CIRCULAR IMPACTS

The macro-economic and societal impacts of the circular economy

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1 :: Introduction

The circular economy is an instrument to reduce primary resource use and environmental impacts of the economy. However, in current policy documents of the EU (EC 2015) it is also seen as a way to increase growth, employment, and international competitiveness. This may be one of the reasons why one would like to include the progress towards the circular economy in the communication between member states and the EC in the European Semester. The objective of this report is to assess ways to analyse the macro-economic and societal impacts of concrete circular economy opportunities.

In order to get a grasp on the background of this report, we investigate shortly the policy background and especially the role of the circular economy in the European Semester (section 2), which will be developed more thoroughly in another report (Deliverable 2.2). Then the first step in analysing the macro-effects of new circular opportunities is to list them in a consistent manner according to some criterion of profitability (section 3). Case studies that will be developed in work package 4 of the project are meant as examples of elements in such a list. After having made the list, the main question is why they are not part of the baseline development of the economy if they are so profitable as suggested. Different barriers are mentioned, where externalities are important ones. In order to guide the economy on a circular pathway, policies are needed, where we will see later on that these policies determine in many studies to a large extent the macro-effects of the circular economy.

After making clear where the circular economy scenario is about, available approaches on the macroeconomic and societal impacts of the circular economy are discussed by putting them in a general theoretical context. First, the main purpose of the circular economy is the reduction of primary resource use and negative environmental impacts. Because GDP growth and employment are important focuses of the European Semester, we start the impact assessment with GDP, employment and international trade effects (section 4 and 5). It is argued that the these effects are not automatically positive. However, the purpose of the circular economy is environmental, and if you include the societal benefits of these environmental effects in a broader welfare analysis, the circular economy may generate positive welfare effects that are not included in GDP, employment or competitiveness analysis (section 6).

Finally, some conclusions are drawn about the design of case studies that are meant to get an insight in the macro-effects of the circular economy.

2 :: Policy background

The background of the project is the integration of the circular economy in the European Semester (ES). Therefore it is relevant to sketch this context. We do this by first describing the process of the European Semester, and then sketching how the circular economy, including resource and energy efficiency, is currently included. We discuss also some suggestions by Green Budget Europe, a Non-Governmental Organisation, to improve on indicators used in the European Semester.

The European Semester is a governance framework of the European Commission to coordinate policies between the European countries. It is created after the start of the euro crisis in 2010 in order to monitor and enforce in first instance the fiscal policies in the context of the Stability and Growth Pact. Next to that it monitors also the Europe 2020 strategy for smart, sustainable and inclusive growth (the so-called Lisbon Strategy) of which many objectives at the moment have not been reached (GBE 2016b, p. 7).

The European semester has an annual cycle.[1] It starts with the publication of the Annual Growth Survey (AGS) in November, where it sets the EU economic priorities for the next year and for Europe2020. In February the country reports are published by the European Commission that analyse fiscal and structural reforms per member state. Additionally for countries recognized as risky by the Alert Mechanism Report (AMR) in-depth reviews (IDRs) are published (in 2017 for 13 countries). In April the member states report on their progress and their plans how to implement the priorities set in the Annual Growth Survey. In May the European Commission gives Country-Specific Recommendations (CSRs) for the member states that must be endorsed by the member states in July (GBE, 2016: 9). CSRs are politically binding for all member states (soft law) while for the euro countries the CSRs about the Stability and growth pact and the Macroeconomic Imbalance Procedure are binding for the euro zone member states, with fines as a measure of last resort (hard law) (GBE, 2016: 15).

For the stability and growth pact a so-called preventive arm has been introduced that sets medium-term budgetary objectives, i.e. nominal budget balances adjusted for cyclical components. Also a corrective arm has been introduced with a fining system included with fines between 0.2% and 0.5% of GDP (GBE, 2016: 19-20). Parallel to this is the Macroeconomic Imbalance Procedure (MIP) that has a scoreboard of indicators with indicative thresholds. For example, there are indicators on real estate bubbles, competitiveness, indebtedness, asset prices, adjustment or inter-linkages with the financial sector[2], and a set of auxiliary indicators (the Alert Mechanism Reports). None of these indicators is on sustainability or the circular economy at the moment.

In 2015 the EU action plan on the circular economy (COM/2015/614) was formally included in the European Semester, but energy and climate were in the same year excluded because there will be created in the near future a parallel process in the context of the Energy Union (GBE, 2016: 6). So, environmental tax reforms, abolishment of environmentally harmful subsidies, or renewable energy and energy efficiency targets that were in since 2011 are not any more included in the Annual Growth Survey of 2016 (GBE, 2016: 11). In the Annual Growth Survey of 2016 the circular economy is mentioned in the context of improving resource efficiency that will "contribute towards stimulating investments with both short-term and long-term benefits for the economy, environment and employment."

In the 2017 Annual Growth Survey[3] in the context of boosting investment, and especially increasing the impact of EU funds in support of investment plans, mentions:

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[1] See for the procedures also https://ec.europa.eu/info/business-economy-euro/economic-and-fiscal-policy-coordination/eu-economic-governance-monitoring-prevention-correction/macroeconomic-imbalance-procedure_en.

[2] http://ec.europa.eu/eurostat/web/macroeconomic-imbalances-procedure/indicators

[3] https://ec.europa.eu/info/publications/2017-european-semester-annual-growth-survey_en

> **"Sustainable investments boost productivity across the economy through enhanced resource and energy efficiency and reduced input costs, whilst reducing external costs and impacts.** More particularly, support for the transition towards a low-carbon and circular economy will create new jobs in services such as innovative, maintenance and repair services and in designing and making new, more sustainable products. Specific areas where the macro-economic relevance of the circular economy and improved resource efficiency is potentially significant include green public procurement, investments in waste and water infrastructure, sustainable construction, critical raw materials, biofuels and biochemicals, as well as energy and climate related investment."

In the context of creating a solid and predictable business environment the Annual Growth Survey 2017 mentions:

> "In addition, work on the Energy Union, the Capital Markets Union, the Single Market Strategy, the Digital Single Market Strategy, the circular economy package and international trade and investment agreements covers specific measures that will help to remove barriers, promote innovation and improve the environment for investment, when fully implemented. For example, as part of the Energy Union, there should be a governance process building on national energy and climate plans for 2030 and beyond, providing predictability for businesses, investors and society at large."

So, the Annual Growth Survey for 2017 focuses on the employment effects, the removal of barriers, and the stimulation of innovation and investment. A stable and predictable policy is essential for this.

We use the Netherlands as an example for the in-depth reviews. Comments were made on not reaching the renewable energy target, but compliments for improvement in energy and resource efficiency. So, energy targets are still in these reviews. They warn that energy dependency will increase. As positive examples of policies are mentioned the successful tendering of offshore wind energy, support for investment in renewable energy and the development of a long term energy vision as one of the first countries. Also problems with respect to regulation are mentioned: the procedure for construction permits became even worse. Regulatory, planning and policy clarity could help to reduce uncertainty and therefore financing cost for private investment in renewable energy. Also signing of an international agreement of cooperation is mentioned.

When one evaluates the targets that are investigated one sees that targets on environmentally harmful subsidies or green taxation are not in, although the Annual Growth Survey 2016 in general suggested a shift of the tax burden from labour to other sources (GBE, 2016: 33) (which by the way could be consumption instead of the environment).

Green Budget Europe(2016:37) suggests to make the European Semester a tool for the Paris climate agreement by reviewing the Macroeconomic Imbalance Procedure scoreboard in the light of their climate impact, adding an indicator on climate action and climate, energy and resource efficiency, and making the European Semester a tool for divestment in unsustainable sectors. They suggest a legal enforcement mechanism for carbon budgets at EU level (p. 39), a better focus on environmental and fiscal issues and monitoring of soil, air and resource use. This would recognize the relevance of climate and energy for the Macroeconomic Imbalance Procedure.

What could in the end be the reasons to include the circular economy in the European Semester? The first reason may be the saving on primary resource use that is one of the

fundamental reasons for the Circular Economy. Reduction of resource use may reduce the pressure on resources in the EU, but the main reason seems to be the reduction of dependence on imported resources. When critical resources become more scarce prices may increase or become less stable. Furthermore, for a lot of resources supply is determined by a limited number of suppliers, making the EU politically dependent on them.

