Rightsizing production: The calculus of “Ecological Allowance” and the need for industrial degrowth

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Abstract: Pressures arising from sustainability demands from resource markets, customers, political regulation and societal stakeholders demand a new strategic approach of the firm. This is especially the case with the manufacturing enterprise, as its economic activities create the most severe ecological damage. The aim of this contribution is to develop a strategy framework for rightsizing production beyond the dominant growth paradigm as well as to supply an outline of an ecological measure to determine whether or not a firm’s operations are within the limits of a finite Planet. Traditional measures, like lifecycle assessment methods or carbon footprint, only compare the sustainability of products and processes on a relative scale. What is needed, however, to give management a robust basis for decision making, is a measure of absolute scale: the calculus of “Ecological Allowance”, an answer to the question “what size of production is just right”.

Keywords: Sustainability, Corporate Degrowth, Ecological Footprint

The need for degrowth

Sustainability can be observed as a problem complex arising from ecological demands of economic activities exceeding the Planet’s carrying capacity. Carrying capacity is determined by the ability of planetary sources (material and energy resources, land area, biomass) and sinks (atmosphere, water, soil) to regenerate themselves (to reproduce resources, to assimilate waste) in a given time period. The impact of economic activities on the Earth’s ecosystem can be calculated by various means. One prominent measure is the so-called ecological footprint, relating economic activities with ecologically productive land area needed to supply the economy with resources and providing for sinks [1]. According to this measure, economic activity today is exceeding the carrying capacity of the Planet by more than 30 percent e.g. humanity is using up resources faster than nature can regenerate them. In other words, humanity has started to become an ecological debtor for roughly the last 25 years. Projections of the current development, if nothing changes, would lead to an overshoot of carrying capacity by 100 percent by around 2040 i.e. humanity would need two planets by then to fulfill their ecological demands from economic activities [2].

Two strategies are available to tackle this problem [3]: the eco-efficiency revolution and the sufficiency revolution. Eco-efficiency is adhering to the dominating techno-economic paradigm of technological innovation and change within the market system of free enterprise and a growing monetary base as. More fuel efficient cars or cars with new engine technologies, like hydrogen fuel cells or batteries, are examples for this strategy. Sufficiency, on the contrary, is focusing on product use and product demand itself and has the tendency for less or "small is beautiful": less products, less material throughput, lower scale of economic activities that are in line with the limits of a finite Planet. When using a simple spreadsheet calculation, the effects of both strategies can be estimated quite easily. If economic growth, the growth in numbers of products and services per year expressed in monetary terms, is set at a fixed rate of three percent (the desired rate of the so-called Lisbon Agenda of the European Union) and a similar rate for eco-efficiency innovation is taken into account (which is also a desired goal for the sustainability strategy of the European Union and would mean an instant doubling of energy and resource efficiency), then GDP will more than triple between 2010 and 2050, whereas as total ecological impact will only decrease by less than two percent. Although impact per GDP unit (per Euro e.g.) would be lower by more than two thirds compared to 2010, economic growth of total GDP will destroy almost all efficiency gains.[1] The only option, it seems from this simple calculus, is a mixture of efficiency increases and reduction of economic growth in order to reduce ecological impact by economic activities towards a level which is sustainable in the long-term.

This idea is not new, in fact the first mentioning of abandoning growth dates back to 1972 and the first report to the Club of Rome, "Limits to growth" [4, 5]. In recent times, however, these ideas have been revitalized by the concept of decroissance or degrowth in the fields of ecological economics and sustainability research. Degrowth is understood "as a voluntary transition towards a just, participatory, and ecologically

[1] It has to be added that GDP has been subject to long-lasting debates about its relevance as a welfare indicator. See e.g. the discussion in Jackson (2009) [6]or alternative measures like the Index of Sustainable Economic Welfare (ISEW).

sustainable society." Its objectives "are to meet basic human needs and ensure a high quality of life, while reducing the ecological impact of the global economy to a sustainable level, equitably distributed between nations." [7]. Although the demand for lowering material throughput i.e. physical degrowth can be seen as mutually accepted, the demand for economic degrowth remains controversial. The implications of full-scale degrowth for the manufacturing enterprise, both physically as well as economically, remain unclear. What is missing is a strategy framework for degrowth business models as well as a measure or calculus for assisting corporate degrowth.

