Valuing the impact of food:

Towards practical and comparable monetary valuation of food system impacts

A report of the Food System Impact Valuation Initiative (FoodSIVI)

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IMPLICATIONS SUMMARY

A consortium of intergovernmental and institutional actors and experts (a societal process), in collaboration with the food sector, should develop a protocol or agreement to standardise food impact footprints and targets. The same consortium should develop costings of those impacts for the practical, ethical, and risk-based arguments made in previous sections.

Footprints are wedded to quantities that, historically, have changed society, changed populations starving over winter from bad harvests, and provided individuals longer and better-quality lives. That even higher levels of footprint are now reversing some of those benefits through damage to human health and nature, prompting reduction in those footprints, reflects the fundamental basics of the economic system - equilibrium.

By reflecting the mid- to long-term economic damage from activity now, impact costing provides signals to the market and Government that counter, or moderate, short-term signals. Costs of the impact of food are, like the costs of carbon, almost certainly positive and large. Implying that Governments are failing in their management of the economy if they do not address the economics of food system transformation. Like carbon costs, there are large uncertainties in food impact costing. The impacts associated to the multiple quantities of food system impact are also correlated, e.g. climate and health. Correlations increase the chance of extreme welfare losses.

Staged realisation of abatement portfolios attached to marginal abatement costings would achieve a radical change in agricultural subsidies and tariffs, incentivises for land management, and market opportunities for sustainable and healthy food products.

Present impact reporting does not enable footprint disclosure and tracking toward either footprint or impact targets for food system transformation. There is a potential for misalignment between performance and incentivises from impact investment, and progress to targets. Opportunities exist for a bloc of food companies to align their reporting with science-based targets, accelerating footprint and target-based disclosure while distinguishing their own reporting from competitors.

Present impact reporting is observed to selectively disclose impact reduction. In some cases, the non-financial accounting is flawed. Wider economic benefits received by businesses are often not counted alongside the reported benefits to society. Equity concerns in capital exchanges are not addressed. To overcome this, statistics, like the Gini index, for inequity of the value of the capital exchanges in a company's activities and value chain are discussed. Three statistics measure value in capital exchanges: between national economies and levels of socio-economic development; between generations; and between certain costs and uncertainty benefits. The last statistic would highlight the perverse risk sharing in food's global value chains – the retailers and consumers in richer countries that are most able to bear shocks are buffered by the long value chain and are the least exposed to the effects of climate change, while those in production and in poorer countries least able to bear shocks are most exposed.

Recommendations for a best practice guide to food system impact valuation are given, based upon the technical and ethical challenges identified in previous sections. The use of software and private methods for shadow pricing could become *de facto* standardisation without investment in a societal process. This risks bias in valuations which may systematically under or overestimate cost of impacts. The result would be too much or not enough economic adjustment. It is argued that the recommended societal process for impact costings mitigates this risk.

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IMPLICATIONS

The main recommendation has been repeated through the report, along with argument and evidence.

A consortium of intergovernmental and institutional actors and experts (a societal process), in collaboration with the food sector, should develop a protocol or agreement to standardise food impact footprints and targets. The protocol would ideally progress to a food system non-financial accounting standard that formalises impact pathways as a basis for comparable impact valuation.

The global footprint of food is huge – 30% of CO2-equivalent emissions, 70% of freshwater use, over 50% of synthetic nitrogen production and phosphorous use, 66% of the 740 million people living in extreme poverty globally are agricultural workers, 33% of adults obese and 12% of the global population hungry and undernourished[1]. Associated to the footprint are extensive human and social impacts.

The same consortium should develop costings of those impacts for the practical, ethical, and risk-based arguments made in the body of the report.

By reflecting the mid- to long-term economic damage from activity now, costing provides signals to the market and Government that counter or moderate short-term signals. Costing brings to the market quantities that are unlikely to be included or sufficiently priced by the market by itself. Costs of the impact of food are, like the costs of carbon, almost certainly positive and large. Implying that Governments are failing in their management of the economy if they do not address the economics of food system transformation. Food impact costing moves beyond a reboot of the “polluter pays” principle. The pollution is systemic. Footprints are wedded to quantities that, historically, have changed society, changed populations starving over winter from bad harvests, and provided individuals longer and better-quality lives. That even higher levels of footprint are now reversing some of those benefits through damage to human health and nature, prompting reduction in those footprints, reflects the most fundamental basics of economics and the economic system - equilibrium.

A food system non-financial accounting standard would specify:

- Issues associated to the major external costs introduced by the food system – which guide what to measure and setting footprint targets.
- Footprint: what quantities associated to a business or food system actor’s operation are associated to the major impacts; what units; what to disclose, what targets.
- Capitals: what to measure, i.e. the capital change most relevant to societal impact, intersected with the capital change attributable to food system actors.
- Formalisation of the exchanges and contributions between footprints, capitals, footprint to capital and capital to human well-being relevant to impact (impact pathways), including scenarios which contextualises the footprint incurrence and the progression to impact in time and other dimensions.

[1] IPCC, *IPCC Special Report on Climate Change, Desertification, Land Degradation, Sustainable Land Management, Food Security, and Greenhouse gas fluxes in Terrestrial Ecosystems*, Intergovernmental Panel on Climate Change (2019), https://www.ipcc.ch/report/srccl/; P. C. West et al., "Leverage points for improving global food security and the environment," *Science* 345, no. 6194 (2014), https://doi.org/10.1126/science.1246067; FOLU, *Growing Better: Ten Critical Transitions to Transform Food and Land Use, The Global Consultation Report of the Food and Land Use Coalition.*, Food and Land Use Coalition (New York, 2019), https://www.foodandlandusecoalition.org/global-report/; Global Nutrition Report, *2020 Global Nutrition Report* (2020), Section 1.1, https://globalnutritionreport.org/reports/2020-global-nutrition-report/.

Footprints, as discussed in detail in the body of the report, need to capture spatial and production differences to represent the major variances in impact. A tonne of nitrogen applied for corn production in Iowa in the US has different impacts than the same tonne applied in Malawi. The same macro and micro-nutrient intake from a food product has different impacts depending on the consuming population and their diets. The footprints are factors to societal and human welfare like other quantities measured and tracked by the economic system. The spatial and production distinctions are important to outcomes – costings should not end up penalising nitrogen application in Malawi and should not reward increased per capita caloric intake in Samoa.

Accounting for food impact footprints needs disclosure to keep track of progress towards targets, and for assurance and verification of footprint reduction. The UN body, UNEP, produces an annual report on the progress toward carbon emission targets called “The Emissions Gap Report”. The gap between current impact footprints and targets should similarly be reported for food.

Footprints and targets facilitate abatement costing, which is the impact costing that connects the performance of companies and sustainable products displacing unsustainable counterparts to achieving science-based footprint reduction targets. Abatement costing of food system impact provides the opportunity to both measure and manage. It will indicate merit orders of products and practices needed to achieve reduction targets. Staged realisation of such a merit order would achieve a radical change in agricultural subsidies and tariffs, incentivises for land management, and market opportunities for sustainable and healthy food products. Abatement costing of food impact is difficult, however. It presents several technical challenges that would require dedicated research and investment in that research.

Like carbon costs, there are large uncertainties in food impact costing. The impacts associated to the multiple quantities of food system impact are also correlated, e.g. climate and health. Correlations increase the chance of extreme welfare losses. Society is bearing, or will bear, many of the impacts of current production and consumption in the food sector. The high uncertainty in the cost of those impacts means that considerable risk is being transferred to society from business and individual activity. There is a strong argument that society should include a risk premium in impact costing to cover the transfer of risk.

This report has argued that disclosure efforts should be prioritised over more granular measurement of footprints that are relatively well-measured, and that technology through sensors and digitised value chains offers revolutionary potential for tracking and assurance of footprint calculation. The technology exists. It is unclear if this potential will be fully realised. Applied research and investments in tracking in food supply chains almost exclusively focusses on food safety and personalised nutrition.

The scientific foundation for food system impact accounting and valuation exists. The gap in applying it to market correction is in the political and societal process, and structures to enable that process. We discuss some additional aspects of the process for developing shadow prices below, including evidence from carbon costing of the need for updates.

We consider a few other implications that have been raised by the investigation or examination of food impact costing.

- Implications for impact statements and impact reporting in the food sector.
- Some features enabled by the linear model of shadow pricing, including equity statistics for substitution and ethical parity choices.
- Databases of shadow prices and updating.
- Risk in alternatives to a societal process to develop shadow prices.

Impact reporting

Under the EU Non-Financial Reporting Directive 2014/95/EU, large companies, banks, and insurers in the EU have been obliged since 2018 to annually report information on the way they operate and manage social and environmental challenges[2]. Guidelines published in 2017 did not provide the specifics required to ensure that useful and relevant disclosures are made by companies. The EU, generally, is ahead of the US on non-financial reporting[3]. Impact valuations are being used by companies in reporting non-financial positions and externalities[4]. As noted in the chapter Introduction and Glossary the reports are called Impact statements, Impact reports, or Integrated Profit & Loss statements (I P&Ls). Presently there are no standards for impact reporting in the food sector and companies develop their own format, their own methodology, or engage consultants[5].

More importantly, due to the lack of development of abatement costing, it is unclear if positive impact according to social costs used in impact reporting accords to a positive trajectory toward science-based footprint targets. Some other caveats to impact reporting are given below.

