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Sustainability, Resource Efficiency and Competitiveness.

An Assessment of Resource Efficiency Policies in the European Union

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Sustainability, Resource Efficiency and Competitiveness

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Abstract

Addressing high and volatile natural resource prices, uncertain supply prospects, reindustrialization attempts and environmental damages related to resource use, resource efficiency has evolved into a highly debated proposal among academia, policy makers, firms and international financial institutions (IFIs). In 2011, the European Union (EU) declared resource efficiency as one of its seven flagship initiatives in its *Europe 2020* strategy. This paper contributes to the discussions by assessing its key initiative, the *Roadmap to a Resource Efficient Europe* (EC 2011 571), following two streams of evaluation.

In a first step, resource efficiency is linked to two theoretical frameworks regarding sustainability, (i) the sustainability triangle (consisting of economic, social and ecological dimensions) and (ii) balanced sustainability (combining weak and strong sustainability). Subsequently, both sustainability frameworks are used to assess to which degree the Roadmap follows the concept of sustainability. It can be concluded that it partially respects the sustainability triangle as well as balanced sustainability, primarily lacking a social dimension.

In a second step, following Steger and Bleischwitz (2009), the impact of resource efficiency on competitiveness as advocated in the Roadmap is empirically evaluated. Using an Arellano–Bond dynamic panel data model reveals no robust impact of resource efficiency on competeveness in the EU between 2004 and 2009 – a puzzling result. Further empirical research and enhanced data availability are needed to better understand the impacts of resource efficiency on competitiveness on the macroeconomic, microeconomic and industry level. In that regard, strengthening the methodologies of resource indicators seem essential. Last but certainly not least, political will is required to achieve the transition of the EU-economy into a resource efficient future.

Keywords: *Sustainability · Resource Efficiency · Competitiveness · Dynamic panel data model · European Union.*

JEL classification: *Q38 · Q51 · Q56 · Q58 · C23.*

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1) Introduction

The European Union (EU) has experienced challenging years since the start of the financial crisis in 2008. The severe economic recession has spurred discussions concerning the EU's 'business model' and its *Limits to Growth* (Meadows 1972). This paper examines three key concepts in that regard: sustainability, resource efficiency and competitiveness. The mantra of sustainability[1] combines economic, social and environmental aspects and serves as an overreaching goal for policy makers. Numerous policy areas can be identified for fitting into the sustainability framework. This paper will have a closer look on resource efficiency policies in the EU. Policies concerning the efficient use of natural resources are often associated with an economic agenda aiming to increase the output of the economy. However, resource efficiency has also been recognised as an environmental policy given environmental impacts of resource usage and climate change mitigation targets. Thus, sustainability, resource efficiency and competitiveness are closely connected. The following simplified visualisation displays this relationship.

The background for resource efficiency policies are high and volatile natural resource prices, uncertain supply prospects, reindustrialization attempts, environmental damages related to resource use, a growing world population and the economic development of emerging economies. People consume more resources as they become richer: distributional scarcity and environmental impacts become a rising concern. Growing resource demand, however, is not only a phenomenon outside the EU. The average EU-citizen consumes 16 tonnes of material *per annum* while 6 tonnes are considered waste (EC 2011 571). Moreover, the EU has the highest net imports of resources per person worldwide accounting for 20% of material usage in the EU (SEC 2011, p.4) reflecting the EU's high dependency on resources from outside its borders. According to Meyer (2011) import penetration of total material requirements[2] is likely to increase. "By 2030 the import share will reach on average over all Member States 66.1%" (Meyer 2011, p.5).

[1] The concept of sustainability can be traced back to the symbiosis of *Aristotle's Trias* (Aristoteles 2006).

[2] Total material requirements (TMR) measure the primary material that is globally needed to satisfy domestic production and consumption, taking offshore production including unused extraction and imported intermediate products into account. The statistics on average consumption by EU citizens are based on a different indicator called domestic material consumption (DMC).

Driven by global interconnectedness of economic decisions and an amplified public awareness regarding the environment, the EU and its member states adopted several initiatives to approach the issue of resource efficiency. These initiatives are framed under the umbrella of national and European sustainability and growth strategies. To understand the scale of importance, approximately one third of energy and resource consumption could be saved through efficiency gains, as resource productivity[3] of land, water, energy and steel account for 50% of the gap between current greenhouse gas (GHG) emissions and the ambitious goal of limiting the temperature increase to 2°C (Berg 2011, p.9 and cfr. Jochem 2004, McKinsey Global Institute 2011, SEC 2011, p.9). Given the challenges described above, in 2011 the EU declared resource efficiency as one of its seven flagship initiatives in its *Europe 2020* strategy. One of the flagship's main objectives is to secure and gain competitiveness given that access to and affordability of certain resources has natural as well as geopolitical constraints. Reliable resource supply is essential for the EU-economy. However, environmental concerns are strongly connected with the use of resources as well.

Generally, there are three ways to deal with resources in a (environmentally) sustainable manner:

- Increasing resource efficiency thereby augmenting output per unit of input – (relative) decoupling (cfr. Ekins 2012, p.254)
- Substituting environmentally harmful resources with those of a lower environmental impact or sustainably produced renewable ones
- Lowering absolute resource usage – absolute decoupling or dematerialisation

Sustainability in the long run can only be achieved if solely renewable resources are used. However, this is only theoretically feasible, which suggests that resource efficiency can become an important element in reducing the environmental pressures from resource usage if there are no adequate substitutes available. This paper will mainly focus on the first option of increasing efficiency.

The remainder of this paper follows two steps.

Firstly, two theoretical concepts of sustainability and their link to resource efficiency will be introduced. These two theoretical concepts of sustainability will be used to assess the *Roadmap to a Resource Efficient Europe* (EC 2011 571; from now on abbreviated as 'the Roadmap'). The results will be formulated into policy recommendations including a discussion concerning the adequacy of how resource efficiency is measured.

[3] Resource productivity describes the efficiency of resource production (the ratio of output per unit of resource use), whereas resource intensity is the inverse of resource productivity. In order to aim towards sustainability, resource productivity needs to be maximised while resource intensity ought to be minimised (cfr. Ekins 2012, p.252-253). For further definitions concerning resource efficiency and resource productivity, please refer to OECD (2012, p.6).

Secondly, a quantitative analysis will evaluate the specific link between resource efficiency and competitiveness as being advocated by the European Commission in the Roadmap.

It is hypothesised that there is a positive relationship between resource efficiency and competitiveness. The analyses will conclude by putting the results into perspective and providing an outlook for future research on resource efficiency in the EU.

2) Sustainability and Resource Efficiency: A Theoretical Approach

This section briefly introduces two theoretical concepts of sustainability and connects these to resource efficiency. The aim is to outline the framework for assessing resource efficiency policies in the EU. The evaluation of the *Roadmap to a Resource Efficient Europe* according to this framework will follow in the next section.

Sustainability

The conventional concept of sustainability consists of three dimensions sharing equal importance: an economic, environmental, and a social dimension, which together define the *sustainability triangle*. Moreover, intra- and inter-generational justice (Howarth 1991) – taking part in all three dimensions – play a crucial role in defining sustainability (Baumgärtner, Quaas 2010). The sustainability triangle can serve as the first tool to assess to which degree policies follow the sustainability approach.

