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Short Assessment of the report

"GROWTH WITHIN: A CIRCULAR ECONOMY VISION FOR A COMPETITIVE EUROPE"

published by the Ellen MacArthur Foundation
and the McKinsey Center for Business and Environment

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I. EXECUTIVE SUMMARY

The report by Ellen MacArthur and McKinsey provides a vision of the European economy transiting from – according to EMA - a very resource-intensive towards a "circular" economy for Europe. The circular economy, understood as a very broad concept, is reached by reducing waste, increasing reuse of materials and remanufacturing of products, by switching to renewable energy and by an altered consumer behavior that relies more strongly on sharing, renting, and reusing rather than buying and discarding of products. This is the central theme of the report. The report posits that the transition, and the large efficiency gains that are to be realized in the process, are made possible by emerging smart technologies ("technology revolution") such as big data, virtualization, mobile communication, and autonomously driving vehicles, but also by smart policies. EMA 2015 identifies various barriers towards achieving these goals, it names regulatory and market failures as important obstacles that need to be addressed by appropriate policies, but also customs and habits and a lack of capital. The report singles out three sectors - mobility, food production, and the provision of office and residential spaces - as key sectors that allow realizing unused potential.

To be sure, it is highly desirable to realize unused efficiency gains, where they exist, through the removal of market and regulatory failures. Environmental regulation needs to optimally address

negative externalities, which are those negative effects of producing a good that are not reflected in the market price, the most prominent example being pollution or other forms of environmental degradation. Therefore an intelligent policy needs to identify market failures, quantify the consequences thereof and design instruments that obtain the desired results in the least invasive form.

By addressing the resource-intensity of production and pointing out ways to reduce it the report raises very important and relevant issues and in that sense is a very welcome contribution. Yet it does neither clearly identify or quantify the externalities that give rise to market failures nor does it provides concrete policy recommendations and thus is no blueprint for policy action. The report does not detail in what ways efficiency gains can be realized through the advent of new technologies, which create new business opportunities to be taken up by firms operating in competitive markets, and where market and regulatory failures prevent the realization of societal gains. Only market and regulatory failures would constitute a justification for government intervention; yet these are not clearly identified and quantified and no instruments are proposed to adequately address these problems. Not even a path for CO2 emissions is specified, which would be the central entry point for addressing global warming, the biggest market failure.

Likewise, it is very clear that a far-reaching switch to renewable energy, or the creation of integrated multimodal mobility systems, as proposed by the report, imply major investments and disinvestments. Yet, it does not become clear from the report how large these investments need to be, which costs they entail, and for whom. In addition, international repercussions need to be taken into account much more than the report does. While the report suggests that the switch to the circular economy will increase the competitiveness of the European economy, it does not answer the question whether the technological progress - one of the key enablers for the circular economy - is assumed to be limited to Europe or whether it is global and if so, how the increase in competitiveness will come about if advanced technologies are adopted in other parts of the world as well. If regulations are tightened, costs will typically increase and it is not obvious how this should increase competitiveness. In short, the report is surprisingly vague about implementation issues.

While the report is very vague in identifying concrete policy recommendations, it is surprisingly concrete - and very optimistic - about the scenarios it projects. The empirical basis on which these projections are made, is however insufficiently documented so that a final assessment on the reliability of the projections is infeasible. Central assumptions are not detailed, no sensitivity analysis with respect to these assumptions is carried out and thus it remains opaque how plausible the estimates are. In particular, assumptions on the rate of technological progress, a main driver of the projected scenarios, are neither detailed nor are reasons provided why the values used are best estimates. Thus plausibility of the results cannot be assessed. Repeatedly, assumptions and projections seem overly optimistic; but essentially they cannot be independently assessed on the basis of this report or the documents cited.

In all likelihood, the emerging technologies will create a potential for enhancing productivity and for further decoupling resource use and growth. Therefore analyses that project these developments and analyze a potential need to adjust existing regulations to the new circumstances are very welcome. Moreover, it is by no means clear that all current environmental regulations are efficient in design or dosage and thus concrete analyses that help to optimize existing regulations or adjust them to changing technologies are very useful. To be policy-relevant these analyses need to be concrete, detailed and provide a clear analysis on which grounds - and to what extent - regulations have to be imposed or altered. The report by Ellen MacArthur and McKinsey does not provide such an analysis. It can neither serve as a policy guideline nor does it provide a sufficient empirical basis on which such a policy guideline could be built.

The report formulates a vision, which is useful as a starting point for providing incentives for more detailed, better documented and more cautiously interpreted results. It is not a basis from which policy decisions can be derived, but it is hoped that more extensive and more accessible research will eventually provide such a basis.