However, in lot of policy documents like the EU Circular Economy package the circular economy is also seen as a road towards increases in GDP, employment and international competitiveness. So, the circular economy could be seen as a road towards creating a stronger economy. Finally, the circular economy is one of the tools to reach goals on the environment, including greenhouse gasses.

3 :: Circular opportunities and circular policies

3.1 Introduction

The starting point for an analysis of the macro-effects of the circular economy is a listing of circular opportunities. In many studies it is assumed that these opportunities are profitable. But if they are so profitable, why wouldn't they happen already in the baseline? After having answered this question, policies may be designed to make the circular opportunities happen. A macro-analysis of the benefits of a circular economy must always include the mechanisms that transform the baseline into a more circular economy and therefore the policies involved. This is a fundamental question that has to be answered before the effect of policies leading to a circular economy can be analysed. Furthermore, the case studies that will be accomplished in Deliverable 4 are meant to be elements of such a list of circular opportunities, and so the relationship between the list and the macro-outcome is extremely relevant in the context of the whole project.

3.2 Listing of the circular opportunities

An economy is growing and changing because of technological change, changes in relative prices, and changes in population. This implies that at any moment in time new profitable investment opportunities arise, either because demand for specific commodities is increasing, new technologies can be implemented that improve efficiency or generate new commodities or because at new prices new technologies become profitable. From a social point of view, one may sort all these business opportunities based on its return on investment, either the private return or the social return. In theory one would expect that the most profitable investment opportunities are accomplished, but in practice the markets are not that flexible. However, one must be aware that in the baseline at every moment in time there are profitable investment opportunities.

Characteristically, in some reports on the impacts of the circular economy circular investment opportunities are explicitly mentioned (the same for resource and energy efficiency reports). These investment opportunities may be defined in euros spend per unit of resource efficiency or in another way such as the return on capital for the different investment opportunities. Be aware that the results depend on the market prices and

discount rate used. A much cited example is Dobbs et al (2011), who provides the cumulative resource efficiency increase (in dollars) sorted by net cost per unit of resource efficiency improvement. The figure presented there suggests that US$ 2 trillion resource benefits per year can be generated with negative costs, i.e. a positive return on investment (Dobbs et al., 2011, p. 75; UNEP, 2017, p. 92/3). These are the microeconomic costs, i.e. costs for private investors, where also such a figure is created including the external costs, implying much larger welfare gains (Dobbs et al, 2011, p. 77).

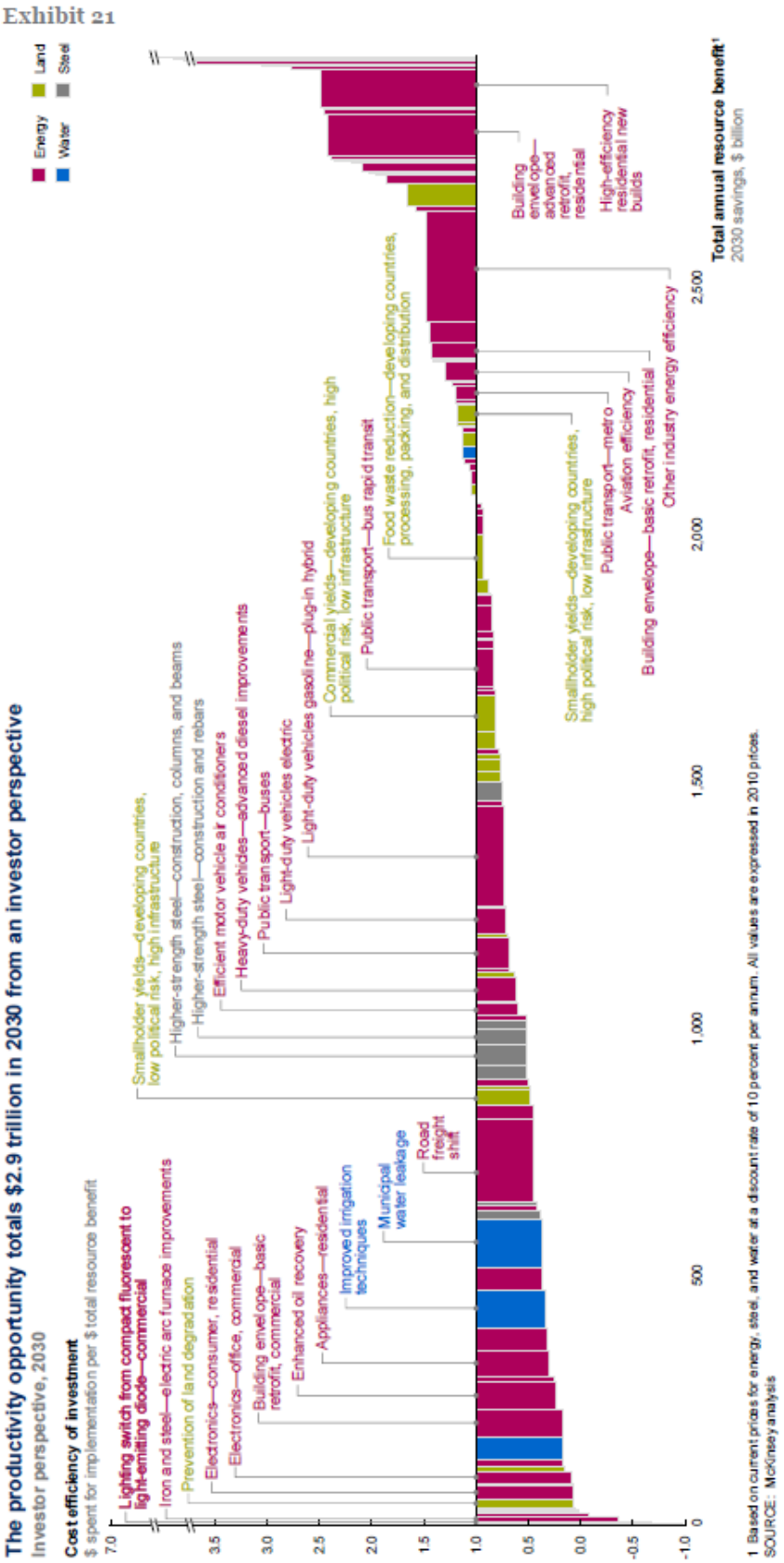

Figure 1 Micro-benefits of resource efficiency investment (Source: Dobbs et al. , 2011, Exhibit 21, p. 75)