Other concepts of sustainability exist and form a second assessment tool. A differentiation between *weak* and *strong sustainability* (Turner 1993)[4] can be drawn. The concepts reflect an academic discourse concerning the rate of substitution among various kinds of capitals. Sustainability and intergenerational justice hold true if the overall sum of capital remains unchanged (Solow 1974a, 1974b and Stiglitz 1974). *Weak sustainability* states that the marginal rate of substitution is close to one making (perfect) substitution across different kinds of capitals[5] possible. One prominent example is the *Statens pensjonsfond* in Norway. Natural capital should be transferred to future generations by exchanging it with financial capital – justifying the extraction of non-renewable resources (Ekins 2000).

[4] Turner (1993) differentiates between four types of sustainability. For a further elaboration, please refer to Ekins (2012).

[5] Ekins (2012) defines the following types of capital as relevant: natural, human, social/organisational and manufactured capital (opt. cit., p.233-234). Financial capital is necessary for all kinds of capital described above.

On the other hand, *strong sustainability* points to the restrictions and minimum thresholds involved while dealing with substituting natural with other kinds of capital. Natural capital plays a significant role since using it could cause irreversible changes (climate change, biodiversity loss, etc.) once it surpasses the absorption capacity by nature (Ekins 2012, p.239-241). The concept of *strong sustainability* treats the different capitals as complements rather than substitutes. Consequently, using natural capital needs to be reduced since current economic systems seem to permanently over-consume it (Costanza 1997).

These two approaches can be combined into *balanced sustainability* (cfr. Hauff, Kleine 2009 and Hauff, Nguyen 2013). A critical threshold of natural capital is needed to sustain ecosystems and environmental functions. At the same time, economic growth generated by natural capital and therefore substitution between different capitals is not *per se* rejected. The crucial question of *balanced sustainability* is how growth is created (Stiglitz, Sen, Fitoussi 2009) and if it stays within planetary boundaries (Rockström et al. 2009). *Balanced sustainability* will be taken as the second tool to assess resource efficiency policies.

Against this background, sustainability extends the economic perspective and combines it with social as well as environmental issues, including thresholds. Resource efficiency policies are seen as being part of a sustainability agenda. The next section will assess whether resource efficiency policies in the EU respect the *sustainability triangle* and *balanced sustainability*. Prior to that, the following subsection connects the two theoretical concepts to resource efficiency.

Resource Efficiency

The two theoretical concepts of sustainability can be adapted to the way we use resources. Resource efficiency hereby sets the objective to use resources in the *best* manner from an input-output point of view. But how can sustainability ne linked to the way resources are used? One example could have been the prominent *Yasuní-ITT Initiative* in Ecuador.[6] Sustainability weights economic interests (extraction of oil reserves) with respect to environmental (possible threats to biodiversity) and social aspects (protection of indigenous communities, distribution of profits). Hence, sustainable economic polices with regards to resources ought to take ecological as well as social objectives into consideration. The *sustainability triangle* serves as a guideline on how resources should be used in a broader sense, not *just* focusing on economic issues. Thus, the *sustainability triangle* is used as a first tool for the subsequent analysis.

[6] For more information http://yasuni-itt.gob.ec/Inicio.aspx (19 April 2014).

Several implications arise when adapting *balanced sustainability* to the framework of resource efficiency. It is essential to quantify adequate rates of substitutions between e.g. natural and manufactured capital as well as minimum thresholds of natural capitals required to sustain our ecosystem. However, quantifying natural capital in a common unit of account comparable with other forms of capital is subject to moral and cultural evaluations changing over time (Ekins et al. 2003). Going back to the *Yasuní-ITT Initiative*, *balanced sustainability* suggests quantifying the 'exchange rate' between expected economic profits and environmental as well as social costs. The proposal came up with a rate of substitution between natural and financial capital of 0.5 (cfr. Vogel 2009 for similar estimations); the international community should have compensated Ecuador with 50% of its expected profits from extraction through a trust fund of the United Nations Development Program. Such compensation accounting for 50% of the forgone profits can be seen as an approximation the value of economic capital. Therefore, environmental and social capital account for the remaining 50%. Bearing in mind that the assessment of such accounts is complex and subject to uncertainty, an adequate evaluation of natural capital can only be approximated for a specific point in time. Nevertheless, *balanced sustainability* can provide crucial insights for assessing resource efficiency policies. It is therefore used as the second tool during the further analysis.

In the course of the following section, a closer look at EU policies concerning resource efficiency will be taken. Hereby, the two tools – the *sustainability triangle* and *balanced sustainability* – will be used to assess resource efficiency polies in the EU, specifically the *Roadmap to a Resource Efficient Europe*.

3) Resource Efficiency and Sustainability in the Roadmap

The previous section outlined the link between sustainability and resource efficiency on a theoretical basis. This section tries to evaluate the degree to which the *sustainability triangle* and *balanced sustainability* are reflected in current EU policies regarding resource efficiency – focusing on the *Roadmap to a Resource Efficient Europe*. The first subsection introduces the Roadmap. Subsequently, the Roadmap will be assessed as to which extent it follows the sustainability framework, also taking the importance of resource indicators into account.

The Roadmap to a Resource Efficient Europe

In 2011, the EU declared resource efficiency as one of its seven flagship initiatives in its *Europe 2020* strategy.[7] Generally, the results of the *Europe 2020* strategy will be integrated into the EU Sustainable Development Strategy to ensure consistency throughout several sustainability policies (MEMO/11/614). *Europe 2020* aims to transform the EU-economies to follow sustainability goals by 2050.

Resource efficiency as one flagship is seen as a major driver in order to achieve the EU's target to reduce GHG emissions by 80-95% by 2050 (EC 2011 21), secure resource supply, and simultaneously increase its industrial base to make up 20% of EU's GDP by 2020 (EC 2014 14).

The *Roadmap to a Resource Efficient Europe* is one initiative derived from this flagship. It was intended to become an integrated part in the European Semester on economic policy coordination (MEMO/11/614). The Roadmap starts out with a *vision* of what the broader goals are and sets rather general targets called *milestones* to achieve such goals, but only few numerical thresholds are being set[8]. Its main goal is to increase resource efficiency and thereby potentially *decouple* resource use from economic growth, which will be statistically evaluated in the subsequent section. But should all sectors equally try to accomplish these objectives or, alternatively, only specific sectors with the highest likelihood of success? The European Commission points to specific areas in which most potential for resource efficiency gains can be expected. Especially nutrition, housing and mobility[9] ought to be addressed and the Roadmap further identifies "key natural resources such as raw materials, metals, energy, biodiversity and water (…)" (IP/11/1046) for which a more efficient use could have promising results. Resource management, which has been a much debated concept (cfr. OECD 2008a, p.18-25, Bringezu and Bleischwitz 2009, Mont and Bleischwitz 2007, Bleischwitz and Bahn-Walkowiak 2007) plays a significant role in the Roadmap as well. Main instruments on how to increase resource efficiency and manage resources include labelling, investment incentives for businesses, recycling strategies towards a circular economy, investments into research, phase out subsidies harming the environment, internalising all

[7] One has to differentiate between three levels. The first level is the *Europe 2020* strategy, which consists of seven flagships, the second level. From each flagship, initiatives – the third level – are derived.

[8] Except for the *milestones* for water *(water abstraction should stay below 20% of available renewable water resources),* food *(a 20% reduction in the food chain's resource inputs)* and mobility *(on average a 1% yearly reduction, beginning in 2012, in transport GHG emissions)* (EC 2011 571).