II. INTRODUCTION

The report published by Ellen MacArthur Foundation and McKinsey Center for Business and Environment (in the following EMAF 2015) starts with the observation that the European Economy is very resource-intensive. It identifies what the authors regard as potentials to significantly improve resource productivity by reducing waste, increasing recycling quotas, and improving the productivity of infrastructure and consumption good usage. The yet unused potential for productivity enhancement in production and efficiency gains in consumption is identified to be brought about largely by the advent of new technologies that make “smarter” solutions possible, but also through "smart" policies that allow the European societies to fully reap the benefits of increased efficiency and new consumption patterns. Intermediate goals are to preserve and enhance natural capital, optimize resource yields and to foster system effectiveness through internalizing negative externalities (EMAF 2015: 23). These goals are reached according to EMAF 2015 by the shift towards renewable energy, by regenerating ecosystems, increased sharing and reduced product loop speed, and by increasing efficiency in production and logistics through smart technologies, and keeping product components and materials in closed loops. Further measures include switching to virtual products and exchanging old materials, technologies and products with new advanced materials, new production technologies, and new products. The report exemplifies its ideas with three sectors that are deemed most important and to have large potentials for efficiency enhancement: the transport sector including individualized mobility, food production, and the provision of office and residential space.

Of course, low recycling rates, wasteful production and increasing environmental degradation are reasons for serious concerns and thus initiatives to increase productivity, to realize unused potential and to preserve the environment are very welcome. In other words, this author fully agrees with the overall goals that the report seeks to pursue.[1] Yet, while the goals are

[1] However, it needs to be kept in mind that reduction of waste may not be the only goal; frequently it conflicts with other goals such as food security or safety in general. At times recyclability and waste reduction may be in conflict as well: Some recyclable package material may use more resources than thinner, non-recyclable material. With recycling quotas significantly smaller than 1, it is not a priori clear which option is the preferred one. Yet for Germany, recyclable and non-recyclable plastic packing has become significantly thinner over the past two decades (Schüler 2014). Recycling quotas for packings in Germany are at 71 percent, 98 % of all packings are utilized

undisputed questions remain to what extent the proposed changes bring about the desired results, what these proposed changes actually entail in terms of societal costs and adjustment efforts (and to whom) and to what extent the described changes are anticipated consequences of technology-driven changes in market forces and to what extent they are the result of deliberate policy measures, and if so, which policy measures are being exactly advocated. Lastly, it needs to be clarified to what extent, and in what sense, the projections in EMAF 2015 are based on scientific research, how reliable they are and how sensitive they are with respect to the assumption made for instance on future technological progress, technology spillovers to other world regions, and the behavioral changes in response to altered policies and technologies.

While it is impossible to do justice to the plethora of ideas in EMAF 2015, this paper sketches the main lines of arguments and raise some of the main issues with respect to the general arguments detailed in the report's sections "Executive Summary", "Findings and Conclusions" and Sections 1 and 2. For reasons of space comments on the sector analysis in EMAF 2015 are confined to the section on individual mobility.

The paper proceeds as follows. The next section reviews the main messages of the report and puts forward the central questions that this report raises. Next the proposals for individual transport are analyzed. The last section concludes.

III. THE MAIN FINDINGS AND PROPOSALS FOR REFORM

Point of departure of the report EMAF 2015 is the authors' recognition that production is "surprisingly wasteful" (p. 12) and that environmental degradation is very costly. The authors argue that only 40 percent of all material is recycled or reused, 95 percent of the material and energy value is lost; utilization of many durable consumption goods is very low: In Europe cars are parked 92 percent of the time, when they are used they are used by 1.5 persons only and congestion costs in big cities are substantial; about 50 percent of inner city land is devoted to individual mobility. More than 30 percent of produced food is wasted, 95 % of fertilizers do not provide nutrients for the human body, but 50 percent of European population is overweight or

obese. Office spaces are used only 35 - 40 percent even during office hours (p.20). The wasteful production and high energy and material consumption create large environmental costs for instance through loss in biodiversity, soil degradation and fresh water depletion (p. 49). At the same time, the report argues, new "smarter" technologies are emerging, especially in the mobility, food and building sectors, which allow for new business models that are less resource intensive.

According to EMAF (2015) one important reason for the wasteful production and consumption is "abundant market and regulatory failures" (p.21) that need to be addressed. Rather than listing and identifying the most important regulatory and market failures and concretely explaining what needs to be done to address these, the report provides some examples and an overview figure for obstacles in general (Figure 6 in EMAF 2015), both of which remain relatively vague. Integral parts of these obstacles are market and regulatory failures, but also customs and habits (see below). The report makes no attempt to specify the regulatory failures, let alone to differentiate them by sector or by country and thus paints a very general – and vague – picture of claimed policy failure.

First the report argues, waste regulations "treat waste primarily as an environmental hazard" (p.21), but do not provide incentives for waste managers to separate waste adequately and disallow recovery and reuse due to legal and administrative barriers. The report does not exemplify what such administrative barriers would be. In other words, it does not become clear why exactly firms would not use the identified potential for reducing waste, which in the absence of the unspecified regulations would be profitable. It would have been extremely helpful if the report had been more specific - this would have allowed to assess the validity of this assertion.