Companies presently describe positive non-financial performance according to two benchmarks. The first form of benchmarking is the company's own 'total' aggregating social and environmental externalities, a form of insetting where social benefits created by the company may offset social costs. The second form of benchmarking is comparison against competitors[6]. The first form of benchmarking is problematic due to the ethical issues with substitution (discussed below), and the ambiguity in evaluation of social costs as described in the chapter Food System Impact Valuation in Practice. The second form of benchmarking is problematic, as a positive contribution compared to competitors may still be not enough to achieve science-based targets. The societal benchmark is not competitors. Corporate responsibility that markets itself on positive impact compared to competitors will not catalyse economic adjustment at the scale required to transform the production, processing, and consumption of food.

Present impact reporting does not enable footprint disclosure and tracking toward either footprint or impact targets for food system transformation. There is a potential for misalignment between performance and incentives from impact investment, and targets identified by the scientific community.

Evolving best practice in food sector impact reporting could begin with a third-party review of I P&Ls and Impact Statements to identify the major issues and omissions. The review could also provide basic best practice guidance. An investment group sponsoring that review could catalyse progress by promoting the guidance or by preferential investment in food sector companies conforming to the guidance. There are opportunities for certification services for food sector impact statements due to the regular need to produce the statements (annually) and the complexity of food system impact. There are opportunities for a bloc of food

[2] https://ec.europa.eu/info/business-economy-euro/company-reporting-and-auditing/company-reporting/non-financial-reporting_en; https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52013SC0127

[3] H. Stolowy and L. Paugam, "The expansion of non-financial reporting: an exploratory study," *Accounting and Business Research* 48, no. 5 (2018), https://doi.org/10.1080/00014788.2018.1470141.

[4] J. Unerman, J. Bebbington, and B. O'dwyer, "Corporate reporting and accounting for externalities," *Accounting and Business Research* 48, no. 5 (2018), https://doi.org/10.1080/00014788.2018.1470155. M. Jones, *Accounting for biodiversity* (Abingdon: Routledge, 2014).

[5] Unerman, Bebbington, and O'dwyer, "Corporate reporting and accounting for externalities."

[6] S. Vionnet and J.-M. Couture, *Measuring Value - Towards New Metrics and Methods*, Quantis and Ageco (Switzerland, 2015).

companies to align with the guidance as best-practice, accelerating footprint and target-based disclosure while distinguishing their own reporting from competitors.

Evolving best-practice can lead from guidance mentioned in the last paragraph to adoption and sponsorship of the development a food system non-financial accounting standard as recommended in this report. However, incentives for adoption must be clear and sufficient to sponsor development. Parallel to development of footprint protocols and accounting standards, investment products that utilise the same framework are needed. For example, a bond price or coupon rate linked to standardised impact performance.

Challenges in impact reporting practice

The monetary valuation methodologies for impact statements or I P&L statements have several issues that have been raised in the report. Addressing these issues would enhance assurance to impact investors that investments are indeed contributing toward food system transformation targets with the least social harm and reducing capital risks. Broader challenges to impact reporting can be found in the non-financial accounting literature[7].

Without the comparable accounting and costing framework recommended in this report there are risks that impact statements and I P&L's are selectively disclosing impact reduction.

The selective disclosure includes selective accounting for benefits as well as costs. Impact statements concern wider economic costs and benefits and need to consider the interface of the company with the wider economy.

For example, it is common for impact statements to include the wider benefits, or multipliers, of the taxation the company pays and income to employees. The external benefits of taxation mostly accrue in locations and populations that are distant from those bearing the external costs, but this point will be examined when substitution is considered below. The social benefits that the business *provides* to society for free, as a multiplier to the financial amount of taxes or employee incomes paid, is usually not subtracted from the social benefits the business has *received* from society for free in the accounts[8]. This is a poor account and overestimates the social value of the company[9]. The business is the beneficiary of taxation, some of the benefits that flow in to the company are in exactly the same categories as the claimed benefits that flow out to society – improved education of workforce, stable working and societal conditions in which to operate, multipliers from publicly provided or supported critical and digital infrastructure resulting in growth in production and revenue, and so on.

Once the social benefits received by the company are subtracted from the social benefits provided, the net value of benefits from tax paid is likely already reported by real value adds. The multiplier might be reflected by general economic growth rather than the disproportionate multipliers pulled from literature. The same applies to incomes unless the company can systematically isolate specific practices that distinguish it from the wider economy and general multipliers, such as significantly different working conditions and development initiatives with

[7] Stolowy and Paugam, "The expansion of non-financial reporting: an exploratory study." Unerman, Bebbington, and O'dwyer, "Corporate reporting and accounting for externalities." Jones, *Accounting for biodiversity*. M. Erkens, L. Paugam, and H. Stolowy, "Non-financial information: State of the art and research perspectives based on a bibliometric study," *Comptabilité Contrôle Audit* 21, no. 3 (2015), https://doi.org/10.3917/cca.213.0015; R. Barker, "Corporate natural capital accounting," *Oxford Review of Economic Policy* 35, no. 1 (2019), https://doi.org/10.1093/oxrep/gry031.

[8] There are few studies on business benefits received from society, outside of economic analysis of subsidies. On education: Deloitte Access Economics, *Estimating the public and private benefits of higher education*, Deloitte. Australian Government Department of Education and Training (Canberra, ACT, 2016)..

[9] M. E. Porter and M. R. Kramer, "The Big Idea: Creating Shared Value. How to reinvent capitalism—and unleash a wave of innovation and growth," *Harvard Business Review* 89, no. 1-2 (2011).

significant social outcomes compared to the average corporate or national context[10]. Correcting net social value to be a, generally, modest multiplier of taxes and income would reverse the 'net positive impact' conclusion of many current impact statements.

Some externalities are already internalised by the tax system and existing regulation. Companies, generally, should avoid counting externalities that may already be offset by the taxes or levies they pay. For reasons discussed in the chapter Economic Theory of Change, it is unlikely that this potential source of double-counting to costs makes any discernible difference to food sector impact costs discussed in the report. The major global impacts identified for the food system are predominately not internalised, either directly by programs funded by government revenue or indirectly through market services. The impacts have become global issues by escaping internalisation.

Ignoring substitution effects for the moment (that tax is paid in jurisdictions different from where the impact occurs), at a global and monetary level could the tax the food sector pays offset the impacts it causes? The figure of 11% of annual global GDP from the FOLU estimation is crudely an estimate of long-term costs and suppression of economic activity due to food impact (case study 3 in the chapter Case Studies of Food System Impact Valuation). Some of these costs of the food system are benefits to society through employment in the health sector, etc. The net costs of the food system in terms of long-term average GDP loss are therefore less. How much less would need to be calculated by considering the long-term non-optimality of the structure between the food sector and other sectors created by the impact. If the GDP loss created by the food sector is even 1% of global GDP, we can compare it to the food sector tax-to-GDP contribution. Assume food sector value add contributes roughly 10% to global GDP, taking value add as an overestimate of profit, and an average 25% corporate tax rate[11], then food sector taxes contribute 2.5% of global GDP. The food sector (here the global food sector comprises all farmers, producers, manufacturers, and retailers) would face a minimum 40% increase in taxation to offset its impact, substitution aside.

This low level spreads the global burden across the global sector, which is fundamentally disproportionate. Looking at a micro-level at food manufacturers, the KPMG study mentioned in the introduction valued environmental externalities alone at 200% of profits[12]. Therefore, at the mentioned corporate tax rate, tax would have to increase on food manufacturers by 800% and redistributed to offset their direct economic impacts.

These estimates, though rough, when combined with substitution, indicate that the current tax paid by most food sector companies likely to produce an impact statement offers marginal, and probably fairer to say no, offset to the food system impacts of concern.

Other potential double-counting in costs are present in using third-party valuation factors. Where multiple footprints (e.g. Figure 18 in Food System Impact Valuation in Practice)

[10] G. Lenssen et al., "Creating shared value as a differentiation strategy–the example of BASF in Brazil," *Corporate Governance: The international journal of business in society* (2012). R. Goffee and G. Jones, "Creating the best workplace on earth: what employees really require to be their most productive," *Harvard Business Review* 91, no. 5 (2013). C. Bowe and D. v. der Horst, "Positive externalities, knowledge exchange and corporate farm extension services; a case study on creating shared value in a water scarce area," *Ecosystem Services* 15 (2015), https://doi.org/https://doi.org/10.1016/j.ecoser.2015.05.009.

[11] http://www.fao.org/economic/ess/ess-economic/gdpagriculture/en/; FOLU, *Growing Better: Ten Critical Transitions to Transform Food and Land Use, The Global Consultation Report of the Food and Land Use Coalition.*; OECD, *Revenue Statistics 2019*, OECD Publishing (Paris, 2019). E. Asen, *Corporate TaxRates around the World*, Tax Foundation (Washington DC, 2019), https://files.taxfoundation.org/20191209111406/Corporate-Tax-Rates-around-the-World-2019.pdf.

[12] KPMG, *Expect the Unexpected: Building business value in a changing world*, KPMG International Cooperative (Netherlands, 2012), https://assets.kpmg/content/dam/kpmg/pdf/2012/02/building-business-value-exec-summary.pdf.

contribute to a common outcome, it can be difficult to track what damages have been costed in the valuation factors.