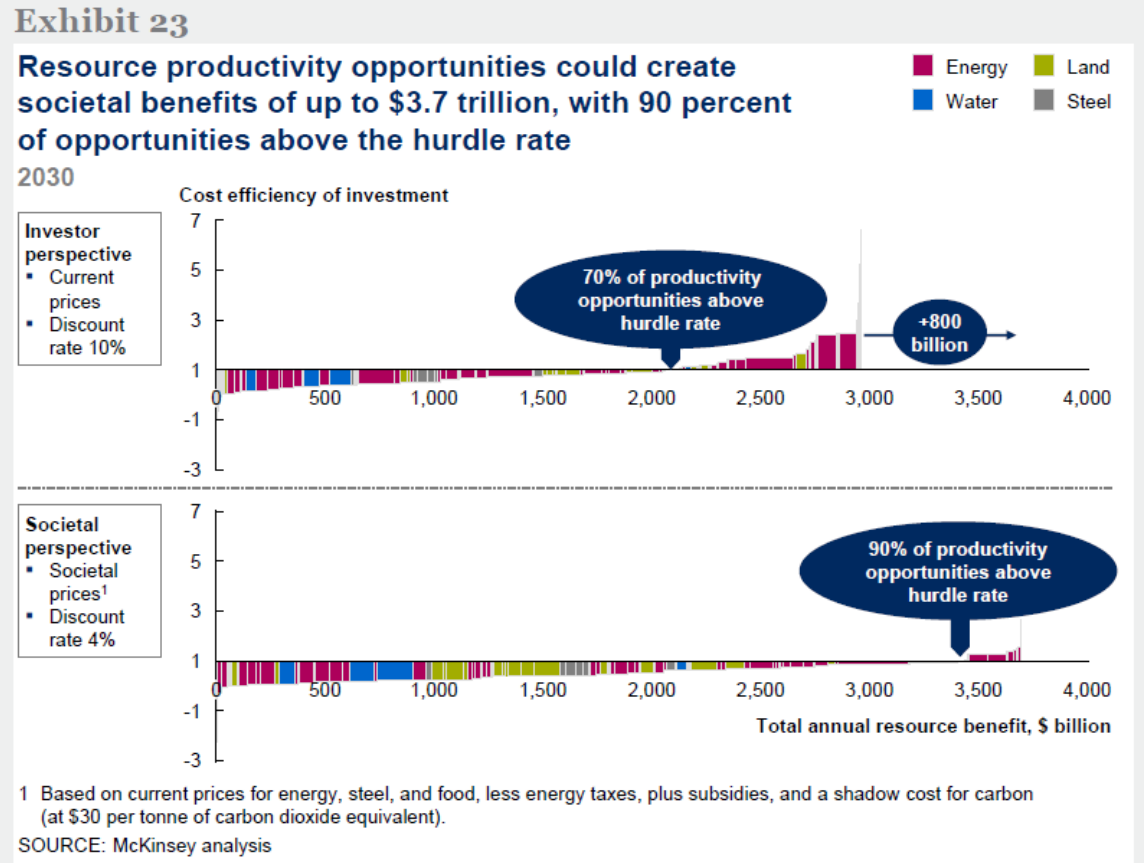

Figure 2 Micro versus macro resource productivity opportunities (source: Dobbs, 2011, Exhibit 23, p. 77)

Normally, according to the description of the baseline above, there will be circular opportunities that have negative costs or formulated differently positive returns on investment. A lot of these opportunities may be implemented already in the baseline, so nothing special is needed. So, policies around the circular economy become relevant at the moment that circular opportunities that are profitable from a private or social perspective are not implemented in the baseline because of barriers.

Another example of such an approach can be found in the report "Resource efficient scenarios for the built environment" (EC 2014). It analyses a number of options for resource saving in construction (including road building), and including options to increase sharing. In evaluating these effects results of Life Cycle Analysis (LCA), Life Cycle Cost analysis (LCC), environmentally extended input-output analysis and expert insights about net cost per ton material saving are used (table 0.1, p. 6). Specific policies are mentioned to realize those options, including green public procurement, eco-labelling and certification, standards including quality standards and building codes, specific criteria for demolition and building permits, education and training (table 3.1, p. 24).

As a last example we may refer to the report "Growth Within" of the Ellen MacArthur foundation (EMF, 2015) that explicitly differentiate between the realization of circular opportunities in the baseline and circular opportunities that will only be realized when specific circular policies are implemented.

3.3 Why don't they happen?

An assumption in many Circular Economy studies is that there are untapped sources of increases in resource productivity that also reduce cost, i.e. win-win strategies are possible. Mainstream economics is cautious about these "free lunches", because the current situation is based on decisions that people think are optimal. So, underutilization of capital goods (like private ownership of washing machines instead of hiring washing hours) may be a deliberate choice because of flexibility and transaction cost (Böhringer and Rutherford, 2015).

A listing of circular opportunities that are profitable is therefore no signal that these alternatives are more profitable than a listing of both circular and non-circular opportunities. Even stronger, if you have more choices, it seems plausible that more profitable opportunities exist. So, the question is why the list of profitable circular economy opportunities would have higher macroeconomic impacts than a broader list.

The background basically is that barriers exist in the baseline that are not included in the profit calculation. These barriers may be caused by market failure or organizational failure, but may also be hidden costs that are not included in the profit calculations but are relevant in practice. Examples of hidden costs are differences in quality, overhead costs, training cost, disruption of production cost or the cost of processing and gathering relevant information (UNEP, 2017: p. 92-94). A lot of other and in many cases more detailed taxonomies of barriers for circular opportunities are available (Dobbs, 2011; Scorell et al, 2014; UNEP, 2017; IEA, 2012b; Amoc and BioIS, 2013).

The Ellen MacArthur Foundation (2015b) gives a categorisation of potential barriers that we used as an inspiration for the categorisation below:

- Economic
    - Profitability
        - Further innovation and learning by doing is required to reduce costs or realize benefits.
        - Realistic projections of the profitability of the technology in the long run are difficult to make.
    - Barriers to finance the new technologies.
    - Capital intensive and/or uncertain payback times
    - Availability of the technology not available at scale
- Market failures
    - Externalities not reflected in market prices
    - Insufficient public goods/infrastructure
    - Insufficient competition/markets; competition on the wrong criteria
    - Imperfect information, for example asymmetric information
    - Split incentives (agency problems) when parties have different goals
    - Transaction costs, such as the costs of bargaining
- Regulatory failures
    - Inadequately defined legal frameworks
    - Poorly defined targets and objectives

    - Implementation and enforcement failures
    - Unintended consequences of existing regulation that hamper circular practices
- Social factors
    - Capabilities and skills
    - Customs and habits
    - Social resistance
    - Political resistance

Reducing this type of barriers may be one of the challenges of the European Semester when circularity would be included as an explicit goal.

It may be that market imperfections are generated over time or because of improper government regulation. Therefore, realigning regulatory policies consistent with the circular economy may improve efficiency of the economy. This may be seen from a static perspective, but also dynamics generated through technological change may solve problems around resource constraints and environmental degradation (EMF, 2015, p. 3).

If there are barriers for introducing circular economy measures, the costs of removing these barriers have to be included in the cost-benefit analysis of circular opportunities. Most economic models don't include the cost of removing barriers or the cost of transition like retraining costs and migration costs. So, the models show what would happen if the change was made without these costs. Costs in stimulating the technological change, or solving inefficient policy implementations should also be taken into account (UNEP, 2017, p. 108/9). However, cost of some technological change may be low and if this is the case the model outcomes may be approximately right.

3.4 Policies for the circular economy

In order to develop scenario's for the circular economy, it is important to include policies explicitly. In a lot of quantitative, macro-economic studies GDP and employment effects of the circular economy are caused by policies for the circular economy. Therefore, it is important to have an idea of the main policies. The discussion of circular policies below is meant only to be a sketch, and is especially relevant for understanding what may be behind the circular economy scenarios for which the macroeconomic and societal benefits have to be evaluated.

One of the main reasons why beneficial circular opportunities don't happen are externalities. Therefore, it seems logical to search first for solutions of these externality problems. A lot of externalities are negative externalities, and these require adequate pricing or the definition of new property rights, for example through tradable permits. As far as pricing is concerned this may be accomplished through setting taxes that are roughly equivalent with the negative externality. The revenue that is generated may be used to reduce other, distorting taxes or to finance public expenditures that are beneficial for the economy. Green investment could be an example of such an expenditure.

With respect to innovation positive externalities may exist, and this may be a good reason for subsidies. While a lot of subsidies like subsidies on fossil fuels are generating externalities and these should be abolished, subsidies on innovation may help to

overcome barriers where the R&D costs are for private enterprises while the benefits are disseminated to the whole economy. Even some infant technologies may be subsidized because of positive externalities because costs decrease when the new technology is applied on a larger scale and experience is gathered over time (learning by doing).

A second category of instruments is intelligent and targeted regulation. In general, regulations that subscribe specific processes have the risk of lock-in in less efficient solutions. On the other hand, it may be efficient to set restrictions on technologies or externalities that are not consistent with a green economy. For example, governments may set maximum pollution or resource use requirements per unit of output. Governments may set minimum standards for circularity or energy use of buildings. Especially useful is if governments set these floating standards, i.e. that standards adjust to change of technological possibilities over time. A specific type of regulation is setting responsibility for producers like minimum guarantee periods or responsibility for paying the cost of recycling after disposal of the product.

A third category of instruments is infrastructure development. For example electric cars require an infrastructure of possibilities to charge the cars, public transport requires networks of infrastructure, etc. Providing infrastructure by government or organizing institutions that regulate the provision of infrastructure by private companies may be important to realize the network size that is required for new opportunities to develop.