The report argues, second, that production is wasteful because firms do not cooperate in so called "non-competitive areas" (p.21) such as packaging materials and common infrastructure, because they fear to violate competition laws or to disclose information that provide them with competitive advantage. It is neither apparent, which gains were to be expected if this collaboration would come about, or which administrative barriers are preventing firms from realizing efficiency gains from such a collaboration, nor does it become clear what the losses in

competition would be. The argument, as it stands, is incomplete and unconvincing. Competition laws are here for a reason, competition ensures efficient allocation, provides incentives for innovation and prevents exploitation through market power. The burden of proof lies with those who advocate that an infringement of competition laws may be welfare-improving. No such proof is found in the report.

Third, the report notes that there are "unpriced externalities" (p. 21) and states that the social costs of carbon are much "higher than the current European carbon price" (p. 21). Ample empirical evidence supports this claim; therefore this author agrees with this particular assessment. Yet in the report this assessment remains very vague. It would be very sensible to be more precise about which instrument is proposed and how strict it should be applied and it would be very helpful to point out how this would foster the circular economy.[2] Sensible proposals to fight global warming and to reduce greenhouse gas emissions have been around for quite some time now -- the question arises in what sense the circular economy model goes beyond these proposals and how the circular economy proposal that is set in the European context takes into consideration the international dimension (see below). The report provides no answers to these questions.

Fourth, quoting Coady et al. (2015) the report argues that energy subsidies in Europe are at €300 bn p.a. leading to inefficiently high uses of fossil fuel. While it is rather unclear how this number came about – Coady et al. use as geographical breakdown Emerging Europe (countries such as Albania, Latvia, Serbia) and Advanced Economies, which includes European countries, but also United States, Korea, Taiwan, Hongkong and others, but no category Europe[3] – it remains true that many European countries still subsidize fossil energies and thus a removal of these subsidies would increase overall welfare. Yet this argument needs to be spelled out and backed up by appropriate quantitative analysis.

Lastly, the report sees unused potential in customs and habits, which still support the so called "linear production model", but could be changed towards increased renting, sharing and reusing

[2] Possible instruments could be, inter alia, environmental taxes and tradeable permits, but also incentives for firms to undertake R&D activities in environmentally-relevant areas. It is not clear what instruments the authors advocate and in what composition and stringency.

[3] Cf. Coady et al. (2015), Figures 7 and 8 and Appendix Table 1.

(p.22). It remains however unclear how this behavioral change that the report advocates is to be brought about - whether this should be the consequence of learning and new technologies that are adopted by consumers choosing freely according to their preferences or whether this proposed change should be achieved through educational taxes or subsidies. Again the report should be specific about this – the former may be a welcome alteration of behavior whereas the latter would be paternalistic policies which are at odds with a liberal view of a self-determined individual.[4]

The described ideas lead the authors to conclude that there are large potentials for improving performance. The guiding idea is to decouple value creation from the consumption of finite resources. This is done according to EMAF 2015 following the principles of (1) preserving and enhancing natural capital for example through replacement of fossil fuels with renewable energy, by (2) optimizing resource yields through sharing, looping of products and extending product lifetimes and (3) by fostering system effectiveness by internalizing negative environmental externalities (p.23).

Important basic principles of the report are by now standard in environmental economics and constitute no new ideas; most importantly the notion has long been established that market failures need to be addressed by internalizing negative externalities through taxes or tradable emission permits, which need to be designed to reflect the externalities appropriately. Policy failures need to be eliminated, for instance through the removal of subsidies for fossil fuels as these are not justified on grounds of positive externalities. As a direct consequence production and consumption of these products are reduced and new production technologies are introduced that reflect the altered relative factor prices (including the use of the environment, which would then be given the correct price). This will have obvious effects on resource use, production technologies and product mix; it will affect the economy as a whole. To the extent that the proposed changes reflect these established ideas, issues relate to timing and stringency of the regulation, not to the measures as such. The design of the regulations is particularly

[4] Of course, if the externality had not been priced correctly, an adjustment in the tax rate would be efficiency enhancing and would lead to a change in behavior. Such a policy would not constitute paternalistic behavior; everything beyond an appropriate internalization of external effects however would be paternalistic and not be justified.

important as adjustment costs and possible international repercussions depend on it. Yet, the report is amazingly silent about these issues, as implementation issues in general are very much left unaddressed. Not even a targeted path for emissions of CO2-equivalents is specified, even though it is very clear that the underlying modeling exercises must have specified such a path in order to project a differential gain of the “circular economy” over the "linear economy".

In part, however, the proposals go beyond conventional wisdom of traditional environmental economics. Not only should environmental or congestion externalities be priced and recycling be increased, but the proposals seek to enhance the value of the products through sharing and multiple uses and to retain it through prolonged life span, reuse and refurbishing of products. Recycling would reduce the values of the goods to the values of their material inputs. To enhance the value of used goods beyond their recycling values the report proposes the so-called RESOLVE paradigm. The six elements of this 'new approach are (1) **Re**generation, which implies a shift towards renewable energy and the regeneration of ecosystems for instance through sustainable land management, (2) **S**haring of products (for instance car sharing or Airbnb), reusing of products in secondary markets and prolonging product life through maintenance, (3) **O**ptimization , i.e. increasing the efficiency of a product through reducing waste, resorting to automation, steering and using 'big data', (4) **L**oop, keeping components and materials in closed loops with an emphasis on remanufacturing products or components rather than recycling of materials, (5) **V**irtualization of products such as books or music and of procedures for instance through "fleets of autonomous vehicles" (p.26), virtual offices or online shopping, (6) **E**xchange materials and products for better and smarter products or technologies such as 3D printing or multi-modal transport (EMAF 2015: 24-26).