The food system provides many examples of the complexity in attribution of damages from climate change, land-use, nitrogen application and water extraction.

Climate change and land-use change social costs both include direct costs from change in the amount of land used and the type of activity the land is used for. If estimates of land use change from clearing are not subtracted from land use lost to climate change double-counting can occur. The value of the forest loss on that ha which was estimated to be lost in the future for a climate calculation might actually be the value of agricultural production change on that ha, because the forest was cleared well before the climate changed it from forest. The climate costing model would have to be fairly accurate on land-use change projections from agriculture to avoid this correction, and that accuracy is unlikely for current IAMs (as discussed in Food System Impact Valuation in Practice).

The potential overestimation of costs from this kind of double counting is minimised by basing marginal costs on standardised impact pathways and marginal costing. This will avoid overt double counting. For example, N2O climate impacts are potentially both in a social cost of carbon and a social cost of nitrogen, depending on what is chosen or not chosen to be included in the costs. The overestimation in costs from double counting are probably more than offset by the underestimation due to positive correlation in impact.

Nitrogen application and water extraction have impact on eutrophication through water quality that is more serious combined than adding the individual effects from costing water extraction added to costing nitrogen application[13].

Projected impact on GDP losses from climate change and non-communicable disease associated to dietary intake occurring together are greater since climate change will exacerbate impacts on public health generally[14].

The uncertainties introduced into amounts in impact statements from accounting errors due to the complexity in non-financial accounting cannot be resolved completely[15]. This is part of the rationale for risk pricing and admitting uncertainty in costings.

Setting risk aside for the moment, as a function of skewness of how the uncertainty in costings is distributed, in the absence of more quantitative estimates of the uncertainty we take the position that double counting errors are probably not significant because of the offset from correlated impact.

In using addition to aggregate costs, subtraction of positive impacts from negative ones is of more serious concern than double counting.

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[13] S. Pfister, A. Koehler, and S. Hellweg, "Assessing the Environmental Impacts of Freshwater Consumption in LCA," *Environmental Science & Technology* 43, no. 11 (2009), https://doi.org/10.1021/es802423e.

[14] J. Patz et al., "Health Impact Assessment of Global Climate Change: Expanding on Comparative Risk Assessment Approaches for Policy Making," *Annual Review of Public Health* 29, no. 1 (2008), https://doi.org/10.1146/annurev.publhealth.29.020907.090750; T. Kjellstrom et al., "Public health impact of global heating due to climate change: potential effects on chronic non-communicable diseases," *International Journal of Public Health* 55, no. 2 (2010), https://doi.org/10.1007/s00038-009-0090-2.

[15] Uncertainty in standard financial reporting also supports the move to risk pricing K. Camfferman and J. L. Wielhouwer, "21st century scandals: towards a risk approach to financial reporting scandals," *Accounting and Business Research* 49, no. 5 (2019), https://doi.org/10.1080/00014788.2019.1614267; R. Barker et al., "Moving the Conceptual Framework Forward: Accounting for Uncertainty," *Contemporary Accounting Research* 37, no. 1 (2020), https://doi.org/10.1111/1911-3846.12585.

Substitution and equity in impact valuations

At the heart of food system market failure is the idea that the financial amount a Samoan consumer has paid for highly processed food incorporates an accurate assessment by that consumer of all the value losses to them and their community of consumption of the product[16]. The financial return from that transaction flows through to parent companies in the US or western Europe, creating social benefits for citizens where the parent companies pay tax[17]. The financial exchange observed and reported has attached to it a hidden exchange where the Samoan has exchanged their health capital for the human and social capital of a Swiss or US citizen.

There are similar exchanges across the food system[18], within and across nations, that are the basis of the equity concerns of civil society about the global food system. Lack of information or ability to determine value, lack of availability and access, and lack of market, political or social power to correct, result in financial amounts that do not reflect the full exchange of economic value along food system value chains[19].

The example of the Samoan consumer in the paragraph above highlights substitution of health capital for social capital. The same applies for examples of eutrophication, biodiversity, and other environmental impacts. The impacts are localised and externalised from primary production in underdeveloped regions, while social benefits accrue down the value chain, in generally more developed regions, through value adding and higher wages. Similar natural, or health, capital to social capital exchanges cross socio-economic levels within national boundaries.

Richer countries experience natural capital benefits from food trade by displacing production. Social capital loss is potentially substituted for natural capital gain in the richer country from

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[16] FAO, *Dietary patterns of households in Samoa*, The Food and Agriculture Organization of the United Nations (Rome, 2017), http://www.fao.org/3/a-i5973e.pdf. S. V. Panapasa et al., "Impacts of Long-Term Obesity on the Health Status of Samoan and Tongan Men in the United States: Results from the Pacific Islander Health Study," *Ethnicity & disease* 25, no. 3 (2015), https://doi.org/10.18865/ed.25.3.279.

[17] D. H. M. Akkermans, "Net profit flow per country from 1980 to 2009: The long-term effects of foreign direct investment," *PLOS ONE* 12, no. 6 (2017), https://doi.org/10.1371/journal.pone.0179244.

[18] TEEB, *TEEB for Agriculture & Food: Scientific and Economic Foundations*, UN Environment (Geneva, 2018). C. Hawkes, "Uneven dietary development: linking the policies and processes of globalization with the nutrition transition, obesity and diet-related chronic diseases," *Globalization and Health* 2, no. 1 (2006), https://doi.org/10.1186/1744-8603-2-4. E. Black, *Globalization of the Food Industry: Transnational Food Corporations, the Spread of Processed Food, and Their Implications for Food Security and Nutrition*, SIT Switzerland: Global Health and Development Policy. Independent Study Project (ISP) (Switzerland, 2016), https://digitalcollections.sit.edu/isp_collection/2353.

[19] M. K. Hendrickson and H. S. James, "Power, Fairness and Constrained Choice in Agricultural Markets: A Synthesizing Framework," *Journal of Agricultural and Environmental Ethics* 29, no. 6 (2016), https://doi.org/10.1007/s10806-016-9641-8; C. Rocha, "Food Insecurity as Market Failure: A Contribution from Economics," *Journal of Hunger & Environmental Nutrition* 1, no. 4 (2007), https://doi.org/10.1300/J477v01n04_02; T. S. Jayne and D. L. Tschirley, *Food Price Spikes and Strategic Interactions between the Public and Private Sectors: Market Failures or Governance Failures* (2009-10 2009), http://ageconsearch.umn.edu/record/97142/files/Chapter_Jayne.pdf; J. E. Stiglitz, "Markets, Market Failures, and Development," *The American Economic Review* 79, no. 2 (1989); W. Verbeke, "Agriculture and the food industry in the information age," *European Review of Agricultural Economics* 32, no. 3 (2005), https://doi.org/10.1093/eurrag/jbi017; Verbeke, "Agriculture and the food industry in the information age."; B. A. Swinburn et al., "The global obesity pandemic: shaped by global drivers and local environments," *The Lancet* 378, no. 9793 (2011), https://doi.org/https://doi.org/10.1016/S0140-6736(11)60813-1; R. Moodie et al., "Childhood obesity – a sign of commercial success, but a market failure," *International Journal of Pediatric Obesity* 1, no. 3 (2006), https://doi.org/10.1080/17477160600845044; P. Anand and A. Gray, "Obesity as Market Failure: Could a 'Deliberative Economy' Overcome the Problems of Paternalism?," *Kyklos* 62, no. 2 (2009), https://doi.org/10.1111/j.1467-6435.2009.00430.x.

low wages, pesticide exposure and working conditions lower than the equivalent production in the country of consumption. This is an exchange of social capital for natural capital. It is unclear the associated financial transaction in the value chain of the produced and traded agricultural commodity will capture the full exchange of economic value.

The exchanges are not always detrimental to wider economic value or necessitate large corrections. In some cases, intensive production in saturated ecosystems is dispersed to production in less stressed ecosystems. The dispersed natural capital damage may be offset by large social and human welfare gains from economic activity. Such exchanges need to be accounted for though, as the financial amounts may not compensate for the full economic damage when externalities are difficult to determine.

Accounting for capital exchanges is not intended to cancel present relative financial positions between rich and poor countries, or socio-economic strata. Financial arbitrage, generally, will still enable financially cheaper production alongside economic development. Substitutability in the capital exchange is closer to concerns about fairness, justice, and power[20]. These disparities perpetuate financial gaps, and eventually reveal themselves in economic damage or economic depression through accumulated capital loss. Accumulation of unaccounted capital losses and gains follows the same trend as produced and financial capital. That is, an accumulation of gains for rich countries[21].

Economics has studied substitution extensively under the concepts of weak and strong sustainability[22], and the argument of weak sustainability that rich parts of the world getting richer will end up compensating the Samoan loss (development of health treatments in the US and Switzerland through R&D enabled by concentration of capital eventually reaching Samoa to abate the lost health capital of the Samoan consumer) is highly contested. Corrections for the hidden exchange of capital attached to the monetary transfer should be accounted for in impact costing.