Degrowth strategy framework

The minimum condition for a firm's economic well-being is its ability to pay off all capital costs including wages, R&D investments and all sorts of calculatory costs like employer's salary, and thus having an economic profit of zero. Everything beyond that is excess profit. In short, whenever total revenue (TR) is equal or greater than capital costs (CC), long-term economic well-being (nWB) is ensured: nWB: $TR \geq CC$. In a simple economic logic, the more TR the better might be the desired strategy i.e. there is only one strategic decision: increase TR if below and even if above CC. When ecological constraints are taken into account, the strategic landscape is dramatically changing. TR is then connected to total ecological impact (TEI) by means of a technology factor (τ) and this impact can exceed what is ecologically allowable for a single firm. The concept of ecological allowance (EA), which will be dealt with shortly in detail, is parting from traditional concepts of e.g. lifecycle costing or footprinting insofar, as it tries to capture the question of "what size is just right". Traditional concepts compare relative ecological performances i.e. they enable companies to estimate if a newly developed product or production process has a lower ecological impact than its predecessor. If this impact is "correct" on an absolute scale i.e. if it brings the company and its production within the limits of a finite planet is not calculated. For the moment, let us leave EA as a measure that can describe exactly that.

If so, then TEI can be higher or lower than EA, whereas ecological well-being (IWB) can be expressed as IWB: $TEI \leq EA$. With these two minimum conditions of nWB and IWB, and the concepts of CC, TR, TEI and EA, four context situations can be formulated as shown in the table below.

economic well-being \ ecological well-being	TEI ≤ EA	TEI > EA
TR ≥ CC	1. Rightsize Profits	2. Ecological Excess
TR < CC	3. Economic Loss	4. EcoEco Disaster

Right size profits are the long-term sustainable state of a company, when both minimum conditions are reached. In fact, rightsize profits are synonymous with what can be termed as a sustainable business or a sustainable company. Ecological excess on the other hand requires a reduction in TEI or an increase in EA in order to become sustainable. Having said that TEI is connected via τ with TR, two strategic options arise for reducing it: first, change τ by increasing eco-efficiency, and second, reduce TR by means of lowering product sales. Changing τ might be the favored strategy; however as has been shown in the example above, this is not sufficient for tackling ecological impact.[2] A degrowth strategy in product sales needs to accompany if not substitute an efficiency strategy. This might be implemented by refocusing on product use and getting revenue not from sales but from product maintenance and service, as well as product redesign and remanufacturing (extending product lifecycles). Economic loss is a far more easy context, compared with ecological excess and can be addressed by either reducing CC or/and increasing TR as long as staying below $EA \geq \tau*TR$. EcoEco disaster is the least favored context situation, which implies both a reduction in CC as well as bringing down $\tau*TR$ below EA. However, this situation might yield the greatest transformational possibility towards sustainable business as it stresses the organization to question all its goals and missions, including what it actually produces and sells (a physical product or the option to fulfill a customer need).

The calculus of “Ecological Allowance”

The ecological impact of economic activities can be measured with a number of approaches like lifecycle assessment (LCA) or different footprinting approaches, like the ecological footprint, carbon footprinting or “virtual water”. Almost all of these methods calculate ecological impact without defining a reference state which acts as a

[2] The limits to an efficiency strategy result from the so-called Jevons‘ Paradox [8] stating, in brief, that any efficiency increase in resource use acts as a price cut for that resource which c.p. increases demand and thus “destroying” ecological efficiency gains.

target. What you can say with e.g. LCA is, if one product is more ecologically sound than the other. The only measure that yields insight to it is the ecological footprint. Here, yields of primary products like cropland, forest, grazing land and fisheries are being used to calculate the area necessary to support a specific economic activity. The yields are measured by calculating the amount of biologically productive land and sea area available to provide the resources a population consumes and to absorb its wastes, given current technology and management practices. With that method it is possible e.g. to calculate the footprint of a single individual, a nation as well as the entire footprint of human activity on the planet. This provides then a reduction target for macroeconomic policy i.e. to reduce humanity's impact by one third until the mid-21st century in order to keep world climate and resource levels at a sustainable stage. However, what is missing is a measure for companies, especially for manufacturing companies. The only examples you can find are for retail, energy and agricultural industries, that have a very low-complexity product. There appears to be a difficulty in defining a target for companies, which becomes obvious when thinking about the requirements for such a measure. It needs to

- calculate the total ecological impact of a company's operations, including all impacts before procurement and after sales (which is partly the domain of LCA),
- connect this impact to revenues (and not only costs),
- allot an ecological allowance to the company and compare this to its total ecological impact.