A fourth category of instruments is green procurement by governments. Governments are large customers for many products and services. If governments focus on green procurements innovators may get a market to develop their new products and services. For example, if governments focus on lifetime costs, this may give benefits both to government and to the sellers of energy saving or repairable products, or sellers of products as a service.

A fifth category of instrument is the organization of relevant information for users. This may be through regulation requiring to provide information on energy efficiency or on lifetime costs, or information on environmental sustainability in a comparable way. This may also be relevant for a sixth type of instrument, i.e. instruments to solve financing problems because of imperfect information. Examples of these may be insurance by government of risks related to new circular opportunities.

Finally, one must be aware that a fast change towards a circular economy may create a mismatch of supply and demand of available labour and capital. For capital this is called stranded assets, while for labour this generates qualitative structural unemployment (see section 5.2). For labour it may be important to generate a flexible labour market where training and other measure to stimulate labour mobility are important (OECD, 2017).

As a final comment, one should be aware that the listing of circular policies is not meant to be a complete description of policies, but only to make aware of policies that have to be modelled in order to build circular policy scenarios.

3.5 Conclusion

A listing of circular business opportunities is not sufficient to define a scenario that defines a circular economy. Even in the baseline a number of circular opportunities will be realized, and a policy change is needed to realize more circular opportunities.

4 :: GDP effects

4.1 Introduction

Although increase in GDP is not the fundamental idea behind the circular economy, the idea that the circular economy also increases GDP is an important motivator to embrace the circular economy. Therefore, we analyse in this chapter the mechanisms through which more circularity in the economy may increase also GDP. First, we discuss the main mechanisms involved in theory, and then discuss what is accomplished in a selection of the literature. Because also trade and competitiveness issues are relevant for the outcome, we discuss possible mechanisms that may lead to increases in GDP through reduced import requirements of raw resources and increases in competitiveness because of knowledge generation for the circular economy. Also GDP effects of less political dependence will be discussed shortly.

4.2 Theory

The introduction of circular opportunities in an economy may generate GDP increase through different roads:

1. Through the environmental effect. The purpose of resource efficiency measure is "to reduce risks of resource disruption and environmental damage" (UNEP, 2017, p. 99). However, in most baselines these problems are not included, so it is also not included as a benefit in the policy simulation. If it would be included, this would imply that circular opportunities reduce pollution and therefore may reduce costs of cleaning sources for other sectors. For example, if natural water is cleaner, this reduces costs for tap water companies and therefore increases productivity of the tap water companies. Furthermore, reduced pollution may increase health or reduce congestion and this may increase GDP because less labour days are lost. As a footnote, be aware that costs of health care and costs of cleaning the environment are part of GDP.
2. Increasing scarcity may increase relative prices of resources. Development of resource prices is a race between technology and scarcity. Most baselines don't assume that prices increase, implying that the effect of introducing circular opportunities on resource prices is not very large. Especially if resources are imported, a lower price for resources implies an increase in productivity.
3. Extra productivity increases. It may be that focus on the circular economy reveals some potential for win-win improvements that were not recognized without this lens of looking at the world. The basic question is however to what extent comparable improvement would not be found without this specific lens. Furthermore, the extra productivity in the EU may sometimes be at the cost of resource exporting countries.
4. Reduction in externalities through the tax and regulation system. For example, when taxes on resources increase, distorting taxes on labour may be reduced which may increase employment and therefore GDP. One must be aware that labour tax reductions not automatically increase employment.
5. Effect of increased demand. If the circular economy generates new investment opportunities that are not crowding out other investments, then this may create

extra demand that brings unused resources into use. This effect will only happen if demand restrictions determine GDP growth in the baseline, which may happen in the short or medium term, but seems not very plausible in the long term. The circular economy is in this case used as a type of anti-cyclical policy (see for example OECD, 2017).

4.3 Literature

After having defined the main mechanisms that may explain positive GDP effects of the circular economy, let us investigate what mechanisms are applied in the current literature, where we don't limit ourselves to studies of the circular economy, but also studies on issues related with the circular economy like energy and resource efficiency. We just take a sample of studies that are representative in the sense that they include the main mechanisms found in the literature. This gives the opportunity to investigate the line of reasoning in each of the studies a little bit more in-depth.

Ellen MacArthur Foundation

"Growth within" of the Ellen MacArthur Foundation (EMF 2015) is a well-known example of a study arguing that the circular economy generates extra GDP growth. It is also an important source of inspiration for the EU action plan for the circular economy (EC 2015). Therefore, we have a detailed look at their line of argumentation on GDP-effects of the circular economy.

Their results on GDP growth are based on a Computable General Equilibrium (CGE) modelling exercise by Böhringer and Rutherford, where a standard CGE model is extended with explicit modelling of private transportation, private housing and food production, i.e. the sectors for which the circular innovations are analysed in this study (Böhringer & Rutherford, 2015, p. 10-11). Congestion is modelled by differentiating between rural and urban transport services and an exponential relation between traffic volume and congestion (Böhringer & Rutherford, 2015, p. 13). Driving time is modelled explicitly and has consequences for effective labour supply (Böhringer & Rutherford, 2015, p. 15). Also revenue neutral tax green reforms are modelled reducing labour taxes as compensation for increasing green taxes (Böhringer & Rutherford, 2015, p. 11). Involuntary unemployment is modelled through the wage curve, i.e. a curve that relates unemployment and real wages. Such a wage curve may be defended by wage bargaining processes and efficiency wages (p. 12). However, for disruptive technology shocks this curve is switched off (p. 13), because it is assumed to be relevant only in the medium term. So, Böhringer & Rutherford (2015) argue that it is not correct to include this effect into an analysis of the benefits of the circular economy. Voluntary labour supply seems to be influenced by time requirements of transport (p. 20), but this is not explicitly mentioned in the model description. Only exogenous technological change is modelled, because drivers and mechanisms of endogenous technological change are theoretically and empirically too uncertain (p. 14).

The basic line of simulation is that the model starts with the situation in the base period (BAU) and then models the developments according to the linear respectively the circular model through exogenous technological shifts, i.e. implying that the technological shift is at no additional cost (p. 17) and has no opportunity cost with respect to other technological changes (p. 18). So, this line of modelling would not be correct for the switch to solar energy in Germany that had a cost of more than 20 billion euro annually (p. 18).

The results of the simulations are explained by a combination of dynamic effects as a consequence of technological change and green taxation. Let us try to calculate roughly how the assumptions for 2030 for the linear and circular model translate into the final model results[4]. The estimates of the cost reduction to be realized are derived from the case studies. For transport, for example, transport cost is assumed to be reduced by 20%, and travel time with 30% in the circular model compared with the linear model. For housing it is a reduction in costs of 3.3% and for food a cost reduction of 25%. The shares in GDP are roughly 8, 22 and 12%., in total 42%. The three sectors together being a little bit more than 40% of GDP having about 10% cost reduction, implying in increase of GDP of about 4.2%, where we implicitly assume that the rebound effects are such that the share of the sectors remains the same. For external cost being about 10% of GDP the reduction is assumed to be about 20%, adding an extra 2% to GDP. The reduction of costs of the whole model is about 6.3%. Therefore, most of the GDP-effects in EMF (2015) are based on the assumed productivity increases in combination with a reduction in externalities on the labour market as a consequence of conversion of unproductive time to productive time because of less congestion and perhaps also greening taxation (however it seems that this mechanism is switched off in the model). In summary, the positive GDP results of Böhringer and Rutherford are the consequence of the estimate by the Ellen MacArthur Foundation that technology change will be fast, faster than in most other studies, and the assumption that market failures will be corrected through green taxation (UNEP, 2017, p. 101).

Böhringer & Rutherford (2015) warn explicitly that economic costs like R&D or opportunity costs of foregoing other technological changes are not in the model. i.e. the cost cuts come for free. Real "hidden costs" or costs to reduce the barriers to increased efficiency may reduce the benefits of the circular opportunities. Therefore, according to them there is no proof that the GDP effects will really happen.