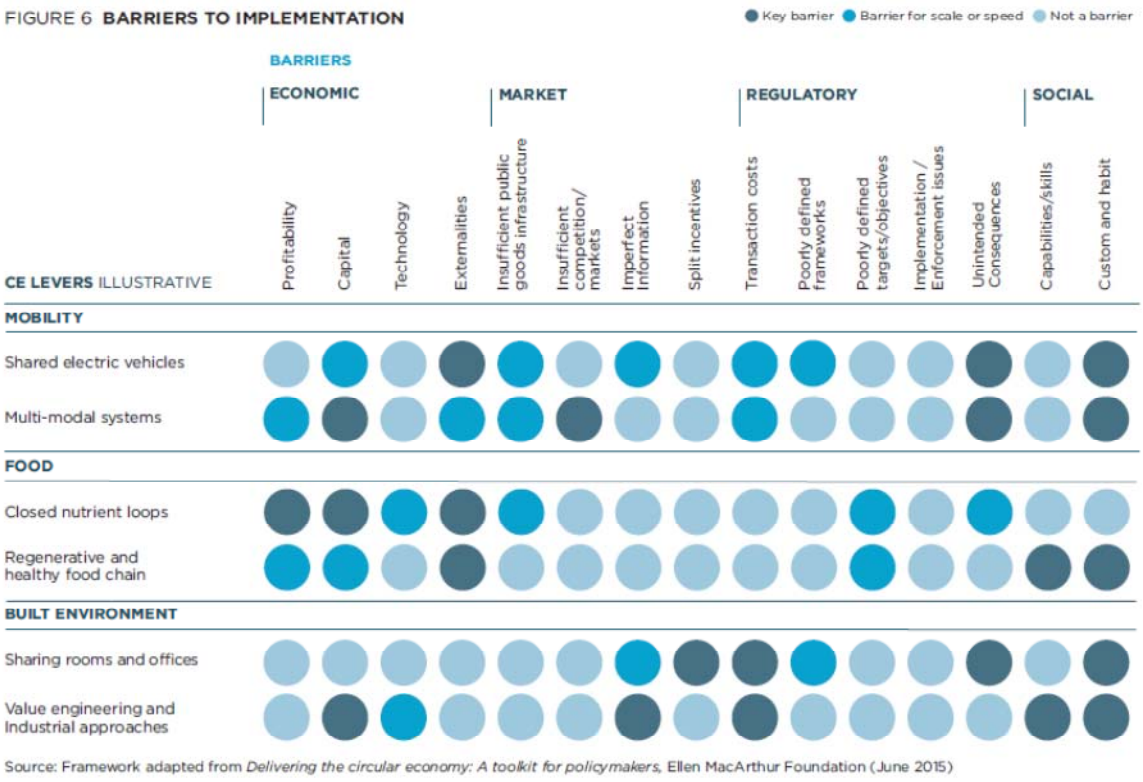
While these are all sensible proposals in principle two central questions remain effectively unanswered. First, to what extent are the proposed changes happening or will they happen due to the advent of new technologies and through market forces in competitive markets that adopt these new technologies and to what extent is government intervention suggested. If new technologies create new business opportunities, market participants will seek to exploit them. It requires no intervention by the government. For instance, if virtual products such as music, news, films and books on files are substantially cheaper than CDs, newspapers, blue rays and

printed books they will displace the 'traditional' forms without making any additional intervention necessary. Likewise if it is a good business opportunity to refurbish old products rather than to recycle the materials as refurbishing retains more value than the simple material value, why is it not happening now (or not happening enough)? Put differently, where is the need for intervention, how exactly should it look like and on which grounds is it justified? Which market or regulatory failure establishes a need for action? The report is quite vague about this issue, even though it repeatedly states that there is a need to intervene.