[9] Their overall effects along the entire value chain cause 70-80 % of all environmental impacts. Food and drink account for 28% of EU's use of materials. Therefore, the Common Agricultural Policy of the EU should see a further increase in sustainability objectives (EC 2011 500).

environmental costs, designing products taking their entire life cycle into account and create comprehensive indicators (MEMO/11/614). All the mentioned instruments follow short (until 2020) and long-term (until 2050) methodologies and consist of both market based and regulatory instruments.

According to the Roadmap, the involvement of consumers, producers and governments is necessary to achieve a resource efficient Europe. Firstly, consumers decide on their purchase preferences, which products will be produced as well as how to recycle and/or reuse existing products. Essential for guiding consumer's purchase decisions are information and prices, which should reflect true social costs by internalising *external effects*.

Rebound effects, which entail overall using more resources despite becoming more efficient, have to be taken into consideration and could potentially be substantial (cfr. Meyer, Meyer and Distelkamp 2012). Secondly, producers face short-term investment costs with uncertain long-term benefits. Resource efficiency could improve the competitiveness of producers through efficiency enhancing innovations. Thirdly, governments can address the issue by implementing policies mainly to provide incentives. Examples range from reducing subsidies harming the environment to installing tax incentives for eco-innovations and including sustainability measures for public procurements – or more generally conducting sustainability impact assessments for all policies.

The next subsection assesses to which degree the Roadmap follows the *sustainability triangle* and *balanced sustainability,* taking into account resource indicators introduced in the Roadmap.

Assessment of the Roadmap to a Resource Efficient Europe

This subsection critically assesses the Roadmap[10] with regards to the two sustainability tools derived previously. In order to systematically evaluate strengths and weaknesses of this initiative, ratings are an adequate yet to some extent arbitrary option. A simplistic approach of categorising the Roadmap into how well it follows the two subsequent categories. Firstly, the *sustainability triangle* (and its environmental, economic, and social subcategories) and secondly, *balanced sustainability* (no further subcategories), which will be underpinned by the following four pillar rating:

++ *full compliance*, + *mostly compliance*, – *superficial compliance* and – – *no compliance*.

[10] The assessment is based on EC 2011 571 unless otherwise stated.

For each category (and subcategory), potential improvements will be stated. Relevancy within the Roadmap hereby serves as the key instrument of assessment, which is among others defined by number of key words represented, *milestones* formulated in accordance with each category (and subcategory), concreteness of these *milestones* and the relevancy of accompanying initiatives.

Starting with the *sustainability triangle*, subgroups for economic, ecologic and social aspects seem appropriate. Economic considerations play an important role throughout the Roadmap. Its related vocabulary is mentioned 61 times. The *vision* of the Roadmap explicitly states that economic growth remains a core objective. Economic performance is mostly related to the micro level. From the supply-side, firms would benefit from selling differentiated products as well as becoming more competitive through innovations reducing input costs and hence generating economic growth.

Furthermore lower negative effects stemming from lower exposure to price volatility reduces uncertainty and induces investment decisions potentially triggering *spillover effects.* Gains on the demand side are unclear.

On the one hand, consumer benefit from lower resource consumption, thus lowering costs. Even if *rebound effects* occur and the level of spending remains constant, *ceteris paribus* they gain utility by increased consumption levels. On the other hand, resource efficiency might require costs in the short term while long-term profits could be uncertain. Such costs, which are often stemmed by producers, might be passed on to consumer. In conclusion, economic considerations play an important part in the Roadmap and hence are *mostly complied with*. The limitation to *mostly complied with* can be made since it is not sufficiently clear, who will end up gaining from the Roadmap. It seems mainly a business driven initiative putting less emphasis on consumer welfare or at least not specifying a possible compensation scheme (for the short-term). As a policy remark, consumer benefits should be clearly outlined in the Roadmap.

Ecological aspects are of most importance throughout the Roadmap – they seem to play the dominant role. They are mentioned 78 times, 12 out of 18 *milestones* are explicitly targeted towards environmental issues and the *vision* setting out the core goals of the Roadmap emphasises this motion even further. Reference to already existing initiatives (water, electricity, ecosystems, air, land, soil, marine resources, etc.) reveal the relevancy of ecological aspects in the Roadmap. Although mentioning and setting objectives are only one first step towards implementing these goals, their importance is clearly visible. However, it is not mentioned what their implementation entails in practise. Reducing resource consumption through efficiency gains might *just* on average reduce environmental impacts (van der Voet, van Oers, Nicolic 2003). Given the emphasis put on ecological concerns, their final implementation remains to be evaluated in future analysis given that the Roadmap was introduced in 2011. Therefore, focusing on the ambition, the main policy advice in this regard calls for a stringent implementation of goals set in the Roadmap and potentially define binding targets. In conclusion, environmental aspects are in theory *fully complied with*.

Social issues are evidently a scarce resource within the Roadmap. They are only mentioned 9 times and only 2 out of 18 *milestones* are somewhat connected to social issues. Only once, social implications arising from resource imports outside Europe are mentioned (opt. cit., p.6). The most prominent example of social implications of the Roadmap can be identified within the initiative to phase out inefficient subsidies. "In the process of EHS [environmentally harmful subsidies] removal, alternative mitigating arrangements may be necessary for the most affected economic sectors, regions and workers, or for dealing with energy poverty, and the impact of possible displacement of production to other countries needs to be considered." (opt. cit., p.10). Furthermore, the attached staff working paper states:

> *"In terms of individuals or regions, those facing short-term losses will be immobile employees without the skills sought in the future economy, and regions which have invested in resource intensive industry and which do not have a suitable policy mix to support adaptation. Policies for managing transitions may require particular support for low-skilled workers." (SEC 2011 1067, p.19)*

Without mentioning how to implement it in practice, the European Social Fund and the European Globalisation Adjustment Fund among others could provide certain financial support to moderate adjustments. One additional reference is suggesting shifting taxation from labour to the use of resources. The goal is to increase job creation without compromising tax revenues and at the same time internalises environmental usage. Yet, the EU does not have any competences besides coordinating negotiations leaving it up to the member states to act on this issue. Taking these shortcomings mentioned above into account, social aspects are at most *superficially complied with*. Given restrictions regarding EU-competences in the field of social policies, policy advice can solely focus on initiating and leading coordinating processes. Nevertheless, distributional arrangements seem essential.

Turning to the second theoretical framework, *balanced sustainability*, the key assessment tools are identifying rates of substitution among types of capitals and minimum thresholds of natural capital. Hereby, the concept of *decoupling* is predominant. Economic output should grow with less natural capital input.

The idea is to decrease the rate of substitution between natural capital and manufactured or financial capital in order to maintain natural capital. The only explicit reference to natural capital is to "properly value" (EC 2011 571, p.12) it. From a minimum threshold perspective, no clear sustainable boundaries are mentioned. Reduction targets in numerical figures for resource consumption are mostly not existent. There seems to be no clear agreement on how to set sustainable levels of resource consumption. Hence, the European Commission points to the need for further research to better comprehend and develop indicators assessing numerical reduction targets. Therefore, minimum thresholds, which are non-trivial to approximate, are underrepresented throughout the Roadmap. In summary, the theoretical framework of *balanced sustainability* is *superficially complied with*. Policy suggestions could focus on better understanding sustainability thresholds of resource usage through increased focus on research initiatives. Developing comprehensive indicators, funding interdisciplinary research initiatives and diffusing the results throughout academia, NGOs and the media could be seen as a first step.