Resource efficient scenarios for the built environment

In order to get a broader view, let us investigate also some other relevant studies. The study "Resource efficient scenarios for the built environment" (EC 2014) build their analysis from a list of resource efficiency increasing opportunities for the build environment. They select a number of options that have negative net costs compared with the baseline, and therefore will increase GDP (EC, 2014, table 4.3, p. 35). The main cause of the increase in GDP in the report is the implied general efficiency increase. The report mentions explicitly that if also options for resource efficiency that increase cost price are included, GDP may not rise at all.

International Energy Agency

IEA (2012) use the general equilibrium ENV-linkage model to analyse climate scenarios with respect to the energy sectors. The focus is on energy efficiency. The spending on more energy-efficient capital goods reduces expenditure on energy consumption and therefore increases disposable income. Energy-importing countries benefit and energy-exporting countries have a disadvantage (UNEP, 2017, p. 100). IEA(2012) describe an efficient world scenario where all economically sensible GHG saving energy measures are

[4] We calculated all in a spreadsheet Calculation of cost reduction transport Bohringer_2015.xlsx, using the assumptions in table C1 of Böhringer & Rutherford (2015) where we interpret BMK roughly as share in GDP and where cost reduction in the linear model are not corrected for a possible decrease in the share of GDP (although through the rebound effect the share of housing may increase, while the share of transport and food may decrease).

implemented. In this scenario primary energy savings are 13% requiring an investment of $2.2 trillion over the period. This investment saves $4.9 trillion on energy expenditures for consumers in the period 2012-2035. As a consequence GPD rises with 1.1%, i.e. $ 0.3 trillion in 2035. So, the GDP rise is caused by the reduction in energy expenditures caused by less energy use and lower energy prices that is higher than the investment expenditures required for it. This benefit is already assumed by the definition of the scenario where only economically sensible investments are considered, while these investments will not happen in the baseline because of externalities.

Econometric models

Econometric models use estimated equations, increasing input of empirical information, but without guarantee that equilibrium happens. Because labour markets may be out of equilibrium this type of model has the potential that employment increases through demand effects. They are mainly used for short and midterm analysis of macroeconomic policies (UNEP, 2011, p. 509), but sometimes also used for long term analyses.

The E3ME model from Cambridge Econometrics is an example of an econometric model. This model pretends also to be long-term by estimating the equations of the model by co-integration and error correction methods with instrumental variables. The Post-Keynesian structure of the model allows for disequilibrium, where Keynesian stimulation may increase employment and production and may also have long-term consequences through endogenous technological change (learning by doing and extra R&D). CE & BioIS (2014) use this model to investigate the effects of resource efficiency improvements. They model market-based instruments, private-funded measures as recycling and public funded capital investments to improve efficiency. Extra tax income from environmental taxes is used to reduce labour taxes. Marginal cost information of the different abatement options is included in the model as abatement cost curves, but based on top-down information, because little bottom up information is available. In the end the GDP effects are mainly caused by the environmental tax reform, not the efficiency improvements (UNEP, 2017, p. 103).

GINFORS is also an econometric model used for resource efficiency evaluation (Distelkamp & Meyer 2016; Meyer et al. 2015, pp. 53-54). It has food and raw material price increases as well as unemployment in its baseline. Furthermore, it is assumed that lower material inputs reduce total cost in manufacturing while costs are also reduced because of lower ore and fossil fuel prices. This generates an increase in GDP for resource importing regions at the cost of GDP in resource exporting regions. However, the main GDP effects in the model are caused by increased investment that does not crowd out other investment, and uses unemployed resources (UNEP, 2017, p. 104). This implies that there is cyclical unemployment or a type of structural unemployment that can be solved through extra aggregate demand (see section 5.2 for the definitions of different types of unemployment).

The same GINFORS model is used by Lutz & Lehr (2015) who analyse the macroeconomic effects of renewable energy and increases in energy efficiency. They report GDP increases because of extra consumption as a consequence of efficiency increases and therefore lower prices, generating extra demand. Reformulated this implies that the GDP increase is caused by increases in efficiency. Therefore, despite the difference in structure the model does not have fundamentally different results from the CGE model that is for example used for the “Growth within” study of the Ellen MacArthur Foundation (EMF, 2015).

System dynamics models

System dynamics models implement causal relationships of different types as differential equations, and are used to analyse complex systems. There is no guarantee that economic logic is implemented as in general equilibrium models, but it is potentially possible. In contrast with general equilibrium models system dynamics models are inherently dynamic. However, dynamics can also be built into general equilibrium type of models.

UNEP (2011) uses the system dynamics Threshold 21 World model (p. 509), being a global model without differentiation between regions. It generates increases in GDP by having natural capital in the production function, and also include land, water, energy, waste and emissions as relevant for cost. Decline of natural capital (fish stocks, forestland, fossil fuels) reduces GDP growth in the baseline, and reduces also employment. By correcting this, GDP can grow.

Summary

In most models, positive GDP effects are generated by increases in factor productivity, greening of taxation where green tax revenues are used to reduce externalities in the labour market and effects caused by extra investment that is not crowding out other investment. Also solving some externality problems like congestion or price increases of imported resources may increase GDP. If models assume a baseline where resource scarcity increases cost, then in the long term the circular economy may be beneficial for GDP.

4.4 International trade and competitiveness

Although not explicitly discussed in the literature, the circular economy may also increase GDP through international trade and competitiveness. The circular economy focuses on the reduction of resource use, and in many cases these resources are imported by the EU. Therefore, without further adjustments net exports of the EU will increase. This implies that either net foreign investment must increase (through an increase of the interest rate), or the real exchange rate must rise because foreign countries need euros to buy the exported goods, generating a reduction in exports and an increase in imports. In the first case the extra investment may increase labour productivity and therefore GDP, while in the second case national income will increase because the real exchange rate is higher making imported goods cheaper and getting higher prices for the exported goods.

Another issue that is often mentioned is that if the EU is an early adopter of new circular technologies and these technologies become mainstream in the world that the EU may develop a competitive advantage in these technologies. The EU may export the commodities that have been developed or the knowledge that has been created. This again must be put into a broader perspective, because trade balance, investment and savings are related. Therefore, if exports of circular commodities or knowledge increases, the real exchange rate may adjust with as a consequence that other commodities will be exported less or imports will increase. In case the factor productivity of the newly exported goods is higher than the exported or imported goods they replace, GDP may increase.

If more knowledge is available in the EU, this may imply that more profitable investment opportunities are available. As a consequence, the inflow of foreign capital may increase and therefore net savings are reduced. This requires smaller net exports, according to the equation

Export – import = Savings – Investment

So, also the investment effect will increase demand for European currencies and therefore increase the real exchange rate, reducing exports and increasing imports.

Finally, a reduction of imports of resources may have important geopolitical consequences and therefore reduces uncertainty. A lot of primary materials are mined in a limited number of regions, making price and perhaps even availability uncertain. When the EU imports less of them, the consequence of sudden price increases or political pressures will be less. We have seen the type of risk involved with respect to oil during the first oil crisis, with respect to gas at the moment Russia reduced its gas exports, and more examples are available. To the extent that companies see this as a real risk, this may already reduce factor productivity and therefore GDP, but when it happens, it may have negative consequences for GDP directly because of disruption of production or firms going bankrupt as a consequence of the price changes. Reducing supply risks and preventing political pressure using supply reduction as a mean, is one of the reasons behind the focus on the circular economy.

4.5 Conclusion

The GDP effects of a circular economy may be attributed to reduction of environmental externalities, reduction of prices of scarce resources in the long term, the assumptions that higher resource productivity also generates higher factor productivity, greening of the taxation system reducing externalities of labour taxation, and increases in demand because of circular investment. A rough estimate of the model outcomes can be made through direct calculation based on the assumptions.

In most models, positive GDP effects are generated by increases in factor productivity, greening of taxation where green tax revenues are used to reduce externalities in the labour market and effects caused by extra investment that is not crowding out other investment. Also solving some externality problems like congestion or price increases of imported resources may increase GDP. If models assume a baseline where resource scarcity increases cost, then in the long term the circular economy may be beneficial for GDP.