From an institutional economics perspective (or the perspective of the 'Ordnungspolitik') the state has to provide an effective institutional setup at the constitutional level including security, democratic decision-making, the rule of law, property rights and the freedom of contract, and appropriate safeguards to guarantee effective competition. Government interventions in the economy beyond the constitutional level need to be justified; justifications are the provision of public goods,[5] the achievement of a desired income distribution including the prevention of poverty, the prevention of market power and exploitation through effective competition policies, and the internalization of external effects. External effects occur if the prices of goods traded in the market do not reflect their true scarcity, for instance if the production of a good creates environmental damage that is not reflected in its price. Global warming is the largest externality. Externalities need to be internalized; in contrast, in the absence of market failures undesired market outcomes do not constitute a justification for government action. The figure below, taken from EMAF 2015, displays barriers to the implementation of the circular economy concept as identified by the authors of EMAF, many of whom do *not* constitute a justification for government interventions. For instance, if profitability is an issue (and prices reflect scarcities) there is no need for government action; the proposed change is just not a profitable line of business. Lacking capital cannot be an issue either – as Europe has developed capital markets a lack of capital reflects the perceptions of low profitability or of high risk on the part of potential investors. "Wrong" customs or habits do not constitute a need for government interventions either – if people do not want to share their cars, offices, or homes it is their

[5] Public goods are characterized by non-rivalry in consumption and non-excludability. Lighthouses, public safety or prevention of infectious diseases are examples for public goods: Individual utility of consuming the good is not reduced by others consuming it as well and no one can be excluded from its consumption. These goods cannot efficiently be provided by private suppliers. Note that not all goods provided by the state are public goods.

choice and government policy should not tell them what to do. Reasons for interventions would be not adequately internalized externalities, obvious regulatory failures, market power and potentially inadequate infrastructure, but not an undesired market outcome if markets are functioning.



Source: EMAF 2015, p. 21

The second central question pertains to the reliability of the projected gains. The report maintains that adopting the circular model would yield benefits of up to €1.8 trillion per annum for the European economy by 2030 (p.12). Given that the GDP of EU 28 was 13.9 trillion in 2014[6] this is a very substantial gain. The report goes on stating that "modeling for 2030 suggests that the disposable income of European households could be as much as 11 percentage points higher in the circular scenario relative to the current development path, or 7 percentage points more in GDP." (p. 14) The report provides no way of comprehending how this result has been

[6] http://ec.europa.eu/eurostat/statistics-explained/index.php/File:GDP_at_current_market_prices,_2003%E2%80%9304_and_2012%E2%80%9314_YB15.png

derived, it mentions the authors of a computable general equilibrium model, Christoph Böhringer and Thomas Rutherford, but cites no document that details the results. Prof. Böhringer was so kind to make a document available, which details the structure of the underlying model (Loch Alpine Economics 2015, henceforth LAE 2015).[7] The model used to calculate the effects of a circular economy is a state-of-the-art computable general equilibrium (CGE) model. CGE models have the invaluable advantage over partial equilibrium models that they can capture the indirect – general equilibrium – effects of policy changes in a multi-sector multi-country approach. For instance, if costs of private transportation go down due to technological improvements this will not only increase the demand for transport through lower prices and higher real income, it will also affect expenditures for other goods through price and income effects. CGE models are able to capture these effects, which makes them prime analytical tools for the analysis of clearly defined policy changes.

Limitations of CGE models are well known and are only sketched here. First, they need to rely on the correctness of the functional form – typically functions are used that assume constant elasticities of substitutions – and they need to adopt the correct values for the elasticities. This is done by literature research and the calibration of the equilibrium values for a baseline period. Often there is no consensus about the correct value of elasticities and it is not clear that the economy was necessarily in equilibrium in the base period. The functional form, even though it is relatively flexible, may be misspecified. For instance LAE 2015 use a Leontief production function in the second stage of their nested production function for domestic output with non-fossil fuel production and it remains unclear why that is. Second, the values of elasticities have been derived econometrically from analyzing behavioral reactions to discrete changes in the past. Yet, if the changes are so fundamental and far reaching as the ones proposed are believed to be by the authors of the report, it is no longer clear that the elasticities derived from past behavior are portraying well the expected future behavior. While these drawbacks are inevitable in an analysis like the one underlying EMAF 2015 and should not be held against the authors of the CGE model (i.e. of LAE 2015) , they reduce the confidence in the point estimates that EMAF 2015 reports.

[7] Thomas Rutherford is the chief economist of Loch Alpine; Christoph Böhringer and he have authored the report.

The report provides no scenarios, no sensitivity analysis, no critical evaluation of the underlying assumptions. This is of particular relevance since essential drivers of the proposed circular economy are technological innovations, many of which are only emerging: it is not yet clear how these innovations will change cost structures, affect demand, alter value chains and the international division of labor, in particular because it is not clear to what extent these innovations will be adopted throughout Europe - whether uniformly or to different degrees - and to what extent they will be adopted outside Europe. EMAF 2015 suggests an increase in competitiveness from adopting the circular economy model. Yet this conclusion is not obvious. If for example precision farming raises agricultural yields as suggested, it is to be expected that these technologies will be adopted also at least by the most advanced competitors, notably the US, with unclear consequences for the competitiveness of Europe in that sector. Thus a modeling exercise needs to make assumptions about the expected effects of these future technological changes on production conditions and on the changes in demand, and how these effects are distributed within Europe and beyond Europe. All of this will affect equilibrium prices and quantities. If for instance, new technologies are adopted globally, resource usage may decline (at least relative to GDP) but competitive positions may remain unaltered.[8] Increased environmental regulations proposed by the report will tend to decrease competitiveness as it adds to production costs. Thus it is not obvious on which grounds the claim has been made that competitiveness will increase substantially. It would need a clear explanation.