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[20] L. T. Raynolds, "Re-embedding global agriculture: The international organic and fair trade movements," *Agriculture and Human Values* 17, no. 3 (2000), https://doi.org/10.1023/A:1007608805843; T. Garnett, "Food sustainability: problems, perspectives and solutions," 72, no. 1 (2013), https://doi.org/10.1017/S0029665112002947; P. Allen, "Mining for justice in the food system: perceptions, practices, and possibilities," *Agriculture and Human Values* 25, no. 2 (2008), https://doi.org/10.1007/s10460-008-9120-6; M. Heasman and R. Early, "Social Justice as Fairness in the Global Food System," in *Lessons for social change in the global economy : voices from the field*, ed. S. Garwood, S. Croeser, and C. Yakinthou (Lanham, Maryland: Lexington Books, 2014).. Explored in detail in Chapter 5: TEEB, *TEEB for Agriculture & Food: Scientific and Economic Foundations*.

[21] R. E. Lucas, "Why Doesn't Capital Flow from Rich to Poor Countries?," *The American Economic Review* 80, no. 2 (1990), www.jstor.org/stable/2006549; P.-O. Gourinchas and O. Jeanne, "Capital Flows to Developing Countries: The Allocation Puzzle," *The Review of Economic Studies* 80, no. 4 (285) (2013), www.jstor.org/stable/43551565; D. Kar and G. Schjelderup, *Financial flows and tax havens: combining to limit the lives of billions of people*, Centre for Applied Research, Norwegian School of Economics. Global Financial Integrity. Jawaharlal Nehru University. Instituto de Estudos Socioeconômicos. Nigerian Institute of Social and Economic Research. (Bergen, Norway, 2015). https://www.theguardian.com/global-development-professionals-network/2017/jan/14/aid-in-reverse-how-poor-countries-develop-rich-countries

[22] Substitution between different forms of capital is discussed extensively in sustainable development economics, under “weak” and “strong” sustainability.: K. J. Arrow et al., "Economic growth, carrying capacity, and the environment," *Science* 268, no. 5210 (1995), https://doi.org/10.1126/science.268.5210.520. G. R. Davies, "Appraising Weak and Strong Sustainability: Searching for a Middle Ground," *Consilience*, no. 10 (2013), www.jstor.org/stable/26476142.. Similar notions are discussed in accounting literature under commensurability, e.g. Section 5 Unerman, Bebbington, and O’dwyer, "Corporate reporting and accounting for externalities."

Business approaches to impact valuation take negative amounts, of say costs from natural capital loss, and offset them by positive amounts, of say benefits from social capital gain, and add them together without considering substitutability of capital[23]. This is a flawed approach to non-financial accounting. In financial accounting the issue does not arise, money is the exchange value. Money is taken as a complete account of value in the substitution of a capital loss for a capital gain.

The approaches to impact valuation mentioned separate out net environmental costs and net social benefits before calculating totals. There is normally little or no indication of where and to whom the main environmental costs are incurred versus where and to whom the main social benefits occur[24]. When these separate accounts, environmental and social, one negative and one positive, are added the assumption is of complete substitution in capital exchanges. Whatever financial transaction or result has occurred for the capital loser is assumed to include complete compensation directly or eventually from the capital winner. It remains unexplained in the methodology of present impact statements why natural capital damage in a developing country is offset by social capital gain in a developed country.

Impact investors should take note of this lack of explanation and estimation. Without understanding where costs and benefits are incurred the change in impact is unknown, despite what the 'total value' indicating positive impact. This is bookkeeping sleight-of-hand. An accounting failure that, if persisted, will do little to address impact. The negative impacts may still be occurring where marginal impacts are exacerbating already accumulated capital loss. The positive impacts are still occurring where marginal impacts in social improvement enrich an already socially rich society. Only on paper have the negative and the positive cancelled each other, and only on paper are planet and people less worse off.

The accounting should indicate if the social benefits occurred in the same community experiencing the natural costs, which offer the possibility that some benefits offset some costs. The accounting should indicate if there is a considerable distance between the costs and benefits and substitutability of capital becomes much less clear. In theory this could apply to all non-financial capital exchanges, between national and subnational economies separated by socio-economic, cultural, legal, spatial, and temporal dimensions. In practice, a financial reporting community genuinely embracing a 'multi-capital approach' should be able to at least track the 'trades' in different capital classes linked to the largest inequities.

Parity, as examined in the body of the report in Food System Impact Valuation in Practice, is a significant consideration for non-financial capital exchanges. Parity is the comparison of economic value between different economies – an exchange rate. Using currency exchange rates to compare economies in combination with total value approaches would incentivise, on paper, massively shifting degradation to poorer countries and welfare improvements to rich ones[25]. Tracking the 'trades' of different capital classes enables different parities to be applied. Currency exchange rates should be applied to exchanges of financial capital only. It is not clear that even PPP, a conventional welfare-based choice of parity based on substitution of produced capital, is appropriate for exchanges of natural, and social and human capital. As discussed in the body of the report, based on the SDGs, there are arguments for using utilitarian approaches (global GDP per capita) for exchanges involving human health, or prioritarian approaches for certain forms of social capital.

[23] KPMG True Value https://home.kpmg/nl/en/home/services/audit/sustainability/true-value.html; EY Total Value https://www.ey.com/Publication/vwLUAssets/ey-total-value-impact-valuation-to-support-decision-making/$FILE/ey-total-value-impact-valuation-to-support-decision-making.pdf; PWC Total Impact Measurement & Management https://www.pwc.com/gx/en/services/sustainability/total-impact-measurement-management.html; Impact Institute https://www.impactinstitute.com/; etc

[24] p. 269: TEEB, *TEEB for Agriculture & Food: Scientific and Economic Foundations*.

[25] Kar and Schjelderup, *Financial flows and tax havens: combining to limit the lives of billions of people*.

Parity consideration for capital exchanges within countries is linked to wider notions of welfare for national economies. From a conventional economic view, food exchanging health of consumers into health care sector revenue is a zero-sum game. Food sector health impacts and health sector gain being substitutable is only broken either through conventional equilibrium effects, eventual external effects of large magnitude changes on GDP such as in social cost calculations of climate change (broader equilibrium effects), or by welfare measures beyond GDP as described in the body of the report in Food System Impact Valuation in Practice.

Equity statistics of capital exchanges

Equity statistics concerning substitution of economic value should be reported alongside totals in impact reporting. The statistics reflect capital exchange in the underlying non-financial accounting which totals cannot capture. Three equity statistics are proposed below.

The equity statistics are measures of inequity, like the Gini index. They measure distance between capital gains and losses across three dimensions.

The first statistic, called the socio-economic spatial statistic, reflects capital exchanges crossing national economies and levels of socio-economic development.

As an example, if, because of activity in the food sector which produced the footprint being valued, social benefits were mostly accruing in the same communities experiencing health costs, the socio-economic spatial statistic would be lower. If social capital benefits were mostly accruing in developed nations while natural capital costs accrue in developing nations, the socio-economic spatial statistic would be high. If capital loss occurs in a national economy more able to bear it, such as social capital losses occurs in a richer country in exchange for preservation of critical natural capital in a developing country, the socio-economic spatial statistic would be lower.

The second statistic, called the socio-economic temporal statistic, reflects capital exchanges crossing generations. If, because of activity in the food sector which produced the footprint being valued, social capital benefits were mostly accruing in the present time while natural capital costs from present activity accrue at later times then the socio-economic temporal statistic would be very high. In the body of the report, besides climate impacts, obesity and poverty intergenerational effects for food system impact were raised. Other potential intergenerational effects have also been discussed in the literature[26].

The third statistic, called the capital exchange risk statistic, reflects where more certain costs are exchanged for uncertain benefits.

The statistics are not independent. If social capital benefits were mostly accruing in a distant future time from natural capital costs incurred now, then the socio-economic temporal statistic and the capital exchange risk would be very high. Future benefits are not always realised or delivered, while present natural costs such as water pollution are usually directly observed and incurred to a higher degree of certainty in the present.

Another situation which the capital exchange risk statistic would highlight is a kind of inequitable resilience in food value chains. In financial terms most of the value add in long value chains resides with retailers and consumers in rich countries. Retailers and consumers are buffeted from many sources of shock to the food system, which occur mainly to inputs and production such as extreme weather, crop disease and pests (pandemics and their impact on

[26] K. Aoki, "Food forethought: intergenerational equity and global food supply - past, present, and future.(Symposium: Intergenerational Equity and Intellectual Property)," *Wisconsin Law Review* 2011, no. 2 (2011).

labour and distribution aside)[27]. Only a low percentage of the price of the final food product in a developing world context is the price of agricultural commodities. The price of bread in the UK barely changed despite massive volatility in the wheat price during the 2007/2008 food price spikes[28]. Income and social capital are barely stressed for rich consumers for the mentioned shocks. However, in rural communities and households associated to agricultural production, social consequences play out in in terms of stress, suicide, poverty, and living at the margin of environmental change. Their exposure to volatility in agricultural commodity prices and production volume changes is many times greater than consumers. Those exposed generally have less available social and financial capital to ride out the shock compared to rich consumers[29]. Therefore, the value chain is perverse in terms of risk sharing – those most able to bear shocks are less exposed, those least able to bear shocks are most exposed[30]. GDP effects of serious erosion in social capital due to the food system is a problem unlikely to self-correct, since those with the market power to create resilience in the system are those with little incentive to. Capital exchanges along food value chains where capital gains accrue at consumption with little variation due to climate change, and capital losses accrue in production with large variation due to climate change, are an example of large uncertainty in costs and small uncertainty in benefits due to capital exchange.