A more circular economy will have consequences for the import of raw materials by the EU, and this will influence the real exchange rate and perhaps also net investments in the economy. It may be that benefits for the EU of less import requirements and lower prices of imported raw materials has negative consequences for resource exporting countries. Finally, development of new circular technologies may potentially provide a competitive advantage for the EU, both for exporting the technologies and exporting the products produced with the new technologies.

We have to keep in mind that GDP increases are not the primary purpose of the circular economy, where a lot of positive welfare effects from the perspective of cost-benefit analysis are not included in GDP. This will be discussed further in section 6.

5 :: Employment effects

5.1 Introduction

The main reason for attention to employment growth is the reduction of unemployment. In order to understand potential effects of the circular economy on employment, it is important to understand the unemployment problem first. Then shortly the idea of green employment is discussed, but the main focus is on the question to which extent total employment may increase as a consequence of the circular economy.

5.2 Unemployment and the circular economy

In order to understand the effects of the circular economy on unemployment it is important to understand the causes of unemployment. First, there is *frictional* unemployment which is normally short term. This happens at the start of a career, when switching career, after moving to a new region or after a period of being outside the labour market. Second, there is *structural* unemployment, which can be long term. This is when the skills of workers or their minimum income requirements don't match the jobs available. This may be caused by insufficient education. It may also be caused by skills becoming outdated because of technological change or outsourcing to other countries without the labour force being trained for the requirements of the new jobs or not having the capability to do these jobs even with proper training. In these cases this may be called *qualitative structural* unemployment, implying that there may be vacancies for some types of jobs and unemployment for other types of jobs while aggregate demand for jobs equals aggregate supply. If income requirements of workers are higher than the productivity this maybe called *quantitative structural* unemployment, i.e. aggregate demand for jobs is smaller than aggregate supply of jobs because the wage to be paid to workers is higher than the equilibrium wage. The income requirements may be individual, set by government, set in collective agreements, or just because firms want to motivate workers by paying them above equilibrium wages to improve efficiency (efficiency wages).

Finally there is *cyclical* unemployment, i.e. unemployment caused by insufficient demand. According to Say's law cyclical unemployment is temporary. However, as Keynes (1936) mentions lack of aggregate demand may be long term in case. The latter is called "secular stagnation".

5.3 Green employment

A lot of literature exists on gross green employment effects, i.e. increases in employment in new activities of the green or circular economy without considering that jobs in other sectors may be destroyed.

Jacob et al. (2015) provide an overview of the literature on employment in the green economy, with a specific focus on developing countries. They distinguish the sector-based and macro-economic green job concept, where the first is focused on the gross employment effects of expanding green sectors and the second is focused on the net employment effects (Jacob et al, 2015, p. 42). The sector-based green job concept can be either the number of jobs in green sectors (Eurostat and OECD, 1999), or all jobs in

businesses that have more environmentally friendly production methods (US Bureau of Labor Statistics), or even include decent working circumstances (ILO 2012) (Jacob et al, 2015, p. 20).

Direct employment effects, especially in the narrow sense, are relatively easy to measure. The indirect employment effects include the employment effects in the upstream and downstream sectors in the value chain and are called multiplier effects in input-output analysis. Finally, even induced employment effects are sometimes included being the employment generated through spending of the extra earned income by the additionally employed people (Jacob et al, 2015, p. 42-43). Employment factors are defined as gross employment per million euro investment (Jacob et al, 2015, p. 43). Jacob et al refer to the political importance of the sectoral green job concept and therefore suggest that no internationally recognized definition will emerge (Jacob et al, 2015, p. 60).

Wijkman and Skänberg (2015) of the Club of Rome conclude that unemployment can be reduced if the trade surplus increase that is generated by smaller import of fossil fuels and materials is invested. This implies that exporting countries will see a reduction of employment. This is based on an input-output analysis. However, an input-output analysis ignores potential feedback effects through the labour market, credit market or otherwise. This type of effect is included in general equilibrium analyses. Wijkman and Skänberg (2015, p. 35) acknowledge that these general equilibrium effects should be included but are not (p. 107).

Dobbs et al. (2011) calculate employment effects of resource efficiency by using numbers derived from another study, i.e. the Federal Highway Administration (2007), that uses input-output analysis to derive the employment effects of extra investment. The fundamental idea behind it is that extra expenditures (in this case through investment) generate extra jobs. The calculation is basically a gross employment effect that is only compensated if unemployment is low, in the order of magnitude of 1 year of employment created per $ 45,000 to $ 1,000,000 spend on investment (in infrastructure).

A step further in the analysis of green employment may be to subtract the employment in the sectors that are replaced. For example, if wind and solar energy are at the cost of fossil energy, the net effect may be calculated.

In conclusion, counting jobs in directly or indirectly related activities gives an impression of the dynamics that is generated by the introduction of the circular economy. However, it does not tell to what extent the circular economy also reduces unemployment. For this, net employment effects have to be calculated.

5.4 Net employment effects: theory

In order to investigate net employment effects of the circular economy, a consistent view on the labour market is required, where it is made very explicit what type of unemployment is influenced by the circular economy. Horbach et al. (2015, p. 19) investigated studies on green employment and conclude that not many have a consistent economy-wide view with a consistent labour market, and no one analyses the net employment effects of more recycling or refurbishment activities.

Empirical studies on net employment effects use economic models. Computable general equilibrium models, system dynamics models and econometric models may be distinguished (Jacob et al. 2015, p. 11). Most studies show no or only small employment effects (Jacob et al. 2015, p. 60), but it may be that when price effects of increasing resource scarcity are included the growth effects of green policies can be positive in the

long term (Jacob et al. 2015, p. 61). However, extra growth does not automatically generate reduction in unemployment. Even wrose, because of potential negative effects for the sectors that have to shrink unemployment may even increase in the short term. Therefore, it is important to have labour market and social policy instruments to increase labour mobility. If a green policy is accomplished through green taxation the revenues of the green taxes may be used to reduce distortionary labour taxes or to pay for labour mobility programs (Jacob et al. 2015, p. 62).

The reasons for net employment effects can be distinguished in the following types.

- Reduction of distorting labour taxes through green taxation reducing structural unemployment.
- Increase in profitability that in case of quantitative structural unemployment increases labour use at fixed minimum wages
- Increase in investment or other spending reducing circular unemployment
- Better adjustment to job skills and income requirements of workers, reducing qualitative structural unemployment
- Reduction in qualitative structural unemployment by having a larger range of commuting distance because of less congestion or better infrastructure, or a healthier population.
- Social programs focused on the circular economy, giving people a subsidized job that saves on social security payments and at the same time makes repair or recycling cheaper.

When analysing the final effects on employment one has to take into account the whole economy. This implies that if investments in the circular economy are made, one must be aware that investment is determined by the circular flow in the economy. Therefore, if investment is done for one purpose and savings and money creation don't change, then this will crowd out other investment, including the employment that may have been generated by the alternative investments. If employment opportunities are created for the circular economy then this implies extra demand for labour and when the labour market was in equilibrium before some other labour may be crowded out.

5.5 Net employment effects: literature

After having defined the main mechanism that we can think of as explaining possible positive employment effects of the circular economy, let us investigate what mechanisms are applied in the current literature, where we don't limit ourselves to studies of the circular economy, but also studies on issues related with the circular economy like energy and resource efficiency. We just take a sample of studies that are representative in the sense that they include the main mechanisms found in the literature. This gives the opportunity to investigate the line of reasoning in each of the studies a little bit more in-depth.

Neither IEA (2012) nor Böhringer & Rutherford (2015) report employment effects in their general equilibrium analyses, probably because it is not significant (UNEP, 2017, p. 107). Böhringer & Rutherford (2015) state explicitly that the main employment generating mechanism, the labour supply curve, is switched off because their purpose is to analyse long-term effects, implying also that changes in taxation will have no effect on employment. However, in an older study, Böhringer et al (2013) use the model with a labour supply curve and gradually adjusting wages, allowing for structural unemployment and therefore generating some employment effects.

