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From productive interactions to impact pathways

**Understanding the key dimensions in developing SSH research
societal impact**

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Abstract

Impact is increasingly important for science policy-makers; science policy studies has reacted this heightened urgency by studying these policy-interventions meaning that policy has developed more quickly than theory. This has led to the prevalence of a 'common sense' impact definition: research's societal impact are direct economic effects, such as income generated by licenses, patents and spin-out companies. These indicators are recognised as weak proxies for research's societal benefits, and in response, science policy has undertaken a huge descriptive effort to more precisely define impact. SSH disciplines have been highly active in this because economic metrics are very poor measures of their societal impact. One interesting theoretical development describing diversity was Spaapen and Van Drooge's 'productive interactions' concept. In this paper we seek to realise the potential that Spaapen & Van Drooge's productive interactions concept offers, but which we argue has been lost through its operationalisation as 'counting interactions'. We address the wider conceptual framework for describing SSH pathways to societal impact by paying attention not only to productive interactions but to the changes they mediate. Drawing on a comparative analysis of 60 examples of SSH impact, we develop a typology of SSH pathways to societal impact. We conclude by arguing the usefulness of the extended conceptual framework and propose policy measures to stimulate and support impact processes.

Keywords: entrepreneurial university; regional innovation system university; performance; internal structure; region.

1 Introduction

Impact is an increasingly important goal for science policy-makers, driven by a desire to see research organisations deliver benefits in return for past substantive increases in science budgets. Science and innovation policy studies sought to rapidly address this increasing emphasis on creating societal impact resulting in policy developing more quickly than theory (Donovan, 2017). Popp Berman tied the popularity Market University concept in America (Popp Berman, 2011) to reducing university impact to a handful of economic indicators, framing research's societal impact as primarily economic. This emphasis was reinforced by multi-lateral organisations, most notably the OECD but also the European Commission, and the World Bank (McCann & Ortegez-Argiles, 2013; Benneworth, 2014). This created a common sense definition of research's societal impact as direct economic effects, often articulated as income generated by licenses, patents and spin-out companies (Benneworth, 2014).

These narrow economic indicators are recognised as weak proxies for science investments' societal benefits, whether in the hard sciences (such as science, technology, engineering and medicine, hereafter STEM), or in other disciplinary fields, such as social sciences and humanities (SSH) (Donovan, 2007; Morton, 2015). Science policy has undertaken a huge descriptive effort to more precisely define impact, but it has proven difficult to get beyond description and define what precisely constitutes research's societal impact that is legitimate to both policy-makers and diverse disciplinary communities (Benneworth et al., 2016). One interesting development that progressed beyond describing diversity was the 'productive interactions' conceptual proposition (Spaapen & Van Drooge, 2011). This has achieved a degree of uptake on policy communities: in the Netherlands productive interactions have influenced policy debates as evinced by the recent launch of the Quality and Relevance in the Humanities (QRIH) metric set¹. But even within QRIH, a sense emerges that the individual indicators proposed for research evaluation were not developed based on productive interactions' theoretical criteria but rather because they can easily be gathered and deployed.

In this paper we seek to realise the potential that Spaapen & Van Drooge's productive interactions' concept offers, but which we argue has been lost through its operationalisation as 'counting the final interactions' (cf Benneworth & Olmos-Peñuela, 2018). We address the wider conceptual framework for SSH pathways to societal impact by paying attention not only on productive interactions but on the changes they mediate. Drawing on a comparative analysis of 60 examples of SSH impact, we develop a typology of SSH pathways to societal impact. We conclude by arguing the usefulness of the proposed conceptual framework and the policy implications to stimulate generating societal impact.

2 Developing a conceptual theory for evaluating SSH research impact

Productive interactions arise through moments of contact between two very different systems (the societal and the scientific), and each system values societal impact in very different ways. Finding mutual value in that interaction is important, and we argue that value in both arises when network arrangements shift, as academic disciplines solve urgent scientific problems and as societies address negative living conditions. But research evaluation to date has not considered the consequences of the productive interactions in terms of these changing relationships. This has engendered a tendency for research evaluation to seek out and make claims of ‘extraordinary impact’ made by a few researchers rather than looking at the more mundane and manifold ways that everyday impact generation arises from scientists’ research practices (Sivertson, 2017). In this section we explore why the concept of productive interactions emerged, to articulate particular lacunae in economic metrics, noting that the concept has not yet facilitated a wider conceptual breakthrough in understanding impact despite providing a good definition of impact production.

2.1 Societal impact in the framework of research evaluation

It is only since 2005 that we have really started to see impact creation explicitly within research evaluation frameworks in leading countries (Benneworth et al., 2016; Petersohn & Heinze, 2017). From 2002 in the UK, grant applications had to include an impact statement, and from 2014, *ex post* impact creation featured in the REF as a specific area of resource allocation (Bulaitis, 2017). In the Netherlands, from 2000, impact was a policy goal, it featured in the 2005 SEP, and from 2009, it started to be taken seriously as a policy goal (Van der Meulen & Rip, 2000; Benneworth et al., 2016). But there remained an ambiguity in these assessment processes regarding precisely what need be assessed, and against which criteria (Molas-Gallart, 2014). The indicators that led to impact’s popularisation (economic) are too limited to be taken seriously as a meaningful impact proxy, even where they are legitimate for distributing funding as in the UK’s Higher Education Innovation Fund (Benneworth & Jongbloed, 2013).