A linear model for food system impact valuation was recommended in the body of the report in Food System Impact Valuation in Practice, and observed in all case studies in Case Studies of Food System Impact Valuation. The linear model adds together shadow prices multiplied by footprints. The sum is the impact valuation and can obscure capital substitutions. Adjustments due to uncertainty in shadow prices and footprints were discussed in Food System Impact Valuation in Practice, but the risk-adjusted model it is still a linear model based on summation and admits subtraction of negative terms from positive terms.

The linear model was designed so that the calculations behind the model allow the three equity statistics to be reported alongside the final total. The linear model separates out value changes in other nations from footprints incurred in each nation. The linear model also separates out value changes in future time periods from footprints incurred now. The risk pricing version of

[27] H. C. J. Godfray et al., "Food Security: The Challenge of Feeding 9 Billion People," *Science* 327, no. 5967 (2010), https://doi.org/10.1126/science.1185383; R. Bailey et al., *Extreme weather and resilience of the global food system*, UK-US Taskforce on Extreme Weather and Global Food System Resilience. (London, UK, 2015); Global Food Security, *UK-China workshop on extreme weather and global food system resilience*, Global Food Security Programme (London, UK, 2016); P. J. Ericksen, "What Is the Vulnerability of a Food System to Global Environmental Change?," *Ecology and Society* 13, no. 2 (2008), www.jstor.org/stable/26268000.

[28] M. J. Puma et al., "Assessing the evolving fragility of the global food system," *Environmental Research Letters* 10, no. 2 (2015); J. Piesse and C. Thirtle, "Three bubbles and a panic: An explanatory review of recent food commodity price events," *Three bubbles and a panic: An explanatory review of recent food commodity price events* 34 (2009).

[29] M. Philippe et al., "Reserves and trade jointly determine exposure to food supply shocks," *Environmental Research Letters* 11, no. 9 (2016), http://stacks.iop.org/1748-9326/11/i=9/a=095009; D. M. Tendall et al., "Food system resilience: Defining the concept," *Global Food Security* 6 (2015), https://doi.org/http://dx.doi.org/10.1016/j.gfs.2015.08.001; M. Kalkuhl, "How Strong Do Global Commodity Prices Influence Domestic Food Prices in Developing Countries? A Global Price Transmission and Vulnerability Mapping Analysis," in *Food Price Volatility and Its Implications for Food Security and Policy*, ed. M. Kalkuhl, J. von Braun, and M. Torero (Cham: Springer International Publishing, 2016); S. Rotz and E. D. G. Fraser, "Resilience and the industrial food system: analyzing the impacts of agricultural industrialization on food system vulnerability," *Journal of Environmental Studies and Sciences* 5, no. 3 (2015), https://doi.org/10.1007/s13412-015-0277-1; D. Seekell et al., "Resilience in the global food system," *Environmental Research Letters* 12, no. 2 (2017), https://doi.org/10.1088/1748-9326/aa5730; J. Berazneva and D. R. Lee, "Explaining the African food riots of 2007--2008: An empirical analysis," *Food Policy* 39 (2013).

[30] M. K. Hendrickson, "Resilience in a concentrated and consolidated food system," *Journal of Environmental Studies and Sciences* 5, no. 3 (2015), https://doi.org/10.1007/s13412-015-0292-2.

the linear model can capture the uncertainty in negative terms and positive terms separately. The separated calculations are recombined in the total impact valuation.

A consortium of intergovernmental and institutional actors and experts charged with formalising impact pathways and develop costings could embed different parity calculations within the determination of shadow prices of footprint quantities (capital changes are intermediate in this determination, as described in the body of the report in Food System Impact Valuation in Practice). Even with parity adjustment within shadow prices, and the overt description of parity adjustment between nations and discounting in the model, it is still useful to report on equity statistics that provide a measure of the substitution implicit in the valuation and an account of non-financial capital exchanges.

Most of this section has discussed social costing. However, uncertainties are still present for abatement. Achievement of abatement targets occur over long time periods, and exchange of economic value is implicit in disaggregation of global footprints to national scales. The need for national abatement markets for non-carbon food system footprints, creates similar considerations for abatement costing.

Impact investors should ask for equity statistics, like those discussed, to be reported alongside an impact statement or an impact valuation to understand equity in capital exchanges. With only 'total value' amounts, or net environmental costs and net social costs amounts, costs incurred in richer countries with an existing large social capital base and natural benefits accrued in developing countries, would be indistinguishable or even lower impact value than a reversal of this capital flow, where social capital costs accrue in the developing country for natural capital benefits in the developed one. For investors concerned with equity, companies whose activities result in the former capital flow should be distinguished from the latter.

Alignment and standardisation in food system impact valuation

The case studies in Case Studies of Food System Impact Valuation show a large amount of variation in the footprints used, variation in the detail of the pathway from footprint to impact, and variation in the marginal costs applied to footprints. The main body of the report argues that comparability through alignment and ultimately standardisation will be more efficient and accelerate use. Businesses can concentrate on footprint calculation and avoid or reduce ethical and technical choices in marginal costing.

Best practice

A simple way to begin comparability is to list the main choices for footprints, sources of marginal costs, and a checklist to comment on the issues and challenges for food system impact valuation in practice identified in the main body of the report. A best practice guide with suggested forms to record metadata about the valuation keeps flexibility for practice while starting to bound and identify choices, methods, and communication about the impact valuation. Heading directly into standardisation of sustainability metrics without a staged process of gradually bounding, testing, and refining best practice has proven difficult for the food system[31].

[31] FAO, *Sustainability Asessment of Food and Agriculture Systems (SAFA) Guidelines*, Food and Agriculture Organization of the United Nations (Rome, 2014), http://www.fao.org/3/a-i3957e.pdf. CISL, *How businesses measure their impact on nature: a gap analysis*, University of Cambridge Institute for Sustainability Leadership (Cambridge, 2017). S. Mullender, L. Smith, and S. Padel, *Sustainability Assessment: the need for convergence*, The Organic Research Centre and Sustainable Food Trust (Berkshire, 2017). E. M. de Olde et al., "Assessing sustainability at farm-level: Lessons learned from a comparison of tools in practice," *Ecological Indicators* 66 (2016), https://doi.org/https://doi.org/10.1016/j.ecolind.2016.01.047. E. M. de Olde et al., "When experts disagree: the need to rethink indicator selection for assessing sustainability of agriculture,"

Having a standardised list of footprints and inclusions in impact pathways does not imply that an impact valuation study of the food system considers all of them. It is a record of what is, and is not, being considered in scope, and what is being measured for compatibility with other studies using the same list.

The nine case studies in Case Studies of Food System Impact Valuation, and Table 1 of global food system issues in Economic Theory of Change, provide enough scope to inform an initial list of footprints and impacts. The best practice guide should indicate omissions that matter and frequently occur, and hotspots for underestimation and overestimation. A list of capital changes specific to food system impact pathways could be extracted from the TEEB AgriFood Evaluation Framework or the performance indicators in the EU SUSFANS project[32].

The guide should record choices made for the components of valuation (Figure 17 in Food System Impact Valuation in Practice). Forms should require comment or list common options, based on the technical and ethical challenges discussed in the main body of the report.

Footprint quantities

Environmental: GHG emissions; Nutrient pollution; Land use; Freshwater use.

Social & Human: Accidental Child labour; Human exposure to toxicity in production process; Antibiotic Use; Market share per food product or commodity category per reference population.

Multifaceted: Contribution to food waste per reference population.

Considerations: Which reference populations are the receivers of social and health impacts? Are marginal costs available for the footprints chosen? Where are footprints occurring? Are the marginal costs appropriate for footprints in this location and for the reference population? What are the caveats or assumptions made in matching marginal costs to footprints? Are the major impacts from the activities within the scope of the study captured? What is the potential magnitude of impact from omitted footprints?

Capital changes (impact pathway)

Natural Capital: Climate change (incl. CO2-eq forcing + albedo); Nitrogen and Phosphorus excess (incl. air pollution, water pollution, soil degradation); Ecosystem stock and ecosystem renewal (incl. pollination, deforestation, desertification, biodiversity loss).

Social Capital: Provision of or loss of livelihoods; Provision or loss of community infrastructure (incl. access to natural capital, customs, judicial and political); Equality (social, gender, income) and other rights.

Human Capital: Developmental gain and loss (incl. child labour, stunting, education, skills); Human health (incl. pesticides, antibiotic resistance); Human health (incl. deviation of dietary intake from reference population ideal diet).

Produced Capital: Effects on labour, income, profits, taxes; Effects on assets and liabilities (both private and public, incl. institutions and infrastructure, capital accumulation, market share).

Environment, Development and Sustainability 19, no. 4 (2017), https://doi.org/10.1007/s10668-016-9803-x; C. Schader et al., "Scope and precision of sustainability assessment approaches to food systems," *Ecology and Society* 19, no. 3 (2014), 42, https://doi.org/10.5751/ES-06866-190342.

[32] TEEB, *TEEB for Agriculture & Food: Scientific and Economic Foundations*; M. Zurek et al., "Assessing Sustainable Food and Nutrition Security of the EU Food System—An Integrated Approach," *Sustainability* 10, no. 11 (2018), https://doi.org/10.3390/su10114271.

Considerations: What are the exchanges across national boundaries and socio-economic development levels? What are the time frames of impacts – for footprint incurred now how long will a third-party experience impact? What is the uncertainty in capital losses compared to capital gains? What is the stock of the capital being exchanged, is it abundant or scarce? For scarce capital, has increased impact been considered and factored into costs? For abundant capital, has a more marginal change in impact been factored into benefits?