The first requirement is more or less fulfilled by LCA, however different use scenarios and an interactive impact assessment is missing. In other words: how can the company react if use patterns of products change and thus ecological impact turns out to be higher than expected. The second and third requirements have not been met by any standard yet on the firm level. The problem for allotting an ecological allowance is the unclear unit of reference or exchange value. With economic indicators it is quite easy; all measures can be expressed in terms of monetary units. The only appropriate measure on the material and energy level appears to be carbon dioxide (CO_2). First, it is the main cause for anthropogenic climate change which in itself is the most pressing problem today; second, CO_2 can very easily be connected to energy consumption to which it is tied in an almost fixed manner; third, we can estimate the maximum sustainable yield of CO_2 in the Earth's atmosphere that would cause global temperature not to rise beyond the two degrees goal; which gives us, forth, the possibility to allot allowable CO_2 emissions for industry. This is done already by different so-called cap and trade systems e.g. in the European Union or in some parts of North America. However, being part of macroeconomic policy decisions, cap and trade systems are exogenous institutional regulation for companies. What is sought with this contribution is a measure that enables companies to make their sustainability strategies "calculable" and subject to managerial decision. When companies can assess their position within the sketched context situations with some relevance, the choice to transform themselves towards sustainability is a conscious one – just as the choice not to do so.

Three Proposals for calculating Ecological Allowance

Germany's output of CO_2 emissions amounts to 868,351,000 t in 2006 [9, p.313]. Agriculture and forestry emitted roughly 10.0 Mill t CO_2, the manufacturing sector contributed with 525.7 Mill t, and services with 113.2 Mill t. Private consumption was responsible for 219.4 Mill t of CO_2 in 2006. The scientific advisory council for global environmental change of the German government (WBGU) estimates a world CO_2 emission allowance of about 750 Bill t for the 40 years between 2010 and 2050, if the tow-degrees limit in world temperature should not be exceeded [10]. What does this mean for the German manufacturing sector? If 750 Bill t of CO_2 is broken down equally for each year, the annual allowance is 18.75 Bill t for each year. Currently 6.9 Bill people inhabit the planet, with about 82,002,000 being German. Under ceteris paribus conditions we calculate the following figures for 2011, with the ecological allowance for Germany being 222,831,522 t of CO_2. This is only a quarter of the current output and shows that a drastic decrease in CO_2 emissions is necessary for a truly sustainable economy. How can we distribute this allowance to a single company to provide a goal for emission reduction? First, we have to make another assumption. All products consumed, need to be produced. Therefore, emissions from private consumption will be allocated to the sectors of agriculture, production and services. With that, 2 percent of the complete allowance can be given to the agriculture and forestry sector, 81 percent to the manufacturing sector, and 17 percent to services [9]. The allowance for the manufacturing sector then amounts to 180,523,978 t. The distribution to a single company, however, can be calculated in several ways.

1. *Tie CO_2 emissions to sales*: The overall sales of the manufacturing sector in Germany in 2006 [9, p. 365] are 1,695 Bill EUR. With the above mentioned allowance, every Euro sold may only contribute with 0.106 kg of CO_2. For a German medium sized car with an average price of 34,000 EUR approximately 3,619 kg CO_2 would be allowed to be emitted. Current emission per car at one German automotive manufacturer (anonymous case) is 820 kg on average, according to its sustainability report. This seems to be well within the limit. While the allowance for this falls below, other products are exceeding the limit. For example 1 liter of petrol at 1.40