In this regard, the *Sustainability Gap* follows a promising methodology to set *sustainability standards* in order to maintain environmental functions (Ekins and Simon 1998, 1999, 2001; Ekins 2000, 2001, 2012).

Table 1 Roadmap rating

Group	Rating	Policy Advice
Sustainability triangle	**+**	***Including social aspects and consumers' benefits***
Economic	*+*	*Clearly outline consumers' benefits*
Environmental	*++*	*Stringent implementation of goals*
Social	*–*	*Balancing redistribution effects*
Balanced sustainability	**–**	***Developing sustainability indicators for resources***

Table 1 summarises the assessment of the Roadmap. The Roadmap introduces resource productivity as an indicator to approximate resource efficiency. One definition considers resource efficiency as a ratio of two variables with the same unit. For example, it is defined as the ratio of useful resource output (RO) and resource input (RI). Productivity however, is often referred to as a ratio of two variables of different units. For example, resource productivity is defined as the ratio of economic output (Y) and resource input (MI) (cfr. Dahlström und Ekins 2005).

Thus, productivity is a measure for the effectiveness with which resource input generates value added output. The Roadmap uses resource productivity as defined by the ratio of GDP and DMC – DMC is thereby taken as a proxy for resource input. The indicator is part of Eurostat's sustainability indicators (Eurostat 2011, p.81-128). In order to critically assess the indicator, it is noteworthy that the current resource productivity indicator in the EU does not include *indirect effects* (resources needed for producing traded goods). Thus, a country could improve its resource productivity by offshoring production whereas its global environmental impact remains unchanged. Those *indirect effects* of 'exporting' *negative environmental externalities* are estimated to be substantial (cfr. Meyer 2011, p.5) and increasing especially due to increased trade flows (Schütz, Moll and Bringezu 2003; Bringezu et al. 2004). Nevertheless, the questions are if and how *indirect effects* should be included in the indicators methodology? The first question seems legitimate since there is no apparent reason why the EU should take impacts outside its borders into account. Nonetheless, since the environment is a *public good*, it requires a global approach. Taking environmental issues even outside the EU into consideration is from a sustainability point of view fundamental. Currently, it seems that the European Commission might adopt the indicator raw material consumption (RMC) (European Resource Efficiency Platform 2014). The RMC measures *indirect effects* (used extraction) from imports and exports in raw material equivalence – going beyond the current methodology of a solely domestic approach (DMC). Nevertheless, this indicator does not capture unused extraction.

In summary the *Roadmap to a Resource Efficient Europe* can serve as a baseline for developing a blueprint to transform the EU's economy into a resource efficient one. Several restrictions and shortcomings have been discussed with the aim of providing further thought on how to overcome them. The Roadmap complies with economic considerations. However, consumer benefits should be clearly outlined. On the environmental side, the EU should implement its far-reaching goals, which will require on-going assessments in the future. Social aspects lack most in the Roadmap and need to be addressed. Agreeing and setting targets for resource efficiency might be an option, yet questionable whether this makes sense for all resources.

After generally assessing the Roadmap regarding the degree to which it follows the sustainability approach, the next section will focus on the specific justification for the Roadmap: competitiveness.

4) Resource Efficiency and Competitiveness

After assessing the *Roadmap to a Resource Efficient Europe* using theoretical tools, this section focuses on a quantitative evaluation of the relationship between resource efficiency and competitiveness. One of the main justifications for the Roadmap is to increase competitiveness in the EU. "The Roadmap to a resource-efficient Europe (…) is an agenda for competitiveness and growth based on using fewer resources when we produce and consume goods and creating business and job opportunities from activities such as recycling, better product design, materials substitution and eco-engineering" (IP/11/1046). Especially given that European companies face global competition but not in all cases a level playing field concerning environmental regulation, resource efficiency is a strategic policy subject.

A study on the competitiveness of European firms and resource efficiency summarises the micro level opportunities as well as barriers (Ecorys 2011). Key drivers for becoming resource efficient are reducing production costs, enhancing productivity, diffusing innovations (product, process, organisational, behavioural) and improving the corporate image. The necessary short run (incremental changes) and long run (structural changes) face barriers. Besides financial barriers, lack of information and technological as well as managerial capacity, and regulatory heterogeneity, a lack of incentives to invest in resource efficiency is most relevant for current and future policy debates.

Improvements potentially include direct and indirect financial support by the EU and development banks [11], increasing consumer awareness, but also harmonising and incentivising the underlying regulatory framework (opt. cit.).

This section will focus on the specific link between resource efficiency and competitiveness. Following the Roadmap, the hypothesis is that there is a positive relationship between resource efficiency and competitiveness. But can we find evidence for this notion in the data? The analysis will focus on the macroeconomic level. Adequate data on resource usage on firm level are not systematically available over a long time horizon (cfr. Ecorys 2011, p.6), which is a major bottleneck for in-depth analysis. The section first provides the economic rationale behind the connection between resource efficiency and competitiveness followed by presenting the data used for the analysis. Subsequently, descriptive analyses will provide insights into the *decoupling* process in the EU. Later, the econometric analysis and the results will be presented. The section concludes with an evaluation of shortcomings, suggestions for future research, and an outlook.

[11] For example, the *European Bank for Reconstruction and Development* recently started a Sustainable Resource Initiative.

Economic Rationale

The economic rationale behind the relationship between resource efficiency and competitiveness will now be explained. Following Steger and Bleischwitz (2009), resource productivity can be associated with competitiveness using correlation analysis. Despite the importance of the relationship, little evidence has been provided on a macroeconomic basis. This paper tries to address this gap.

From a macroeconomic perspective, increased resource efficiency may strengthen country's competitiveness by stabilising the macroeconomic environment. A study focusing on Germany models a policy induced increase in resource efficiency until 2030 and divides such policy measures into three categories (Distelkamp, Meyer and Meyer 2010). Firstly, economic instruments (i.e. substituting income with resource taxes), heavily reduces material consumption with only little negative impact on GDP and employment. Secondly, information instruments (i.e. best practise campaigns for firms) GDP and employment increase substantially, and material consumption decreases. Thirdly, regulation instruments (i.e. recycling rules) there are minor positive effects on GDP and employment, but a major decrease in material consumption. Combining all three instruments, material productivity would double between 2010 and 2030. There are positive effects on GDP (+14%), employment (+1.9%), public debt (–11%) and a reduction of material consumption (TMR –20%). Such effects are the upper threshold and can therefore be referred to as the potential for efficiency gains.