Costing

Welfare: What is the underlying measure of human and social well-being? How is it being associated to monetary amounts: Direct losses without accounting for equilibrium effects; GDP; GDP projections; GDP adjusted for well-being; other well-being measures?

Marginal costs: What is the origin of the costing estimates? Are they social or abatement costs? Are they being mixed? If social, what are the parity and discounting choices in the context of the capital exchanges across time and national boundaries and socio-economic development levels? If abatement, what are the footprint reduction targets assumed and what are the assumptions about realising the abatement measures? Are the costs for some regions, such as the EU, being extrapolated to others (benefit transfer)?

Uncertainty: What are the significant sources of uncertainty in the costing? Provide a qualitative description of uncertainty in costings to caution potential users (government, investors). What scenarios have been assumed for social costs or realisation of abatement? What are the potential risk transfers if impact is much larger or much smaller than expected?

Methods

Footprint calculation: LCA? List standard LCA databases used or other. Own calculations?

Valuation calculation: List third-party valuations factors used. Standard sources (e.g. national handbooks)? Non-standard sources (e.g. ad hoc literature)? If own costings derived from modelling, indicate: data on total footprints and projections used; models used for attribution of capital changes; models used for valuation of capital changes.

Recording Spatial, Temporal Data and Reference Populations:

Timeframe of footprint producing activity: Periodic (e.g. annual impact report); Specific (e.g. a once-off timeframe in continuous activity of actor, e.g. impacts 2013-2018); Limited (e.g. once off activity, project impact assessment)

Spatial context: A long list that breaks down each footprint to its spatial level and context that produces the main different to impact per same unit of footprint, e.g. water: catchment or aquifer, extraction method, use

Reference populations: Spatial level (Global, National, Sub-national); Age division (Children <5 and adults); Other Demographic division (Gender, Socio-economic status); Medical divisions (BMI).

Data sources are not as difficult to consolidate as models, for example most footprint calculations use a limited set of large LCA databases. The other methods are modelling studies (of which there are many options, so here the checklist can just indicate that a modelling study from literature was used) and environmentally or socially extended input-output analysis (of which there are few routinely applied). There are a few standard choices for discount rates. It can be recorded whether the valuation is target based, for which targets. For corporate users, a standard list might include SDGs and planetary boundaries and safe operating spaces.

The standardised recording of impact valuation studies will improve identification of gaps in practice and methods[33]. Recording best practice, so that users can report against the assumptions in their study, could eventually lead to the ability to swap in and out marginal costings to perform the most basic comparative assessments of calculations.

Aligning valuation factors

The report recommends that a consortium of intergovernmental and institutional actors and experts (a societal process), in collaboration with the food sector, should develop shadow prices for food system footprints for the practical, ethical, and risk-based arguments made in the body of the report.

Businesses use lifecycle analysis software to implement a linear model of impact valuation, which, in its simplest form, requires as input a standard list of footprints from the business's own operations and provides as output a valuation. The software pairs Lifecycle Analysis (LCA) with handbooks of valuation factors for impact valuation. In the environmental dimensions, Lifecycle Inventories (LCI) and Lifecycle Impact Assessment (LCIA) represent standardised structure for footprints and impact pathways. The structural consistency enables handbooks of shadow prices to be attached to the LCIA such as the CE Delft EU28 Environmental Prices attached to SimaPro[34] and TruCost pricing attached to GaBI[35] (case studies 7 and 8 in Case Studies of Food System Impact Valuation).

The convenient use of software could become a *de facto* standardisation of the costings from national handbooks and consultants. Users are not required to consider the details and difficulties of marginal costs. They will not know answers to, or be able to answer because of the proprietary nature of some of the costings, many of the questions for best practice in the last section. Despite this, users are still making implicit ethical choices and have not reduced the uncertainty in the costings by using the shadow prices suggested by the software. The handbooks are incomplete regarding food impact costing, as discussed in the body of the report in Development and Inventory of Methods, requiring a benefit transfer argument to translate the costing to other national and regional contexts. The national costings from consultants are proprietary, while the global average costings, which are not proprietary, are limited in their application.

If large companies in the food sector widely use the software with attached costings, then the costings may become agreed values with little examination of bias, ethical choices, and uncertainty. This risks valuations systematically under- or over-estimate cost of impacts and little incentive to improve or update costing outside of corporate incentives (Table 5). The result for society from systematic under- or over-estimates would be not enough or too much economic adjustment. *De facto* standardisation through widescale uptake of the software for

[33] J. Janker and S. Mann, "Understanding the social dimension of sustainability in agriculture: a critical review of sustainability assessment tools," *Environment, Development and Sustainability* (2018), https://doi.org/10.1007/s10668-018-0282-0.
[34] https://simapro.com/
[35] http://www.gabi-software.com/international/index/

valuation also risks a perception that the 'problem of costing' is solved, dissipating the momentum for a societal process to develop costings.

There are several potential mitigations for *de facto* standardisation.

If society, through internalisation, requires of business comparable valuations, business can demand of the software vendor the capacity to apply, if they exist, different sets of costings to the same footprint data. This, at least, by using different sets of costings, reveals the variation in costings and inherent ethical choices. Demand for comparison needs to stimulate supply of solutions by private providers so that different costing sets exist. Information on the costings (e.g. discount rates, parity choices, spatial considerations in impact) should also be part of the demand.

Lifecycle data is expensive to generate, and most software relies on lifecycle databases generated in the EU and US from publicly funded projects. Therefore, even though LCA enables switching in and out of alternative data, there are often only a few original estimates that have been repeated through datasets. The same situation would likely happen for datasets of costings. As impact data, datasets of costings are potentially harder and more expensive to generate than footprint data. A repetition of calculations can already be observed in the case studies, as discussed in Case Studies of Food System Impact Valuation. Consequently, a supply of multiple costing datasets may not reduce the risk of systemic bias in costings.

Private providers can provide an efficiency for companies that want to "press a valuation button" on their footprint and turn it into impact, if there is parallel evolution of a credible set of shadow prices attached to footprints. Costings from national handbooks and consultants are a short-term solution to stimulate take-up of valuation, which should eventually evolve into databases of impact costing that are specific to the food system and generated by a societal process. This development process for costing was examined in the main body of the report in Development and Inventory of Methods. Private initiatives to develop costings have a horizon limited by the legitimacy of the private sector valuing its own impact on society.

Table 5: Different sources for impact costings and the implications if they become the *de facto* standard through wide scale use. The first source is diverse abatement and social cost estimates from literature. The second source is collections of costings by consultants and national handbooks, usually from literature and generally without a focus on the food system. The third source is a societal development of costings for the food system. Differences between the sources in terms of costs of development, requirements, and maturity, are discussed in the body of the report.

	Scientific literature	**Private or ad hoc public development of costings**	**Societal development of costings**
Potential for bias in impact costing	Spread of estimates, because of the variation in sources. Coverage will be ad hoc. Uncertainty greater range. If uncertainty induces higher valuations, then lower chance of under-estimate.	Less spread, more certainty implied but values are likely under- or over-estimates. Implied certainty and lack of included risk premium, creates higher chance of under-estimate.	Less uncertainty than general scientific literature and values more likely to be actual ranges of impact (lower risk premium from society, lower chance of over- and under- estimate).
Development	The academic process provides feedback on	Locked into private development. Legitimacy of the	More concentrated science-based process for improvement and

estimates and improvement cycle. No specific investment mechanism for improvement.	private sector valuing its own impact on society.	feedback. Creates a focus for investment and can facilitate regular (5 yearly) updating.

National accounting sits at the other end of the scale from LCA models of impact pathways and inventories of footprint. Initiatives such as the UN sponsored System of Environmental-Economic Accounting components SEEA-AFF and SEEA-EEA, are creating standardisation in national non-financial accounts. The degree to which this offers an envelope for accounting at the level of actor footprints instead of national footprints[36], and sponsors choices for footprints and impact pathways, is discussed in the body of the report in Food System Impact Valuation in Practice.

Another party to standardisation is small and medium enterprise. Small and medium enterprises in the food system, the majority of which are very small, generally have neither the expertise nor resources to develop LCA models and estimate impact using the software mentioned. Standardisation is required to prevent excluding small and medium enterprise from incentives based on demonstrating impact reduction.

From the perspective of reducing global food system impact, an initial practical step is to treat small businesses as blocs of actors, proportionate to impact. This places their potential for impact reduction on the same scale as large business. Impact valuation should be done for the bloc, and private or public incentives for impact reduction can be rewarded to the bloc and distributed accordingly. Databases of impact costing that are specific to the food system and generated by a societal process provide standardised costing that can be applied to the bloc. Footprint calculation, which has been recommended in the body of the report as the responsibility of food system actors, has also been standardised at the level of similar small and medium enterprises and their products. The European Commission's product and organisation environmental footprints (PEF and OEF respectively) have the potential to provide standardised footprint calculations for food sector products and businesses[37].

