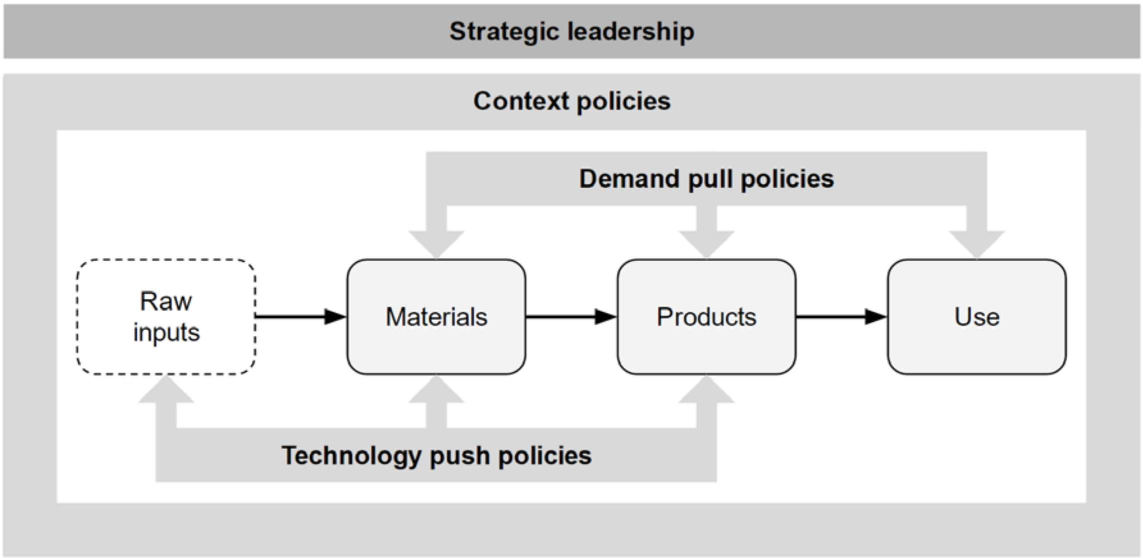

Figure 2 – Policy framework for a resource efficient circular economy.

Table 1 explains strategic leadership and shows examples of policy instruments. It distinguishes three roles of policies – push, pull, and context – and four types of policy instruments: regulatory, economic, information, and voluntary. Many of the regulatory policies in the table stem from European directives, as well as many product standards and labels, and waste and material flow data. There are some relevant economic instruments, including a resource tax (aggregates levy), a product tax (plastic bag levy), and a landfill tax. The UK pioneered a National Industrial Symbiosis Platform (NISP). Voluntary agreements such as the Courtauld commitment on food waste may act upon the entire value chain and could stimulate change through push, pull, and contextual mechanisms.

Table 1 – Push, pull, and context policies and strategic leadership.

	Push	Context	Pull
Strategic	Coordinated policy strategy to achieve a clear goal, guided by specific targets and with a policy process that enables learning		
Regulatory	Producer responsibility, Eco-design, permits	Waste frameworks, market regulation	Green public procurement
Economic	Public support of research & development	Fiscal reform, infrastructure provision	Product, resource, or waste taxes
Information	Waste exchanges, material flow data	Education system, collaborative projects	Product labelling, campaigns
Voluntary	Innovation and research partnerships, product design, and waste treatment agreements, discussion platforms		

The strategic level involves collaboration between environmental and economic policy departments and would require both vertical (political-bureaucratic) and horizontal (cross-departmental) agreement about the relevance of resource efficiency. Importantly, it needs a shared conception of the circular economy and resource efficiency that goes beyond the divide between the environmental and economic discourse in different departments. Coordination should rely on a shared goal, targets derived from the goal, and a strategy for meeting the targets. The policy process concerns the development, implementation and evaluation of a series of policies. The strategy as a whole also needs regular evaluation to enable learning.

5.3. Unintended consequences

A very challenging issue with resource efficiency and the circular economy concerns the trade-off between economic and environmental impacts. Not every strategy that looks good in terms of economics is also good for the environment. Ideally, public policy promotes resource efficiency developments that are good for growth, good for jobs, and reduce not only material consumption but also improves or protects environmental quality. But often a trade-off between environmental and economic benefits is inevitable.

There are two main challenges regarding trade-offs between the environment and the economy. First, economic resource savings may actually reduce environmental quality. For instance when a more efficient technology needs less material inputs but produces more hazardous waste. Second, there might be a rebound from more resource efficient production: cost reductions lead to lower prices and higher outputs, which boost demand. This is good for the economy but partly or wholly negates the original materials savings.

The rebound effect can be direct or indirect. The direct rebound entails consumers buying more of the same product because prices are lower. The indirect rebound refers to consumers using the money they saved on the more efficient product to buy other products which could be environmentally harmful. As a result, resource efficiency measures could increase instead of decrease total environmental impacts, even if impacts per unit of consumption go down. It depends on the product and the market context how strong the rebound effect is.

The rebound effect can be reduced by correcting prices through public policy. If prices reflected the harmfulness of the product, consumption (and ultimately production) would shift towards more environmentally benign products. In the absence of any price correction, the rebound can be lessened to some extent by targeting only the most harmful products through product regulations. If consumers were motivated to consumer fewer harmful products, through any kind of policy measure, and spend their money elsewhere, it would reduce environmental costs.

The short term profitability of business resource efficiency is dependent on resource prices. Unless harmful impacts are incorporated in prices, there are not likely to be many opportunities that constitute both a cost saving and a reduction in the environmental footprint. In the absence of externality pricing, both producers and consumers receive economic benefits from intensive use of cheap but harmful products: even a highly efficient and well-informed entrepreneur is best off using large quantities of relatively cheap fossil fuels when he does not pay for the environmental damage this causes.

Finally, an important consideration is the global character of the material life cycle. The UK imports many product and materials that have been mined or manufactured abroad. As a result, domestic material consumption (DMC) is declining but the material footprint – which includes all materials required to produce final goods – is increasing (Wiedmann et al. 2015). Policy makers should consider the entire life cycle of materials and include the global environmental and resource impacts of consumption in goal setting and policy making. This requires first of all developing and using better indicators.

6. Conclusions

This working paper discusses what resource efficiency and the circular economy are, what potential economic benefits they bring, what the barriers to change are, and what the role of public policy should be. Based on these four themes, this paper draws the following four conclusions.

- Resource efficiency and the circular economy are about generating more wealth and wellbeing using fewer natural resources whilst respecting the limits of the natural environment.
- Resource efficiency can increase productivity which could generate economic growth and increased employment. The potential for jobs and growth strongly depends on sectoral structure, trade, and employment patterns.
- Barriers to achieving resource efficiency range from market failures to inappropriate system conditions for innovation and a lack of guidance for an economy-wide transition towards higher resource efficiency.
- Public policy should go beyond the correction of market failures and should address system and transition failures. A policy mix for resource efficiency is strategically informed and considers push, pull, and context policies.

Finally, public policy for a resource efficient circular economy should consider trade-offs between economic and environmental benefits and take into account the global nature of the material life cycle and its environmental impacts.

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