EUR has an allowance of 0.15 kg. But the emission of CO_2 from 1 liter of petrol is in fact 2.33 kg. While some kind of goods may be within the limits of EA, others are far beyond these limits. To avoid this opaque distribution, consumption and impact of product use must be considered too. We assume that the average mileage of a car is about 20,000 km/year. With a CO_2 output of 130g/km (equals 5.6 l/100 km) that amounts to 2,600 kg of CO_2 emissions. The annual as-is output of CO_2 of a medium sized car p.a. can be assumed to be around 2,737 kg (includes 137 kg of CO_2 during production with 820 kg divided by 6 years of average car use). What is the allowance then? The average sale price of such a car is 34,000 EUR, evenly distributed over 6 years plus 1,116 EUR of petrol costs (price fixed at 1,40 EUR/l). With an allowance of 0.106 kg/EUR the overall EA for a car would be 722 kg of CO_2. This clearly shows that the current output is almost four times higher than the calculated EA. This fits to the observation, that the current overall output of CO_2 in Germany is four times higher than its calculated allowance.

2. *Tie CO2 emission allowance to employees*: About 40 million people are in gainful employment in Germany. CO_2 emission allowance distributed per capita leads to an EA of 5,525 kg per employee. Given the same German automotive company case with approximately 74,000 employees within the country, it would therefore have an EA of 408,850 t of CO_2 per year. The current CO_2 emissions of this company amount to 1,200,000 t/year. The quota is slightly better compared to the first example, but still three times higher than the assumed EA. Furthermore, product use is not reflected here, but a link to social sustainability might prove fruitful for further exploitation.

3. *Tie CO_2 emissions allowance to value added*: Overall gross value added in Germany in 2008 was 2,235 Bill EUR [9, p. 631]. If calculated against the EA of 222 million t CO_2, every Euro of gross value added allows for 0,100 kg. Gross value added at our case was 18.12 billion EUR in 2008, with its EA being at 1,812,000 t. This EA is above its current output, but here it is very difficult to consider impacts of product use/consumption and social issues.

Conclusions

The need for corporate degrowth can be met by supplying companies with clear strategy options and a reliable measure: Ecological Allowance. Both have been sketched in this contribution, with the case of a German automotive company to illustrate the possible calculations for EA. However, key questions remain, like how to balance the need to individualize EA for companies (industry structure, market size, number of employees etc.) with the need for a global limit on carbon dioxide emissions. Having laid the emphasis on carbon dioxide, the issue of total footprint (including land use, resource extraction, water and waste) and how to make this subject for corporate accounting remains open. The strategic implications are another key area i.e. how to formulate operational degrowth strategies that can aid in the transition towards a sustainable company. Probably the most important question, asides from calculating ecological allowances, is how to reach managerial decision makers with degrowth issues despite the overarching dominance of the growth paradigm.

References

[1] Wackernagel, M. & Rees, W. 1996. *Our Ecological Footprint: Reducing Human Impact on the Earth.* Gabriola Island, BC: New Society Publishers.

[2] Footprint Network. 2010. http://www.footprintnetwork.org, accessed 30.04.2010.

[3] Reichel. A., Goll, F., Scheiber, L. 2009. *Linking Sufficiency and Business: Utility Systems Engineering in Producer-Consumer-Networks*. Proceedings of the Academy of Management 2009 Annual Meeting: Green Management Matters. Chicago, USA.

[4] Meadows, D.H., Meadows, D., Randers, J. & Behrens III, W.W. 1972. *The Limits to Growth.* New York: Universe Books.

[5] Meadows, D.H., Meadows, D. & Randers, J. 2004. *The Limits to Growth: The 30-year Update*. White River Junction, VT: Chelsea Green Publishing Co.

[6] Jackson, T. 2009. Prosperity without growth: Economics for a finite planet. London: Earthscan.

[7] Degrowth. 2010. http://www.degrowth.eu, accessed 30.04.2010.

[8] Alcott, B. 2005. *Jevons' paradox*. In: Ecological Economics, 54 (1): 9-21.

[9] Statistisches Bundesamt (2009). *Statistisches Jahrbuch 2009 Für die Bundesrepublik Deutschland.* Wiesbaden: SFG Servicecenter Fachverlage.

[10] Wissenschaftliche Beirat der Bundesregierung Globale Umweltveränderungen (WBGU) (2009). *Der WBGU-Budgetansatz - Factsheet3/2009,* from http://www.wbgu.de/wbgu_factsheet_3.pdf.