[36] The scope of Working Group 5 of the SEEA-EEA https://seea.un.org/content/seea-experimental-ecosystem-accounting-revision:

> "Much of the work in this group is focused on placing in context a wide range of economic and accounting thinking that has developed over time and from this thinking establish proposals for appropriate treatments for ecosystem accounting purposes. Key issues that emerge include:
>
> - Establishing the concept of exchange values in non-market situations for the valuation of ecosystem services;
> - Understanding environmental economic concepts of externalities, disservices and welfare values in an accounting context;
> - Conceptualizing ecosystem capacity for accounting purposes;
> - Measuring ecosystem degradation and enhancement and establishing appropriate recording options for the accounts, including attribution to economic units; and
> - Valuing ecosystem assets, including link to the valuation of land and estimating the future flow of ecosystem services."

[37] S. Sala et al., *Global normalisation factors for the Environmental Footprint and Life Cycle Assessment*, Publications Office of the European Union (Luxembourg, 2017); S. Manfredi et al., "Comparing the European Commission product environmental footprint method with other environmental accounting methods," *The International Journal of Life Cycle Assessment* 20, no. 3 (2015), https://doi.org/10.1007/s11367-014-0839-6; B. Vanessa et al., "Product Environmental Footprint (PEF) Pilot Phase—Comparability over Flexibility?," *Sustainability* 10, no. 8 (2018), https://doi.org/10.3390/su10082898.

Databases of shadow prices for food system footprints and updating

Based upon development and standardisation of impact valuation, the report has argued for investment in databases of marginal costs for food system valuation, with the considerations discussed in Food System Impact Valuation in Practice and Development and Inventory of Methods. Previous studies have suggested the same need and suggested moving from the stopgap of proprietary costings.

From the 2014 FAO food waste full cost accounting report[38]

> "**Develop further and refine available data bases**. This means adding more detailed national or regional data, if available, from a more extensive review of the literature, including grey literature such as governmental and NGO reports, including those in national languages. For example, data on the health costs of pesticide use could be collected in this way. Additional national estimates would then allow refining and improving the benefit transfer to arrive at more complete and credible global estimates;"

From the 2017 Impact Valuation Roundtable White Paper[39]

> "We recommend that the valuation coefficients that a company uses should be made publicly available, and should come preferably from independent third party sources such as UN agencies, OECD, or scientific studies. For some impact categories globally consistent valuation coefficient can be applied (e.g. GHGs), other indicators should be valued with national or locally specific coefficients (e.g. water consumption). To support the discourse around valuation, the logic for choosing a particular coefficient should be documented, explained and disclosed."

A database at the resolution recommended in this report, which has been considered for practicality and to avoid gross under- and over-estimation from applying global marginal costs to highly varied impacts, might have tens of thousands of marginal costs in it. Specific mostly to global food system impact. This goes beyond the scope of a handbook and ad hoc procurement of figures from scientific literature. The listings need to be divided clearly by factors such as footprint (the quantity associated to the marginal cost), time (now, future, how far in the future), population where cost is incurred (national populations initially), social and abatement costing, level of uncertainty, and choice of targets. The database is an asset for specific groups of users that can agree on the same targets or agree to use the same social costs – an example user group is a progressive bloc of large corporations.

Competitive advantage should not be in producing the best customised impact valuation using closed source models. Such attempts will be a target for academia and civil society.

In using comparable, standardised, credible, and scientifically accepted marginal costs the competitive point becomes impact performance. Standardisation highlights performance in impact reduction while customisation makes it opaque. Development can be staged:

- business demands of LCA software comparability and relevant detail on the costings for best practice
- a bloc of companies design a common set, e.g. Value Balancing Alliance[40]
- building up to a societal process.

The staging builds up a network and a consensus on the models required. Inevitable variation such as exists for carbon costing, and the presence of multiple models, is less of a concern if risk pricing is used, than not progressing toward agreed values.

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[38] p. 79: FAO, *Food wastage footprint: full-cost accounting*, Food and Agriculture Organization of the United Nations (Rome, 2014).
[39] p. 10: IVR, *Operationalizing Impact Valuation: Experiences and Recommendations by Participants of the Impact Valuation Roundtable*, Impact Valuation Rountable (2017), https://docs.wbcsd.org/2017/04/IVR_Impact%20Valuation_White_Paper.pdf.
[40] https://www.value-balancing.com/

Marginal costs change over time, not only because they are a function of the quantities that they are marginal too (in this case the global footprints of the food system), but because of changes in other determinants in the calculation of costs. High-level panels on costing carbon have called for regular updates to the social cost of carbon[41]. The social cost of carbon is not a number, it is a distribution of numbers due to the uncertainties in calculating the impacts of unabated climate change. This report has argued for the same view for all the marginal costs associated with food system impact, see Food System Impact Valuation in Practice. An updating process should be seen as a process updating the distributions with increasing information.

Information increase can relate to:

- Scientific knowledge, including a better understanding of attribution of footprints to capital changes, e.g. biophysical processes.
- Information revealed. This can include information revealed that was previously assumed, such as emission levels, new data about dietary intake in present populations, and increase in monitoring capability of natural capital stocks.
- Internalisation and efficiency gains realised (Figure 35). Responses to previous estimates of costs, or value changes, feedback into reduction of footprints and other changes in capital. When abatement is realised, a spread of futures with uncertain social costs is collapsed into a future with the social costs abated for the realised abatement cost. Other changes not associated to the business, such as improvement in recovery rates in renewing natural capital stocks, also change the marginal cost estimates.

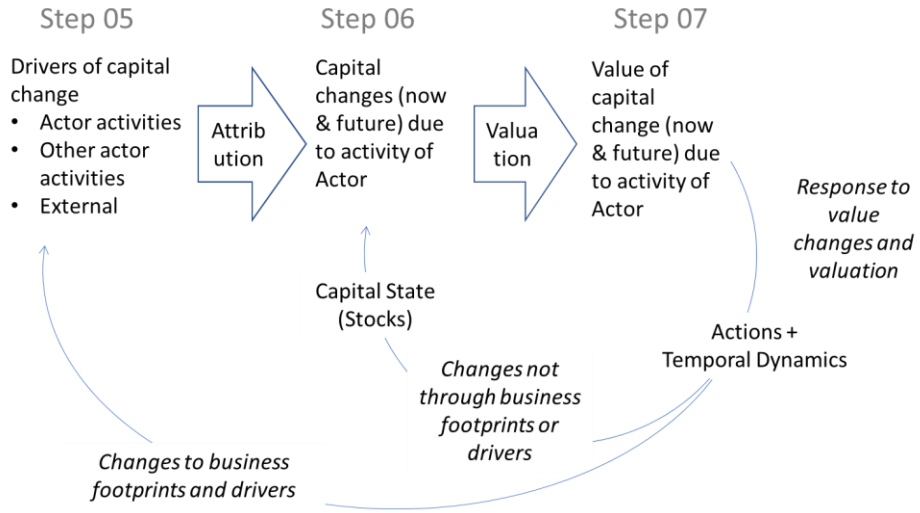

Figure 35: Socio-economic and environmental feedback from responses to internalisation in the market. Footprints reduce or increase, drivers change, natural, social and human capital stocks renew or degrade further. Enough change and the marginal valuation must be recalculated. Some marginal costs will be more sensitive to this feedback (need more regular updating) than others.

There are several precedents for updating marginal costs. The US government formed the Interagency Working Group for the Social Cost of Greenhouse Gases (formerly IWGSCC,

[41] W. Pizer et al., "Using and improving the social cost of carbon," *Science* 346, no. 6214 (2014), https://doi.org/10.1126/science.1259774. National Academies of Sciences Engineering Medicine, *Valuing Climate Damages: Updating Estimation of the Social Cost of Carbon Dioxide* (Washington, DC: The National Academies Press, 2017). G. E. Metcalf and J. H. Stock, "Integrated Assessment Models and the Social Cost of Carbon: A Review and Assessment of U.S. Experience," *Review of Environmental Economics and Policy* 11, no. 1 (2017), https://doi.org/10.1093/reep/rew014.

then IWGSCGG) in 2009. The IWGSCGG produced its first estimates in 2010, which it updated due to modelling improvements in 2013 and commissioned a review by the National Academies of Science, Engineering and Medicine in 2016 for another update. The CE Delft Handbook of EU environmental prices, originally developed for the Dutch Government in 2010 under the term shadow prices, was updated in 2017 and extended to an EU wide version in 2018. The Ecosystem services valuation database (ESVD), established in 2010, has been maintained and started a review process in 2019[42].

An impediment to initiating research on marginal costing as a basis for food economic fiscal policy, and for the establishment and review of a database of marginal costs, is the lack of an established scientific panel and independent intergovernmental body dedicated to food system economics[43].

Opportunities for leaders in impact reduction

The influence of impact costings

Donald Trump's attack on the social cost of carbon, dismantling the IWGSCGG in March 2017 not long after taking office and the US EPA reducing the social costs of greenhouse gases in November 2017 by up to 25 times their previous amounts[44], points to the potential of impact costing to alter business as usual. By provided a quantitative long-term signal for government expenditure and the market, it posed a sufficient threat to the prevailing structure of the US economy to warrant intervention.

The 2019 IPCC Special Report on Climate and Land finds in Section 7.4.4.2 that the global climate mitigation potential identified in the report will not be realised without effective carbon pricing[45]. Even though carbon pricing is a relatively low-cost instrument to implement, and believed to be effective in creating emissions reduction, countries are not exposing their food sector emissions to carbon pricing in a comprehensive way.