Moreover, if technological progress will lead to the creation of new goods, assumptions will have to be made on how these goods change the preferences of people and what the demand for these products will be. In a static CGE model like the one used by LAE 2015 technological progress is modeled as reduction in production costs of the same good and thus this problem does not arise by definition. In addition technological progress needs investment in R&D and eventually in implementation, which is hard to quantify ex ante.

The authors of LAE 2015, Christoph Böhringer and Thomas Rutherford, two very respected experts in the field, are very clear about the approach that they take. They use a static CGE

[8] Competitive positions may also change, depending on a number of factors, but it would be by no means clear that this would lead to increased competitiveness for Europe in the affected sectors rather than in other countries. The shift in comparative advantage would depend on a number of factors.

model, in which technological change is exogenously fed into the model, rather than being determined through an endogenous process of innovation. They write:

"However, the interpretation of results should not be stretched too far. More specifically, the technology shifts are unconditional, i.e., the transition from the benchmark technology to the future technology is not explained endogenously. Technological change occurs as manna from heaven. Thus, neither the simplistic partial equilibrium accounting nor the complex general equilibrium calculations can be credibly used to claim that technology progress is for free and will bring about larger GDP and economic efficiency gains – the unconditional technology forecasting does not quantify the economic cost (e.g. in R&D) to achieve specific technological change nor the opportunity cost of foregoing other directions of technological change. Scenario assumptions on drastically reduced capital and fuel cost for private transportation are not "innocent" since the cost cuts come for free." (LAE 2015:16f.)

Given the complexity of innovation processes, this modeling choice is very sensible; the danger of misspecifying an endogenous innovation process would be very large. Yet, if innovation effects are exogenously fed into the model, and these innovations are in large parts only emerging (such as self-driving cars and efficient electric cars) and at the same time very decisive for the economic effects of the proposed changes, a sound empirical analysis needs to be explicit about the assumptions, justify them with plausibility arguments and investigate the sensitivity of the results with respect to assumptions made. EMAF 2015 does neither of this. LEA 2015 provides some details about a "transport scenario", but not about the other sector scenarios and does not show how innovations in the three sectors interact. How exactly is the "circular economy" modeled in the CGE model? It does not become clear from the quoted documents. Thus the available documents - EMAF 2015 and LAE 2015 - provide no guideline that would allow to judge how reliable these estimates are, how sensitive they are with respect to key assumptions such as innovation progress, or on what quantitative basis the circular model scenario has been derived. In part this is a matter of proper publicly accessible documentation, which to the best of our knowledge is currently lacking; in part it is in the nature of the model. Static CGE models are designed to study well defined policy changes in a comparative static analysis rather than to investigate uncertain future technological progress over a longer time span that is mixed with multiple policy changes.[9]

[9] To be very clear about this: this author does not question the modeling exercise as such. There is no doubt that Böhringer and Rutherford have competently carried out this CGE analysis and it provides useful insights; yet the

In particular there is a great deal of uncertainty in the accuracy of the suggested technological progress. For instance, the statement that "shared mobility on demand would cover one-third of all car-kilometres by 2030."(p.61) depends on so many explicit and implicit assumptions that this projection is one among many possible outcomes. Similar uncertainties pertain to other projections as well. Therefore it is not surprising that in a study for the European Commission Cambridge Econometrics and BIO Intelligence Service (2014) calculate that "resource productivity improvements of around 2% to 2.5% pa can be achieved" (p.6), and that the overall effects on CO2 emissions and GDP per capita growth will be positive, but small. This is in stark contrast to the findings of EMAF (2015) and hinges critically on the assumed rate of technical progress.

IV. SECTOR ANALYSIS: AUTOMOTIVE INDUSTRIES AND THE NEW CONCEPT OF MOBILITY

Again, the chapter on mobility in EMAF (2015) begins with the recognition of the authors that our current system of mobility is highly wasteful and carbon-intensive. In Europe the car is parked 92 percent of the time and when used it is occupied only by 1.5 passengers on average. Mobility is responsible for a substantial part of CO2 emissions and thus for global warming, but individual mobility gives rise to welfare losses also because of congestion, accidents causing injuries and fatalities, and unproductive use of space for roads, car parks, gas stations etc. Individual mobility is deemed unnecessarily costly with total costs of car ownership reaching on average € 9,300 p.a. (p. 54).