CE & BioIS (2014) using the econometric E3ME model from Cambridge Econometrics investigate scenarios with increased resource productivity, where the resource productivity increase is coming from three sources:

- 1/3 publicly funded investments in the capital stock to improve resource efficiency
- 1/3 privately funded business measures (such as recycling systems)
- 1/3 market-based instruments (MBI) (such as tax)

They report employment effects that are mainly the result of using revenues from resource taxes to reduce labour cost (UNEP, 2017, p. 108), implying that they implicitly have a rising labour supply curve, something that has been explicitly switched off in the CGE model of Böhringer & Rutherford (2015) because it is not plausible that labour supply is rising in the long term.

UKERC (2014) analyses the effect of more labour-intensive renewables compared with their fossil alternative, and concludes that this may create jobs in the short run during a recession. So, their employment effects are possible because of the existence of circular unemployment. OECD (2017) is even more explicit, and assumes that till 2020 governments may increase investment for climate policies by generating a budget deficit because of the existence of cyclical unemployment during that period.

Chateau & Saint-Martin (2013) and Château et al. (2011) use the CGE ENV-linkages model of the OECD with lagged wage adjustment to analyse greenhouse gas mitigation options and conclude that in the short term unemployment may even rise because of adjustment processes for wages, but that in the long term the income of the environmental taxes can be used to reduce taxes on wages. This may increase employment. Böhringer et al (2013) analyse the effect of subsidized renewable energy and conclude that if these are financed by wage taxes, the employment effect will be negative.

Morgan & Mitchell (2015) analyse the British economy with respect to mismatch of labour supply and demand with respect to skills and regions in the UK, including potential trends, and then compare this with labour demand for circular economy sectors with respect to skill and region, based on current statistical data and expert interviews. The outcome is presented in figure 3 below, where net job creation of a circular economy scenario is compared with (current) unemployment, suggesting that the circular economy creates jobs in the type of jobs where unemployment is high. A comparable exercise is done for the regional distribution of unemployment.

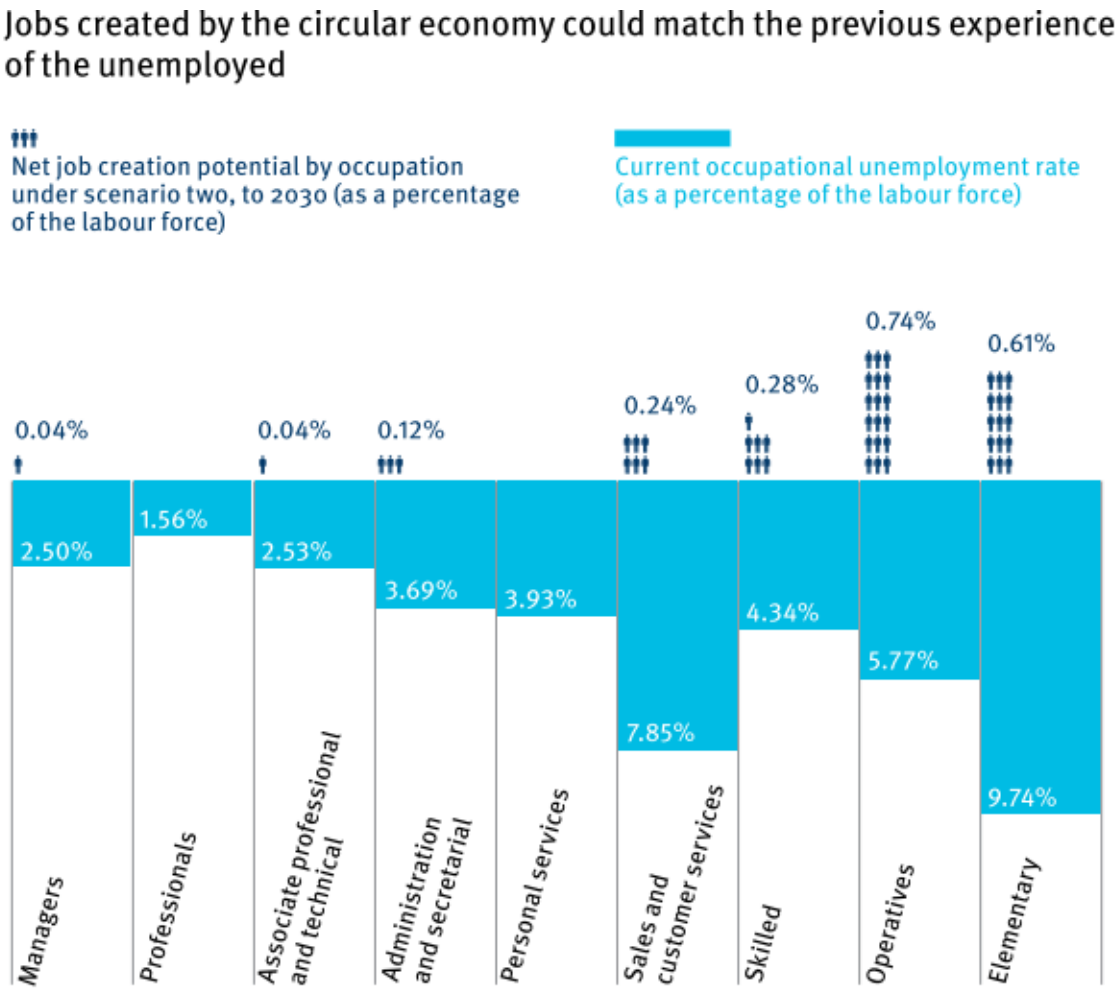

Figure 3 Jobs supply and demand per skill type in the UK (source: Morgan and Mitchell, 2015, p. 17)

In summary, the studies discussed above have as their line of argument that if the circular economy has effects, it may be either in case of cyclical unemployment, or because it either reduces or increases qualitative structural unemployment depending if the change in job composition is more or less focused on the current pattern of unemployment. In case there is quantitative structural unemployment it may be increased or reduced depending on the question to what extent the circular economy reduces or increases factor productivity. Circular economy policies like greening taxation and spending the tax income either on reduction of taxes on low-paid jobs or investment, may also increase employment. As far as the circular economy reduces net imports, it may give a boost to investment that may reduce unemployment in case of circular unemployment.

5.6 Conclusion

Employment effects in most analyses are not based on the circular economy in itself, but on the effect of policy changes or mechanisms that are not specific for the circular economy. First, extra investment or investment in more labour intensive technologies may increase employment in case of circular unemployment or quantitative structural

unemployment. However, there is an issue of timing and targeting these impulses. In case of long-term cyclical unemployment (as after the crisis of 2008 and by the OECD projected to continue till about 2020) or secular stagnation, then increases in spending may increase employment.

Second, employment may increase because of greening the tax system, i.e. reducing the wedge for potentially unemployed people, where it is important to have the tax reductions for people who are difficult to employ because current wage levels are too high. This may be because of social security benefits or collective agreements, minimum wage laws or because institutional dynamics sets minimum wages that are above the equilibrium wage.

Third, if the circular economy opportunities generate jobs in regions or skill categories with high unemployment, then this may reduce qualitative structural unemployment. However, as far as the circular economy is disruptive it destroys jobs in traditional industries where the people who are fired not automatically have the right skills for the circular economy. So, labour mobility programs may be essential for a smooth transition to a circular economy in order to prevent increases in qualitative structural unemployment.

Fourth, sometimes unemployment is reduced by providing low-paid work in the recycling industry to people with less abilities to work, i.e. a choice is made to develop circular projects in social employment programs.

As a comment, it may be that scarcity on the labour market stimulates not only labour productivity but also the efficiency of technology in general because with high wges companies will not survive if they do not increase efficiency. Furthermore, the extra investment or the higher labour intensity of production may also generate employment if it induces extra immigration of labour or creates incentives for people in the labour force to acquire the necessary skills.

As a final comment, one must be aware that employment in the old industries may be reduced, which may have political consequences.

6 :: Environmental and welfare effects

6.1 Environmental effects

An important argument in favour of a more circular economy is to save on primary resources, to a large extent in order to reduce dependence on uncertain imported resources, and reduction of environmental pollution. Therefore evaluation of the environmental effects of the circular economy is one of the main issues.

Calculation of environmental effects is at first sight straightforward. One must just calculate the resource inputs and environmental effects of the sector under investigation with and without the circular opportunity.