The social cost of carbon is considered the most instrumental number in climate economic policy[46]. In suggesting an estimate for an inevitably unrealisable global Pigouvian tax on carbon it not only creates a long-term market signal, but it stimulates debate and high-level work that progresses the eventual realisation of internalisation of carbon into global markets.

What are the central figures of economic food policy? Do we need the social cost of obesity, the social cost of malnutrition, the social cost of food chain equity? This report argues for further investment in the abatement costing of food's footprint because of potential markets for abatement products and the underdevelopment of abatement costing, but this does not diminish the importance of social costs as measures of impact and stimulus for internalisation.

The 2019 EAT-Lancet Planetary Diet advocates a drastic reduction in the consumption of red and processed meat by 2050. The response to the diet suggests that the social costs of food

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[42] https://www.es-partnership.org/services/data-knowledge-sharing/ecosystem-service-valuation-database/

[43] p. 484: W. Willett et al., "Food in the Anthropocene: the EAT–Lancet Commission on healthy diets from sustainable food systems," *The Lancet* 393, no. 10170 (2019), https://doi.org/https://doi.org/10.1016/S0140-6736(18)31788-4.

[44] https://www.nytimes.com/2018/08/23/climate/social-cost-carbon.html; https://www.washingtonpost.com/news/energy-environment/wp/2017/10/11/new-epa-document-reveals-sharply-lower-estimate-of-the-cost-of-climate-change/

[45] IPCC, *IPCC Special Report on Climate Change, Desertification, Land Degradation, Sustainable Land Management, Food Security, and Greenhouse gas fluxes in Terrestrial Ecosystems*.

[46] M. Fleurbaey et al., "The Social Cost of Carbon: Valuing Inequality, Risk, and Population for Climate Policy," *The Monist* 102, no. 1 (2018), https://doi.org/10.1093/monist/ony023.

will have a polarising effect like the social cost carbon[47]. Reports and articles after this one, with subsequent empirical modelling of food impact pricing, will, more than likely, similarly conclude that the mitigation potential of food system transformation will not be realised without effective pricing of impact.

Food footprints are wedded to quantities that have, historically, improved human well-being. As mentioned earlier, that even higher levels of footprint are now reversing some of those benefits through damage to human health and nature, prompting reduction in those footprints, reflects the fundamental basics of the economic system – equilibrium. This new economics, that you pay to produce, and you pay to reduce, is foreign to the status quo. The move to this new equilibrium, even though it shifts society to greater economic value overall, is not a Pareto shift. Meaning that some actors in the food sector will win and some will lose, and lose a lot, if society were to follow the market dynamics correcting for food sector impact.

Impact neutral and opportunities for leaders

The disruption to the food sector from this non-Pareto shift opens opportunities for leading companies and opportunities for new services[48].

The 2019 FOLU report Growing Better: *Ten Critical Transitions to Transform Food and Land Use, The Global Consultation Report of the Food and Land Use Coalition*, estimated annually USD2019 4.2 trillion of business opportunities for leaders and new services by 2030 (Figure 27 in Case Studies of Food System Impact Valuation)[49]. It is unclear in the FOLU calculation how much the losers lose, so what the net long term readjustment to the global economy is in terms of annual GDP. A relative re-adjustment of 0.5% of global annual GDP, however, realised mostly for those bearing the health and social impacts of the global food system, represents a tremendous change in human and social welfare for developed and developing nations and a very different global future.

In deciding whether to be a leader or a follower in food system transformation, any rational corporate board should ask what are the signs that society is moving toward correcting the market dynamics? What is the probability of movement, what are the consequences for moving and what are the consequences of not moving? After inertia and competing pulls from old and new dynamics, once the corrected market dynamics take over, there will be rapid movement toward the new equilibrium, and then a slower pace of settling in.

For signs for EU companies, the 2020 EU Green Deal: Farm to Fork strategy[50] lays out clear footprint target reductions. The European Commission aims to reduce by 50% the use and risk of pesticides by 2030, reduce nitrogen and phosphorous losses by at least 50% by 2030, including reducing fertilizer use by 20% by 2030. The Commission will reduce by 50% the sales of antimicrobials for farmed animals and in aquaculture by 2030 and aim to achieve 25% of total farmland under organic farming by 2030. The Commission did not set a target for reduced mortality and morbidity associated to dietary intake but aimed to empower consumers on healthy food choices.

The EU Green Deal targets demonstrate that carbon neutral is not going to be enough of an aspiration for winners in the food sector. Impact neutrality addressing environmental, social

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[47] D. Garcia, V. Galaz, and S. Daume, "EATLancet vs yes2meat: the digital backlash to the planetary health diet," *The Lancet* 394, no. 10215 (2019), https://doi.org/10.1016/S0140-6736(19)32526-7.

[48] OECD, *Fostering Green Growth in Agriculture: The role of training, advisory services and extentions initiatives*, OECD,, (Paris, 2015).

[49] FOLU, *Growing Better: Ten Critical Transitions to Transform Food and Land Use, The Global Consultation Report of the Food and Land Use Coalition.*

[50] https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal/actions-being-taken-eu/farm-fork_en

and health targets, should be adopted to meet the multiple dimensions of food system transformation targets.

Organisations like the Food and Land Use Coalition and EAT are moving to establish the Food Economics Council, and perform economic modelling examining changes to subsidies, tariffs, and taxes to achieve food system transformation. At least 40% of the EU Common Agricultural Policy (CAP) subsidy will be tied to environmental performance of agricultural producers under the Green Deal.

Like carbon, social costs of food, in suggesting an estimate for an inevitably unrealisable Pigouvian tax, create a long-term market signal and stimulates debate and high-level work that progresses the eventual realisation of market corrections. Those looking to lead, and stimulate the incentives for leading, should be looking to establish and utilise food impact pricing.

External intervention to shift the market, which was argued to be necessary and would drive standardisation of impact valuation in Economic Theory of Change, will introduce a game of winners and losers, market leaders and market followers, in the food sector:

- Leaders position themselves to be adding value in the corrected market, to take the opportunities
- Leaders gain the most reward from accounting for externalities, establishing market signals, and benchmarking progress to set reduction targets
- Leaders gain the most from an abatement market and will be receivers of revenue obtained from Governments realising effective impact pricing - their products are geared to or contributing to providing society the same nutrition and pleasure for less damage
- Followers that are locked into a production method or value chain unable to correct will drag and seek to divert and dissipate movement and pressure.

To reach the new equilibrium the game must be played out. It is playing out for carbon and energy now. As the polarisation caused by the Eat-Lancet Planetary Diet and farmers rioting about nitrogen restrictions in the Netherlands[51] shows, this will play out increasingly for the food sector. Leaders gain the most by increasing their lead over followers provided lack of incentives do not limit their pace.

There are therefore advantages for leading blocs of companies to develop standardised methods, quicker and with more credibility than they could do individually and with a faster and clearer path for tapping into public and private incentives. By investing in the reporting, accounting, and costing that enables them to demonstrate their added value and their progress towards impact reduction, this peloton can lock in a lead over followers.

The Food System Impact Valuation Initiative (FoodSIVI), hosted by the Environmental Change Institute at the University of Oxford, functions to facilitate, research, inform, and set the bar on standardised reporting, accounting and costing of food system impact. FoodSIVI is a collaboration between four leading Universities across environmental change, sustainable food systems, economics, and environmental law. The academic members are committed to food system transformation. FoodSIVI has equal partnership with civil society and leading companies in the food sector, and it does so deliberately based on mutual benefit and accelerating the theory discussed in Economic Theory of Change.

Civil society and leading companies both profit from accounting for food system impact and costing it to facilitate market correction. Both sides can drive each other, and the positive feedback between leaders and creating the social and economic incentives for leading, is the

[51] https://www.arc2020.eu/nitrogen-crisis-dutch-farmers-rage/

only way change will happen at the pace needed to achieve the science-based targets set. Companies positioning themselves as leaders in sustainability and equity in the food sector; are positioning themselves to be ahead of the game on regulatory and investment risk and shaping of supply and demand – that is the advantage they see. But the position needs to be transparent, not an attempt to perpetuate status quo, and the regulatory and funding risks spurring them need to materialise, the sticks need to be real to turn the positioning, the creeping, into a run on first base. In the presence of sparse global leadership outside the EU on transforming food systems, civil society keeps the pressure on and educates consumers.

Uncertainty on when, not if, to take a lead on climate, delayed action on climate change throughout the decade 2010-2019. The laggers, locked into assets that lose their value in a corrected market, are still locked in a game with the leaders, diminishing the incentives and return for leading. Climate action is still at the stage of competing pulls from old and new dynamics, with some momentum showing that the corrected market dynamics might be starting to outpull. For the choice in the food sector on whether to lead or lag on food system transformation, there is still uncertainty on when.

With risk comes return though. Calculated risk and return is investment in sustainability and investment in the future. As the delay continues, the impacts of the food system accumulate, and impact on billions of lives and the crossing of several planetary boundaries continues to occur. Impact valuations are dry numbers, as is the nature of economic data, but it should not be forgotten that behind those numbers, embedded in them, are staggeringly different human and planetary outcomes for the future.

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PREVIOUS SECTION: 8. DEVELOPMENT AND INVENTORY OF METHODS

Valuing the impact of food:

Towards practical and comparable monetary valuation of food system impacts

A report of the Food System Impact Valuation Initiative (FoodSIVI)

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