The report suggest five entry points ("levers") for change (pp. 55-57). First, *sharing* aims at increasing capacity utilization thereby reducing monetary costs and negative externalities, i.e. predominantly CO2 emissions, but also congestion and land use. Car sharing could be organized in various ways through commercial fleet operators, app-enabled car pooling and peer-2-peer car sharing; an intensified use of public transport would have the same beneficial consequences. Second, the large scale introduction of *electric vehicles* powered by renewable energy would reduce CO2 emissions; in addition electric vehicles would have lower annual costs over the life

interpretation of the results by EMAF 2015 (and the documentation of results) is found wanting. It disregards the partly necessarily speculative nature of the assumptions and the limitations of the analysis.

time of the vehicle than comparable combustion engine driven cars according to EMAF (2015). The conversion to electric cars would require a large scale grid of renewable energy production in order to save on CO2 emissions and of course a large grid of electric recharge points throughout Europe. Third, *autonomous driving* by self-driving cars could diminish the space requirements for mobility as safety clearances could be reduced, and lower congestion and the number of traffic-related accidents. It would probably first be introduced on highways and could penetrate the urban space subsequently. Fourth, *materials evolution* would allow building lighter cars with more valuable parts, which would provide incentives for reusing and remanufacturing of car components. New materials would include lightweight carbon fiber, thinner high-quality steel, aluminum and magnesium body panels, among other things. Fifth, *transport modes* would need to be *integrated at the systems level* to allow for energy and cost saving multi-modal transport. People could combine individual, shared and public transportation to keep individual and social costs of transport low and at the same time satisfy their individual mobility needs in an efficient way.

These suggestions all point in the right direction; if greenhouse gas emissions are to be reduced mobility needs to be based on non-fossil fuel energy, which suggests electrification of mobility.[10] Public transport is only attractive if it is embedded in an integrated mobility system that solves the "last mile problem" and allows easy switching from public transport to individualized mobility. Such a change in transport modes would make also less central homes and remote places accessible and at the same time rely on public transport in the most congested urban areas and between cities. Thus an integrated approach to mobility is very sensible. Likewise if technological advances make sharing easier and less costly in monetary terms but also in terms of convenience, it will be taken up more often and as a consequence may reduce private and social costs of transport. If and when technologies for driverless cars are available for mass use and these systems are competitively priced the introduction of autonomous driving may further increase efficiency and welfare.

As before, two central questions arise. First, where is a need for government action and how is it justified, and, second, are the projections in EMAF 2015 sensible, based on serious analyses,

[10] Of course, CO2 reduction is not the only goal of a sustainable mobility system; safety, other ecological and social considerations are likewise important.

and consequently do they provide guidance for policy implementation? We address these issues in turn.

Analytically there is a fundamental difference between technological progress that opens up new and better forms of transport on the one hand and market or regulatory failures that likewise imply a potential for improvement if adequately addressed on the other hand. The former requires no government intervention — welfare gains are realized by letting technological developments run their course. This presupposes that product and factor market competition is working, externalities are correctly priced, property rights are protected and that innovators have access to sufficient capital. Then private incentives for innovation are adequately provided and there is no need for government action; in fact government action would potentially make things worse. To describe these expected technological developments and its consequences for market outcomes is informative, but provides no policy guidance.

In contrast, clearly identified market and policy failures constitute grounds for government actions. Most importantly, if CO2 emissions are not correctly regulated we cannot expect markets to create efficient outcomes. This implies that market failures and regulatory failures need to be clearly identified, correctly quantified and instruments need to be proposed detailing their concrete design and stringency of their application. EMAF 2015 does not make this analytical distinction sufficiently clear and thus it is difficult to reconstruct to what extent the projected changes are the result of technological progress only and what government actions EMAF 2015 proposes. Indeed, two scenarios for the mobility sector are described on page 58 - one without and one with government intervention - but it does not become clear in what sense scenario 2 was enabled through which specific government policies.[11] The report is very unassertive in advancing concrete policies. The most concrete formulation is found on p. 61: "This would require implementing a suite of policies – congestion taxes, underutilisation taxes, preferred lanes for high-utilisation shared vehicles and public transport, and pricing of externalities." This vague formulation in stark contrast to the very concrete and exactly

[11] The report maintains that it took two scenarios out of nine likely mobility development paths from an upcoming report by McKinsey (p. 59 and fn 115, 116). Reading McKinsey (2015) it does not become clear what the nine scenarios are; that report sketches three scenarios for the San Francisco bay area and it is not clear how that would transfer to the EU-28 given the very different settlement and infrastructure patterns.

quantified projections on for instance the growth rates for electric vehicles in 2020, 2030 and even 2050 (p. 59), the share of shared mobility on demand of all car-kilometers in 2030 (p. 61) and so forth. Very obviously, such projections require a clear idea which policy instruments need to be implemented or altered and how stringent they need to be.

Indeed it would be very laudable if the report provided policy guidance. What would the price for carbon need to be, how would it have to be implemented in the transport sector (e.g. how large would a gas tax have to be) and would we need any other instrument in addition to this and a congestion tax, and if so, on what grounds?[12] What scale of new infrastructure for generating and distributing electricity from renewable energy would Europe need to implement, which investment would that imply[13] and how large should the grid for recharge points for electric vehicles be? The optimal system may not entail maximum coverage; optimization could require a more limited coverage. What would that imply for the projected market penetration of electrical vehicle? Such concrete suggestions would make the report much more useful, and provide a basis for sensible discussions. Such discussions might eventually lead to clearer policy guidance, which this report does not provide. Likewise since public transport infrastructure affects private optimization calculus in many ways (see above) it would be extremely helpful to see where and to what extent public infrastructure needs to be upgraded. It is insufficient to point out that new rapid transportation schemes such as SkyTran (p.57) have become available, without referring to cost-benefit analyses of its implementation, at least in general terms. Which cities should strive for the implementation of such a system, how many people could be reached, how would these systems be connected to individual mobility? What can we learn from the Japanese example, or from Hongkong or from the denied implementation of Transrapid in Germany? Since public transport infrastructure has potentially huge external benefits, but creates very substantial costs, a sound policy advice needs to be based on a social cost-benefit analysis. The question is not whether society should implement a fast train system - it should - but what the concrete dimension of such a system should be and why there is