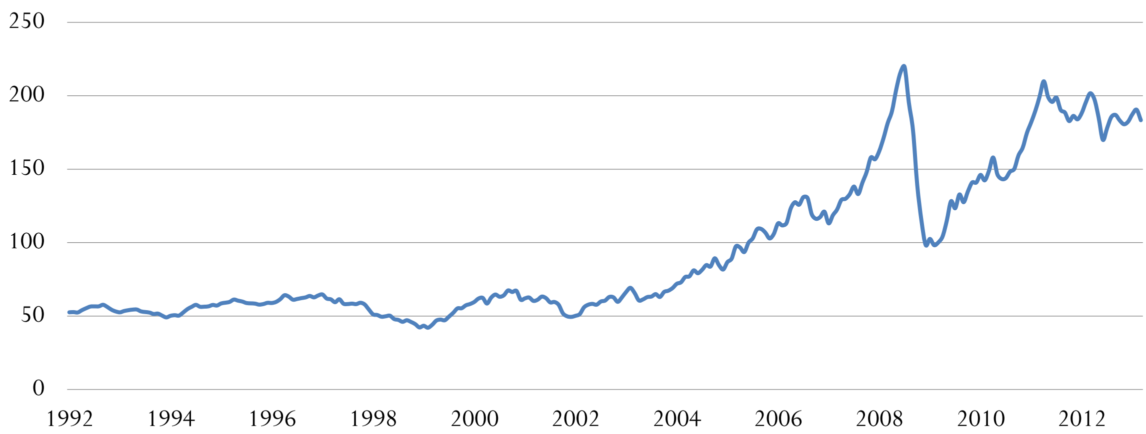
A similar EU-wide study using a variety of different methodologies finds similar positive macroeconomic impacts of resource efficiency improvements until 2030 such as a reduction of resource use by 17-25% (compared to the baseline scenario), increase in real GDP between 2 and 3.3%, and real labour income also increases combined with a creation of up to 2.6 million jobs (Meyer et al. 2012). However, both studies stated do not specifically focus on the link between resource efficiency and competitiveness.

The incentives caused by price changes play a crucial role. To put it simply, input prices *ceteris paribus* increase if demand increases (on account of population growth, economic growth, etc.)[12] and supply decreases (because of market power, lack of investments in supply infrastructure, etc.). In reality, demand increased but supply is sticky, at least in the short term, which increases resource prices at least temporarily (cfr. Valiante and Egenhofer 2013).

[12] Throughout the 20th century, the world extracted 34 times more material resources in 2000 compared to 1900 (EC 2011 571) whilst population *only* grew by a scale of 3.6 (UN Population Division).

High resource price levels[13] are the main incentive to increase resource productivity, as they increase the probability for investments in resource efficiency to pay off. The International Monetary Fund (IMF) all commodity index increased by 131% between 1992 and 2013 (see figure 1) below. Thus, there should be an incentive to become more efficient and therefore gain an advantage over competitors in terms of product prices or quality.

Figure 1: monthly commodity price index from 1992 to 2013



Note: : Commodities include food, beverages, agricultural raw materials, metals, and energy. Prices are non-seasonally adjusted monthly averages in nominal USD. The weights in the commodity basket reflect the Note structure of trade in 2002-2004. The base year is 2005=100. Source: IMF.

There are two main channels regarding the relationship between resource efficiency and competitiveness: lowering input costs and increasing innovation activity. Both channels cause production to be pushed towards the production–possibility frontier. Innovations might shift the production-possibility frontier outwards (Varian and Repcheck 2006). Additionally, by increasing productive efficiency, economies *ceteris paribus* become overall more competitive.

One direct effect can be observed through lowering resource-purchasing costs. *The lower the cost structure of inputs for economies, the more competitive products and services become. If resources are used more efficiently, overall* input costs *ceteris paribus* decrease – already in the short run.

[13] A different case is resource price volatility as it is a double-edged sword. On the one hand, resource efficiency might serve as a hedge against the negative impacts (i.e. fluctuating inputs costs). On the other hand, price volatility increases the uncertainty of future payoffs as future prices become less predictable, thereby obstructing investments.

Nevertheless, competitiveness as defined by the World Economic Forum (WEF)[14] is more than solely focusing on input costs. It is a matter of setting up a macroeconomic environment in which incentivises private investments to efficiently allocate scare resources (cfr. WEF 2012, Chapter 1.1). Nevertheless, input costs play an important role in forming such an environment. Firms for instance can sell their goods and services on domestic, respectively global, markets at a lower price once they become more resource efficient and thereby increase their competitiveness.

The second channel is innovations. Increased resource price levels can create incentives for economies to innovate in order to reduce costs and enhance the quality of the products. It is also possible that the know-how is sold as a potential stream of revenues. According to economic rationale, investments into innovations take place if the expected cost reduction as a result of a more efficient use of resources outweighs the initial investments (including transaction costs) into research and development (see Ecorys 2011, p.21-26). Innovations are a major driver for competitiveness (see Bleischwitz 2010; Carrillo-Hermosilla, del Río González and Könnöla 2009 for eco-innovations; Michael, Claas 1995; Clark, Guy 1998). Product, process, organisational, and behavioural innovations lead to cost reduction, increase product quality as well as resource efficiency (Ecorys 2011, p.6). *Spillover effects* from innovations in resource usage can additionally enhance the overall competitiveness of a country – including an improved image for an environmentally sounder economy. Therefore, in order to become more resource efficient to lower input costs, innovations are an additional channel for becoming more competitive.

However, these incentives for firms to invest in resource efficiency only hold true under perfect information and competitive markets. As mentioned in the beginning of the paper, government failure and generally market inefficiencies are potential barriers in becoming more resource efficient. This 'web of constraints' (POLFREE 2013) includes several inefficiencies such as imperfect information, capacity constraints (e.g. institutional, technical, etc.), financial barriers, uncompetitive markets, and fiscal disincentives (e.g. resource subsidies) (Rentschler and Flachenecker 2014). Hence, public policy can play a role in transforming economies into resource efficient ones given that markets do not provide their own incentives.

[14] Since the European Commission does not provide any definition of competitiveness in the Roadmap, the broadly accepted definition by the WEF is taken here. See Krugman (1994) for an opposing point of view.

Taking such barriers and inefficiencies mentioned above into account, the hypothesis taken from the Roadmap is that there is a positive relationship between resource efficiency and competitiveness. Yet, if this holds true between 2004 and 2009, will subsequently be analysed quantitatively.

Data

The data used is publicly available and retrieved from Eurostat and the WEF. The table describes each variable and its name for the subsequent econometrical analysis. Each variable is taken for the period between 2004 and 2009 for the EU-28 member states as well as Norway, Switzerland, and Turkey.

Table 2: Variables list

Variable	Description	Name
Global Competitiveness Index	Score between 1-7; 7 being the highest	*gci*
Resource productivity	GDP/DMC in PPS per tonnes	*rp*
Labour productivity	GDP in PPS per employed person in percentage of EU-27 total	*lp*
Real effective exchange rate	Deflated by the unit labour costs in the total economy of the EU-27	*exchange*
Patents	High tech patent applications to the EPO by priority year at the national level	*patent*

The Global Competitiveness Index (GCI) from the WEF measures the overall competitiveness for most countries worldwide. It is a weighted average of three main sub-indexes each consisting of pillars. The three sub-indexes are the following: basic requirement, efficiency enhancer as well as innovation and sophistication factor sub-index. Each sub-index represents a different stage in development. The weights of each sub-index in order to calculate the GCI depends on the five thresholds of GDP per capita in USD for each country (see weights and pillars in more detail: WEF 2012, p. 3-12). There is a methodological brake in 2003 (Sala-i-Martin and Artadi 2004). Hence, comparable data of the GCI has to be derived starting with the 2004-2005 report.[15]

[15] Please note that each report is labelled as current year and the following year (from current year t to year t+1). For the analysis, the current year t is taken as the appropriate point in time.

The GCI follows the approach of so-called dynamic competitiveness (based on institutions, infrastructure, education, innovation capacity etc.) going beyond conventional price competitiveness (Porter 1990).

Resource productivity is a measure taken from Eurostat and is defined as GDP in PPS divided by DMC, as recommended to compare countries across time (Eurostat 2014). Simplified, how much does income increase through an increase in resource consumption. This indicator in academia usually referred to as material productivity can be seen as a proxy for resource productivity.