However, in practice this is more complicated. First, there are interactions in the value chain. Therefore, a life cycle analysis of the two alternatives is required. Second, the production of the output may have consequences for the pollution and resource use of the value chain that is replaced by the new value chain. If this is the case, this must be evaluated, too.

Added to this may be the effect that is called indirect land use effects in the case of biofuel policies. In the case of biofuels the direct land use change may involve for example replacement of a food crop to produce a biofuel crop in Europe. However, the food crop that is replaced has to be produced somewhere else. Where the final expansion of cropland occurs determines in that case the final effect of the production of biofuels on greenhouse gas emissions through land use change. This very complicated process of substitutions makes the environmental evaluation of the effect of creating a biological circle through biofuels very complicated.

The next issue is the rebound effect. Three levels of rebound effects may be distinguished (UNEP, 2017, p. 106). First, direct rebound effects are about the goods where the efficiency improvement is; i.e. if the good becomes cheaper demand for it may increase resulting in more demand for the good. Second, indirect rebound effects are the consequence of lower prices of the resources that are used for the goods, generating increases in production in other sectors that are using these resources. Third, macroeconomic rebound effects include also further effects like a possible increase in income that may be used to buy resource using or polluting commodities. All these rebound effects happen if the circular economy opportunities really reduce cost; in the case they increase cost the macroeconomic rebound effect may function the other way round.

An extra thought on the rebound effect may be that some aspects of the Indirect Land Use Change (ILUC) effect of biofuels can also be considered as similar to the rebound effect. In standard calculation of ILUC agricultural land expansion is less than the direct land use for the biofuel because of price induced yield increases and consumption reduction. So, both are just as the rebound effect the consequence of market-mediated changes in production and demand for other commodities.

Policy measures may mitigate rebound effects (UNEP, 2017, p. 106). For example, if the circular opportunities are introduced because of taxes on resources instead of subsidies on the circular opportunity, the rebound effect will be eliminated for the regions where the taxes are, although on a global level they may still exist.

In summary, the evaluation of the environmental effects of circular opportunities may be complicated because the introduction of the circular opportunity may have consequences for the whole value chain and because of rebound effects.

6.2 Welfare effects

Even if the circular economy has no positive effects for GDP and unemployment, welfare may increase. The fact that external costs are not priced, is a fundamental cause of extensive resource use and environmental damage. Internalization of these costs may solve the problem and therefore increase welfare. However, this increase in welfare is not automatically visible in GDP, because some external costs are not included as expenditures in GDP calculation (UNEP, 2017, p. 92). Even worse, some external costs like health care are included in GDP, so reduction of these external costs is an increase in welfare, but not in GDP. Also reduction of consumption through sharing and other means may sometimes imply a reduction in GDP.

Unpriced externalities may be seen as implicit subsidies. UNEP (2017, p. 96/7) shows the explicit and implicit subsidies of fossil fuels. These unpriced externalities include global warming, air pollution, local factors like congestion, accidents and road damage, and

these are very large compared with explicit subsidies. Based on such information Coady et al. (2015) estimate the benefit of eliminating all explicit and implicit fossil energy subsidies, including reduction of CO_2 emissions and less premature deaths from air pollution (using a simple static cost-benefit analysis) as 2% of global GDP. The benefit of using the green tax revenue to reduce distorting taxes or to raise public expenditures with high social value is not included in this number.

Reduced dependency on imports of resources is seen as an important argument for the circular economy. This could be included in a broader view on welfare, where such dependency and the risk of sudden price increases of important resources have negative consequences for society in the EU as a whole. Less resource use gives less risk on price increases, price fluctuations and less dependence on a limited number of regions. Less resource dependency may reduce geopolitical conflicts. A lot of conflicts seem to be caused by international dependencies with respect to crucial sources like crude oil and gas.

7 :: What information is needed from case studies?

Case studies in the project "Circular Impacts" can be seen as elements of the list of circular opportunities that define a circular economy scenario compared with a linear scenario. It is obvious that the case studies will only be a small sample of the circular opportunities that may emerge. Therefore, the scenario definition in Work Package 5 will include more than the listing of the circular opportunities investigated in the case studies. Case studies are meant to show the general principles of investigating the aspects of circular opportunities that are relevant from a macro-economic and societal perspective.

The starting point of the listing was the question to what extent the circular opportunity could be part of the baseline. Therefore, defining this baseline is an important first step in the analysis of the case study. When one knows this baseline, it is important to know what the characteristics of the circular opportunities in the case study are, and especially to what extent they are profitable under baseline circumstances, both in the case that externalities are included and they are not. If the circular opportunities in the case study are not profitable without valuing externalities while it is if externalities are included or the economic structure is changed towards a circular world, then it is important to analyse the barriers and the possible policies to solve the barriers. In order for the circular opportunities in the case study to be relevant in a circular economy scenario, it is important that policies are implemented that are sufficient for the circular opportunities to be realized. We have seen that many macroeconomic and societal benefits of circular scenarios arise because of the implemented policies.

If the circular opportunity is realized, it is important to have an impression of the sectors that are influenced, including the sector that may be replaced by the circular economy, the sectors in the value chain, and available income left for other spending. For environmental evaluation, all these aspects are relevant, because pollution and resource use of all parts of the economy involved determines the final effect on environment and resource use.

For the macroeconomic part, it is important to have an indication of:

- Changes in factor productivity, i.e. input requirements per unit of output, where one has to be aware that also the quality of the output may change.
- Changes in trade flow, especially imports of raw materials
- Amount of investment needed
- Changes in employment quantity, where it is important to prove that the generated jobs are additional to baseline employment
- Composition of labour demand compared with scarcities on the labour market
- Externalities in production that may be reduced by the circular opportunity. For example, better waste management may imply less external costs.
- Welfare effects of the externalities that may be reduced
- Does the circular opportunity create skills or knowledge that gives a competitive advantage or that can be exported to other regions of the world?

This list is an indication of the information that is needed. Everything should be compared with the baseline. What specifically is needed depends on the type of case study.

8 :: Conclusion

The discussion in this report shows that it is not easy to define exactly what the circular economy path is and what its macro-impacts are. The first step is to get a clear view on the circular opportunity under investigation and to show that this circular opportunity is not part of the baseline development of the economy. The case study must show that it is currently or potentially beneficial from the perspective of a social cost-benefit analysis, and must also show the private costs and benefits in order to get a good impression to what extent it may be profitable if some institutional conditions, for example regulations, are changed. If the opportunity is profitable from a private perspective, then win-win situations are possible and therefore it is important to analyse how the barriers to its implementation can be removed. If it is not profitable under current circumstances, then further policies are needed, of which the introduction of environmental taxation could be one.

For the analysis of the environmental effects of the circular opportunity, it is important to have clear data on the inputs and outputs of the circular opportunity and compare this with the baseline opportunity. This analysis includes indirect effects through input-output relations and perhaps also induced effects if incomes are changed and rebound effects if relative prices are changed.

For the analysis of GDP effects insights in productivity changes compared with the baseline are relevant, because this is the main mechanism by which GDP changes. To analyse employment effects, it is important to get insights to what extent the circular opportunity changes qualitative mismatches on the labour market or helps to reduce unemployment that is caused by low aggregate demand or lack of flexibility in wages. If employment effects happen, then this may influence GDP, too.

With respect to international trade, it is important to get a grasp on the effect of the circular opportunity on import and export flows. As far as resource use is reduced,

imports of resource importing and exports of resource producing countries will be reduced, with consequences for investment, savings, employment and the exchange rate. With respect to international competitiveness the circular opportunity may generate a competitive advantage through increased skills, and knowledge, either by R&D, diffusion of knowledge or learning by doing.

Finally, evaluation of welfare effects is a more integral evaluation of the circular opportunity with respect to all aspects of welfare, where we have seen that a lot of aspects of welfare are not included in GDP or employment effects. Examples of these effects are effects on health, stress, social relations and happiness.

What is not included in the current discussion are the consequence of less resource dependency on price stability, international financial stability and political stability. These issues may be very important incentives for a circular economy, especially also from the perspective of the European Semester.

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