[12] For instance the proposed underutilization taxes (see the above quote) are nonsensical if externalities are correctly priced.

[13] How do projections compare to the cost of the German strategy to exit from nuclear and fossil-fuel energy ("Energiewende")?

currently an inadequate supply thereof, if there is one. Again, on the policy-relevant questions the report is remarkably silent.

The second issue is the reliability of the projections in Chapter 2 of EMAF (2015). This is very hard to assess as the report does not properly document the sources on which its projections are based. For instance, the report maintains that the total cost of ownership of a car is €9,300 annually, of which €3,500 are societal external costs (p.54), but it does not provide any source for this claim.[14] It then develops a scenario of increased sharing with sharing accounting for 0.5 percent of total passenger-kilometers by car in 2020, 5 percent in 2030, and 8 percent in 2050. Likewise electric vehicles would increase their share of car-kilometers to 1 percent in 2020, to 14 percent in 2030 and to 60 percent in 2050 (up from 0.02 percent in 2015) (p.59). The share of remanufactured and recycled input could increase to 10-15 percent in 2030 and 40 percent in 2050. It remains unclear on which basis these scenarios have been developed.

Admittedly such projections are inherently very difficult to make and have a large degree of uncertainty attached to them (cf. fn 117 of the report).[15] Yet, if this is the case, these projections need to be treated with caution and must not be mistaken as a sound empirical basis for policy formation, in particular since the net benefits calculated at €270 billion vis-à-vis the current development path are regarded as optimistic estimate and more favorable than most other forecasts, as the authors admit.[16]

V. CONCLUSIONS

The report *Growth Within* by the Ellen MacArthur Foundation and McKinsey is the result of a laudable effort. It addresses central challenges that the European societies – and many others –

[14] One annoying feature of this report is that a number of empirical claims remain essentially unsubstantiated. No source is given, or if a source is given, the reference is so incomplete that it is basically untraceable. Examples are footnotes 104, 105, 107, 118, 122, 123. Examples for unsubstantiated statements are manifold, for instance EMAF (2015: 56) claims that autonomous driving can reduce accidents by 90 percent. On which basis this statement has been made remains unclear from the report. It has been taken from McKinsey (2015, p.6) as a number of other statements as well, but McKinsey (2015) likewise does not provide a source for that claim.

[15] fn 117 reads as: "While the scenario is grounded in facts about current trends, the development path of such disruptive actions is challenging to predict so the scenario rests on some assumptions outlined in the text". These assumptions are not clearly spelled out.

[16] Footnote 136 of EMAF (2015): "The current development scenario used in this report is very disruptive and resource-efficient compared with most forecasts."

face. Global warming and environmental degradation are extremely serious problems; it is evident that greenhouse gas emissions need to be curtailed and alternative energy sources need to be developed to a much larger extent. Rapidly increasing urbanization requires new mobility concepts that put much greater emphasis on rapid, efficient, and congestion-free public transport, embedded in a system that allows for individualized mobility and high connectivity. In that sense EMAF (2015) provides a vision.

Yet, the report provides neither a blueprint for policy action nor is it an accurate assessment of possible future development paths. It does not clearly distinguish between developments that are driven by the advent of new technologies and those that are only attainable through the elimination of regulatory or market failures. Only the latter provide a case for policy interventions. The report is extremely vague about concrete policy changes or the regulatory and market failures that are to be addressed through these policy changes; it does not even comment on what an appropriate path for CO2 emissions would be and through which instruments the externality would have to be internalized. Unfortunately the empirical basis for the asserted gains through the introduction of the "circular economy" – annual benefits of up to €1.8 trillion by 2030 – remains largely unclear. The report – and the documents cited in it – provide no clear guidance how these gains come about and to what extent they are created by specific policy changes. These compared to literature very optimistic projections cannot be reconstructed on the basis of this report. Part of the problem may be an insufficient documentation of the analytical steps taken to arrive at the projected scenario. It could also be that the assumptions are overly optimistic.

Thus the report is a useful vision in the sense that it creates the desire for more extensive research which would need to be clearly documented, be reconstructable and which would explicitly analyze the sensitivity of its central results with respect to key assumptions. It would need to clearly identify current and past policy failures and current market failures and would have to incorporate the international dimension much more prominently. On such a basis policy options could be discussed and proposed. EMAS (2015) provides a starting point for such a much needed endeavor.

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