Direct material consumption (DMC) is defined by Eurostat as follows.

> "DMC *measures the total amount of materials directly used by an economy. It is defined as the annual quantity of raw materials extracted from the domestic territory of the focal economy, plus all physical imports minus all physical exports. It is important to note that the term 'consumption' as used in DMC denotes apparent consumption and not final consumption. DMC does not include upstream flows related to imports and exports of raw materials and products originating outside of the focal economy." (Eurostat)*

DMC records direct material flows, failing to include indirect flows. This goes back to an asymmetry in the way material flows are measured. On the one hand, domestic extraction (being part of DMC) measures the extraction of materials as raw materials. One the other hand, imports and exports are quantified by the weight of the materials that are traded (either directly or incorporated in products). Such measurement excludes indirect materials used throughout the value chain, which are not incorporated in the traded product itself (e.g. metal scrap). Thus, it fails to account for all raw materials used in the production of the traded product. The indicators Raw Material Consumption (RMC) and Total Material Requirements (TMR) would take such indirect flows into account (Wuppertal Institute 2013; van der Voet et al. 2005). Given data availability issues on member states level, DMC is taken for the purposes of this analysis.

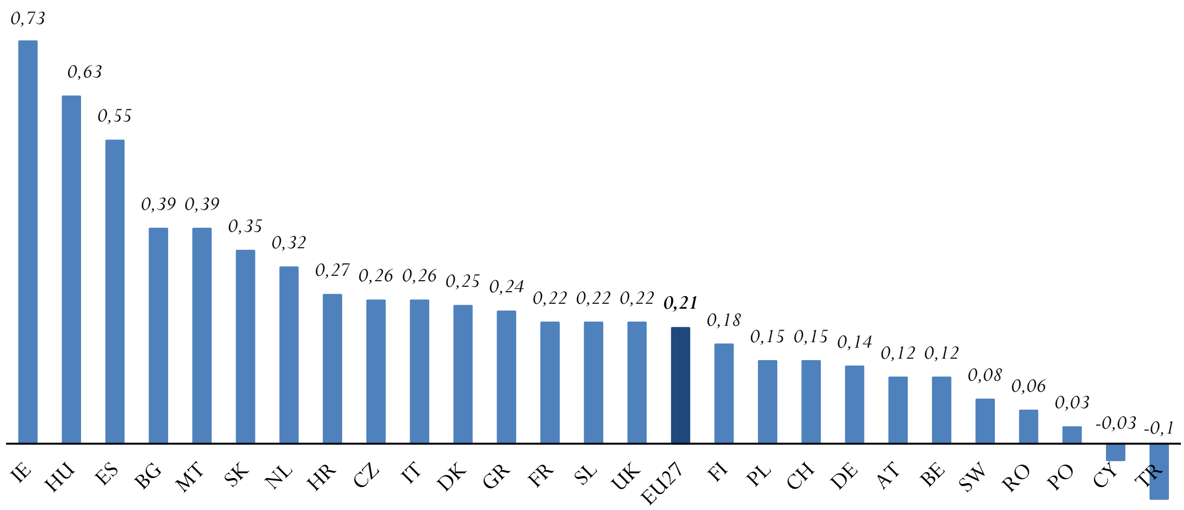
Descriptive Analysis

The panel data is strongly balanced. Simple arithmetic reveals an increase in resource productivity, as measured in GDP/DMC in PPS per metric ton, of the EU-27 average between 2004 and 2009 of 21% (EU-15: 23%; 2000-2009: 17%) (Eurostat 2012a).

The subsequent figure displays the heterogeneity of changes in resource productivity across member states. Due to the components of the resource productivity indicator (i.e. GDP and DMC), the drivers of change cannot be simply decomposed. It might be the case that only GDP grows and DMC remains constant.

However, for instance in Ireland that is not the case since GDP grows and DMC use decreases simultaneously reflecting a shift from a production to a service oriented economy. Similarly, Hungary and Spain increased their productivity levels significantly. Spain's DMC did not decrease until 2009 – among other factors due to its housing boom. Therefore, a further country-specific and especially sector-specific decomposition analysis would be needed to get a detailed picture of the developments of resource productivity in the subsequent figure (Pothen and Schymura 2014).

Figure 2: percentage change in resource productivity between 2004 and 2009

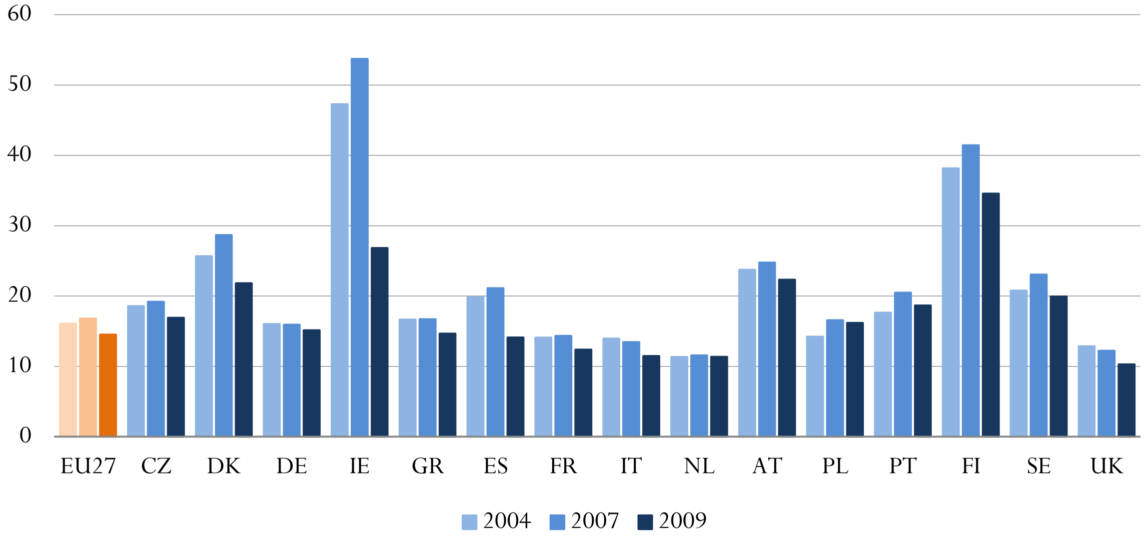


Sources: Eurostat, own calculations.

Looking at per capita resource usage, one can draw two conclusions. Firstly, severe differences throughout European countries exist. Secondly, one can observe an increase between 2004 and 2007 followed by an abrupt decline in 2009. This is especially pronounced in Ireland.

The following figure shows DMC per capita in selected EU-27 member states as well as the average. In 2009, on average, each European citizen consumed 14.5 tonnes of materials. Between 2004 and 2007, DMC is mostly increasing and experienced a sharp decline in 2009 when the financial crisis started to show its first effects on the real economy and hence on resource usage. Again, country-specific analyses are necessary to draw a more comprehensive picture of the underlying changes.

Figure 3: DMC per capita in tonnes for 2004, 2007, and 2009 for selected EU countries



Source: Eurostat.

Decoupling is one of the major challenges for an economy in the transition to become sustainable (UNEP 2011a and Bleischwitz et al. 2012). According to the UNEP (2011a), *relative decoupling* requires economic growth with a relative lower growth rate of DMC usage. *Absolute decoupling* requires output increases while simultaneously resource usage is decreasing. Resource efficiency plays an important role in enhancing *decoupling* for economies. The data (not shown here) indicate that there was no *absolute decoupling* in most economies in Europe (except between 2007 and 2008 on EU27 basis, the UK 2004-2008 and Italy between 2005 and 2008). Since 2005, Portugal even experienced a negative trend in resource productivity. Nevertheless, most countries show *relative decoupling* throughout the time period. Starting with the first negative effects of the financial crisis on the real economy in 2009, the sharp decline in resource usage is accompanied with a less pronounced decline in GDP – *decoupling* in its negative form. This could be explained by the process of reducing inputs and a lagging decline in output, which might be especially pronounced in a service-based economy.

The subsequent table shows the correlations among the dependent (*gci*), the independent (*rp*) and control variables (*lp, exchange, patent*). Resource productivity and competitiveness are positively correlated. The higher the exchange rate, the lower competitiveness is. This seems intuitive as higher real effective exchange rates counterbalances competitiveness increases as exports become relatively more expensive.

Table 3 Correlations

	gci	*rp*	*lp*	*exchange*	*patent*
gci	1				
rp	0.21	1			
lp	0.66	0.40	1		
exchange	-0.21	-0.14	-0.23	1	
patent	0.79	0.16	0.48	-0.21	1

Model

Extending the analysis of Steger and Bleischwitz (2009), the cross-country comparison uses a dynamic panel data model, which is estimated using two-step system GMM (GMM-SYS).[16] This method was made popular by Arellano and Bond (1991) and further developed by Blundell and Bond (1998).

The model for the estimations takes up the following form.

$$\gamma_{it} = \sum_{k=1}^{K} \beta_k \omega_{k,it} + \rho \gamma_{i,t-1} + c_i + u_{it}$$

ω_k describes the vector of regressors other than the lagged dependent variable and includes resource productivity and the control variables. Yearly GDP growth rates in PPS control for economic development. Labour productivity can explain the variation in competitiveness and is also controlled for. The real effective exchange rate states the relative prices and costs one has to pay in order to for example offshore production and hence among other things resource trade. It also reflects the productivity level of an economy. Innovations are additionally controlled for. Therefore as an imperfect proxy, patents control for the dynamic effects of innovations. It is also plausible that current levels of competitiveness are explained by the levels of the previous time period, which is addressed by including a lagged dependent variable and thus accounting for the dynamic effects. Finally, time effects are included in the regression.

Results

This subsection describes the estimation results. Critical remarks concerning shortcomings will follow in the next subsection.

[16] For GMM, see Hansen (1982) who was been awarded the *Sveriges Riksbank Prize in Economic Sciences in Memory of Alfred Nobel* in 2013.

Table 4 : Results from the dynamic panel data model.

	(1) $\ln(gci_t)$	(2) $\ln(gci_t)$	(3) $\ln(gci_t)$	(4) $\ln(gci_t)$
$\ln(gci_{t-1})$	0.900	0.654	0.644	0.623
	(0.000)	*(0.000)*	*(0.000)*	*(0.000)*
$\ln(rp_t)$	-0.0034	-0.0042	-0.0071	-0.0099
	(0.638)	*(0.572)*	*(0.646)*	*(0.480)*
gdp growth	0.0002	0.0005	0.0004	0.0009
	(0.556)	*(0.503)*	*(0.629)*	*(0.178)*
$\ln(patent_t)$		0.0207	0.0196	0.0161
		(0.133)	*(0.211)*	*(0.318)*
lp_t			0.00008	0.0001
			(0.866)	*(0.750)*
$exchange_t$				-0.0009
				(0.001)
Observations	154	152	152	147
Time effects	0.000	0.011	0.008	0.0003
Arellano-Bond test for AR(1)	0.000	0.002	0.002	0.009
Arellano-Bond test for AR(2)	0.195	0.223	0.204	0.461
Hansen test for overidentifying restrictions	0.631	0.429	0.396	0.497

Note: p-values are shown in parentheses and for the tests.

All specifications in all four columns use two-step system GMM estimates (GMM-SYS) [17]. The Windmeijer finite-sample correction for the two-step covariance matrix is used. Time effects are included in the specification and tested. The Arellano-Bond test for AR(1) in the first differenced errors should be rejected, but not the AR(2) test in order to have serially uncorrelated residuals. The Hansen test of overidentifying restrictions should not be rejected. All four regressions produce similar results for Arellano-Bond tests (non-rejection of AR(1) and rejection of AR(2)) and for the Hansen test (non-rejection).

[17] All models have also been estimated with one-step GMM-SYS, which did not significantly alter the results. Also, one and two-step difference GMM has been applied and shows a positive and significant impact of material productivity on competitiveness. However, the Arellano-Bond AR(1) test reveals no first order serial correlation in the first differenced residuals. Adding an additional lag does not systematically change the results.

The first column includes a control for GDP growth. Resource efficiency negatively impacts on competitiveness, but not in a statistically significant manner. Current levels of competitiveness are mainly the result of past levels of competitiveness.

The second column further includes the patents variable. Resource efficiency remains negative and not significant. The main driver for current competitiveness is the past performance of competitiveness, but at lower magnitude as in Column 1.

The third column additionally controls for labour productivity. Resource efficiency persists negatively and insignificantly related to competitiveness. Past levels of competitiveness explain current levels.

The fourth column adds the exchange rate as a control variable, which highly significantly influences competitiveness. The higher the exchange rate, the lower competitiveness is. This seems intuitive as higher real effective exchange rates counterbalances competitiveness increases as exports become relatively more expensive. The dominant determent of competitiveness is nevertheless past levels of competitiveness. Resource efficiency remains negative and insignificant. All tests are unchanged.

To sum up, a positive relationship between resource efficiency and competitiveness as proposed by the European Commission and as taken for the hypothesis of this analysis cannot be verified by the data. We find no statistically significant effect of competitiveness on resource efficiency. The results even show a negative impact on competitiveness.

Discussion

There are several shortcomings to this analysis. Firstly, there might be heterogeneity in the way resource efficiency impacts on competitiveness across the EU-27 member states, which causes serial correlation and thus inconsistent results using dynamic panel data models (Pesaran and Smith 1995). An alternative could be to estimate each member state separately and consider the distribution across the EU member states (Mean Group) or to apply a Pooled Mean Group estimator assuming long run homogeneity (Pesaran and Smith 1995; Shin et al. 1998).

Secondly, in terms of economic interpretation, taking the *indirect effects* into account could be essential in order to provide adequate policy advice (cfr. Schütz, Moll and Bringezu 2003). It remains questionable though whether it alters the effects on competitiveness. Therefore, data availability needs to be expanded since these data are not fully publicly available for all EU-28 member states. Further analysis should focus on GDP relative to RMC as well as TMR and compare the results with those estimated above. The contributions of Meyer (2011) find promising results using TMR data. In addition, so-called Integrated Economic and Environmental Social Accounts including environmental as well as social accounting into conventional accounts can provide supplementary insight into sustainable use of resources (Reilly 2012).

Thirdly, due to the fact that the competitiveness indicator of the *WEF* changed its composition in 2004, an alternative and methodologically uniform approximation of competitiveness would be the European Central Bank´s Harmonized Competitiveness Indicators going back until 1995. In general, the question of which type of competitiveness is altered by becoming more resource efficient seems adequate, as there are multiple competitiveness indicators available (Castellani and Koch 2015). The analysis focused on macroeconomic competitiveness, which calls for a future firm-level approach. It can be argued that resource efficiency is rather an opportunity best explained from the firm level.

Fourthly, the measure DMC is dominated by non-metallic minerals such as sand and gravel representing approximately one-third of the indicator (EEA 2012, p.98) leaving little potential for resource efficiency gains. Alternatively, a specified focus on raw materials with potential efficiency improvements can be looked at. However, resource efficiency as a concept by itself can be put into question as well, as only labour and capital create economic growth according to classical economic theories (Bleischwitz 2001). According to their rational, resource productivity might suggest resources themselves could generate value-added (as an input in the production function). The theories argue, however, that resources do not possess any value themselves, but generate value by adding labour or capital.

Lastly, resource efficiency is still a rather new approach (the Roadmap was introduced in 2011); therefore the effects might not yet be visible in the data. This motion is supported by data from Eurobarometer (2011). European entrepreneurs see current expected increase in commodity prices as the most important incentive to invest in resource efficiency. Nevertheless, 55% have not introduced any measures accordingly, which manifests that the problem is not seen as one of immediate urgency. Maybe there are further barriers for investments that future research should focus on. Besides a lack of incentives discussed above, knowledge on how to make for instance production more resource efficient requires in-depth know-how. Benchmarks set by best practice initiatives might facilitate the transition (Ecorys 2011, p.7). According to de Bruyn et al. (2009), labour costs make up the main cost for businesses (resource costs are defined as the pure cost of the resource excluding all intermediate costs for labour, transport etc.) Hence, enterprises try to become more productive in areas with most cost saving potential. Therefore, relatively more effort is invested into enhancing labour relative to resource productivity. Moreover, technological as well as behavioural lock-ins can delay and even hinder the transformation into a sustainable economy (SEC 2011 1067, p.22).

Further research is needed. Taking more suitable indicators, longer time horizons and firm-level level data offers a huge range of supplementary analysis opportunities. Facing several restrictions on data availability, researchers ought to convince policy makers, statisticians, NGOs and the broader public to initiate wider databases of sectors as well as material specific resource flow accounts on the micro level. Essentially, more empirical evidence is required on macroeconomic, microeconomic and industrial level to better understand the impact of resource efficiency on competitiveness. Additionally, further insights on the drivers of resource efficiency will help to better inform policy makers.

5) Outlook

Despite the shortcomings outlined in the previous section, the relationship between resource efficiency and competitiveness seems at least to be more complex than suggested by the Roadmap. It appears that the European Commission assumes a positive relationship without providing sufficient empirical evidence. A rather puzzling result, given that increasing competitiveness is the core justification for the initiative. But what does this mean for the future of the Roadmap and resource efficiency policies in general?

Recalling major challenges to address increasing and volatile resource prices, ensuring supply of resources at acceptable costs and strengthening environmental ambition, resource efficiency has become a key issue on the European agenda. The European Resource Efficiency Platform (2014) comprises heterogeneous interests of a variety of stakeholders. In March 2014, it endorsed targets for resource efficiency based on the indicator RMC, which is claimed to be a major step forward and has been recognised by the European Commission (EC, 2014) and controversially discussed within the Council of the European Union (Council of the European Union, 2014). Though it remains questionable to set targets for all resources. Generally, it is essential for academia to provide empirical and robust results with regards to resource efficiency and its impacts especially on competitiveness, as the evidence base appears to leave room for improvement.

Resource efficiency policies are continuously being developed on the EU-level. Besides legal restrictions that make resources policies mainly a shared competence of the EU leads to constant negotiations and compromises between supranational institutions such as the European Commissions and European Parliament with member states represented in the Council of the European Union. Agreeing on new indicators for Eurostat, for example, requires consensus among all member states. In addition, the diverging interests between DG Environment for developing the Roadmap and DG Enterprise and Industry for the resource efficiency part of the Raw Material Initiative and the objective to strengthen the EU's industrial base, makes a comprehensive approach for all resources challenging. However, it could also trigger a result-oriented competition to find the *best* solution.

Hence, the Roadmap can be interpreted as a first step towards bold resource efficiency policies in the EU. The Roadmap can only maintain its legitimacy if further initiatives and most of all their implementation follow. This includes setting targets for certain resources based on improved resource efficiency indicators underpinned by a fully-fledged sustainability concept. Progress and implications on economic, ecological and social issues need to be evaluated regularly and findings included into a semi-flexible regulatory framework without compromising set targets. The agenda setting after the elections for the European Parliament as well as the newly formed European Commission will reveal the EU's willingness to tackle this crucial topic during times when purely economic agendas seem to enjoy priority.

6) Conclusion

Sustainability has enjoyed an increased public awareness and popularity among policy makers when it comes to economic policies. However, the inflationary use of the word does not always comply with its definition. Therefore, the paper introduces the concept of sustainability in order to assess resource efficiency policies through two theoretical frameworks. Firstly, the *sustainability triangle* combines economic, ecological and social aspects. Secondly, *balanced sustainability* merges *strong* and *weak sustainability* focusing on underlying causes and effects of economic growth without *ex ante* setting rates of substitutions among various kinds of capital. Nevertheless, it requires minimum thresholds for the use of natural capital.

In 2011, the EU declared resource efficiency as one of its seven flagship initiatives in its *Europe 2020* strategy. The Roadmap was generally assessed according to the *sustainability triangle* as well as *balanced sustainability*. The analysis concludes that mainly social considerations are lacking. The environmental concerns are mostly satisfactory, yet further improvements in the field of economic related characteristics such as clearly outlying benefits for consumers are necessary. Policy advice therefore focuses on spreading potential burdens throughout society as well as better initiating consumer incentives for purchasing resource efficient products.

A special focus is put on indicators. A thorough comprehension on resource flows, which adequately reflects indirect effects, is lacking due to incomplete data availability and (so far) a lack of political will. The European Resource Efficiency Platform (2014) has now put forward suggestions for targets, which have found recognition by European institutions.

The Roadmap’s main justification for the transition to a resource efficient Europe is enhanced competitiveness. This hypothesis is only partially backed up by academic research. Thus, a second quantitative assessment of the Roadmap uses a dynamic panel data model to estimate the impact of resource efficiency on competitiveness. The results indicate that there is no robust impact of resource efficiency on competitiveness. Therefore, it cannot be concluded that the hypothesis provided by the European Commission in the Roadmap is verified.

The field of resource efficiency in the framework of sustainability requires further research – especially its impact on competitiveness. Empirical results are necessary on the macroeconomic, microeconomic and industry level. Moreover, attempts to more adequately measure resource usage are promising and necessary to manage resources sustainably. Nevertheless, implementation of indicators seems to be the bottleneck at the moment. This is partially due to compromising between the European Commission and the member states but also within the European Commission itself. The recent elections for the European Parliament and a newly formed European Commission will have to proof their willingness to develop a comprehensive and bold approach on the resource efficiency agenda.

Resource efficiency policies therefore need to take new approaches and techniques into account in order to be evaluated on a scientific basis by, on the one hand, including theoretical concepts of sustainability stringently, and, on the other hand, empirical analysis to verify as well as justify policy measures and their effects on the environment, economy and society. After all, the underlying importance for the European project demands answers on how to achieve the transition of economies to become resource efficient without compromising economic prosperity, ecological persistence and social justice.

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