Societal impact measures’ legitimacy now lags those for scientific impact where a novel discipline, scientometrics, emerged, which defined ‘scientific impact’ as how far a publication was referred to by subsequent researchers² (Spaapen & Van Drooge, 2011; Petersohn & Heinze, 2016). Citations have emerged in scientometrics as a key impact metric –citing an author shows dependence on their contribution. Although scientific research impact is not perfectly measured by citation scores, bibliometrics is sufficiently conceptualised and operationalised to allow citations to represent a reasonably *proxy* of scientific impact that Petersohn & Heinze argue can lodge a claim amongst policy-makers and scientists to be valid.

This imbalance with societal impact created an urgent policy pressure to produce a social impact definition that can be operationalised and measured, and that can claim to be legitimate amongst both academics and policy-makers, just as bibliometrics achieved regarding scientific impact (see for example KNAW 2011 and KNAW 2012 for the case of the Netherlands). Several work-arounds arose in this absence: the UK (followed by a number of other countries) adopted a peer-review methodology in which research centres submitted case studies that were assessed against three criteria (the scale, the scope and the value of the impact) (HEFCE, 2011; Martin, 2011). Scientometrics companies attempted to develop societal impact measures although these have largely lacked legitimacy (Andrews, 2018). There have also been attempts to measure behavioural or even attitudinal aspects of scientists' orientation in SSH disciplines (see Hughes et al., 2011 or Olmos-Peñuela et al. 2014 for examples from the UK and Spain). But these failed to build this parallel legitimacy amongst both policy-makers and scholars (Wróblewska, 2017).

Science policy-makers recognised these pragmatic approaches' shortcomings, seeking to fund contributing to a more general definition of research's societal impact. An example is the Netherlands' Evaluating Research In Context (ERIC) project that emerged at the interface between science policy and research to create a theoretically-justified operationalisable framework for research evaluation, followed by the wider European funded research project 'Siampi'³ (Benneworth et al., 2016). It was from these two research projects that the productive interactions concept emerged as a first-cut definition of research impact, operationalisable to individual evaluation contexts through interaction's transaction trails (Van Drooge, *pers. Comm.*).

2.2 Productive interactions as a concept of research creating impact

The definition of productive interactions provided by Spaapen & Van Drooge (2011) was:

“exchanges between researchers and stakeholders in which knowledge is produced and valued that is both scientifically robust and socially relevant. These exchanges are mediated through various ‘tracks’, for instance, a research publication, an exhibition, a design, people or financial support. The interaction is productive when it leads to efforts by stakeholders to somehow use or apply research results or practical information or experiences. Social impacts of knowledge are behavioural changes that happen because of this knowledge” (Spaapen & Van Drooge, p. 212).

The framework defines three kinds of productive interactions, namely direct (personal) interactions, indirect interactions (mediated through artefacts) and financial interactions (mediated through exchange relations). The concept focuses strongly on these interactions, claiming these interactions imply more substantive change because interacting partners are embedded within other systems that change through these interactions.

Their definition came in an article within a special issue of this journal, *Research Evaluation*, making a substantive contribution to impact debates by providing a theoretical vocabulary to articulate an important lacuna for research evaluation, namely providing an externally validated framework for societal impact. It imbued the impact definition with a materiality, the transaction, linked back to an underlying scientific process avoiding two common traps in debates around societal impact, assuming scientific research was intrinsically productive, or demanding Sivertson's extraordinary outcomes. The definition offered claims of legitimacy to both academics and policy-makers: academics appreciated its relation to activities they routinely undertook, with policy-makers valuing visible user demand for scientific knowledge.

The productive interaction notion provides a useful concept for understanding the effects that emerge when science and societal systems become coupled, and there have been serious attempts to operationalise it to produce indicators valid to both policy-makers and scientists. A productive interaction represents a moment of coupling where science system encounters societal actors, allowing societal actors to influence scientific actors, creating new kinds of scientific value (e.g., such as asking new kinds of research question, Gläser, 2012). Well-functioning science uses these interaction moments to create scientific value by shaping what kinds of questions are deemed 'good' research (Olmos-Peñuela et al., 2015). That scientific value can be empirically detected in the emergence of new science domains and enhanced scientific productivity. The encounter simultaneously realises societal benefits by imbuing user with assets that can be leveraged and capitalised within different kinds of socio-economic systems, which improves users' power and hence contributes to 'development' (in Corea's language, 2007). This capitalised value may be financial/ economic, such as when technology-based ventures are able to leverage university IP to develop spin-off companies that attract external venture capital investment. But it might also be other kinds of socio-political value, such as where academic knowledge changes the rules of the political game with the formation of new parties or is used as part of a process of democratic renewal (Benneworth et al., 2016).

The emphasis on operationalising productive interactions into evaluation indicators has neglected further development and conceptual specification of the pathways through which productive interactions drive societal changes. These changes are present in productive interactions as concept but are largely absent in its implementation. Productive interactions provides a starting point for understanding the coupling, and in this paper we propose to extend from this starting point and look in more depth at the pathways by which SSH research is associated with societal impact, including but not restricted to these productive interactions. We ask the research question: what are the mechanisms of SSH research leading to societal impact? In the next section we set out our method for gathering and analysing the data. We propose a

conceptual framework by analysing 61 narrative examples in terms of three conceptual elements: productive interactions, their effects on the status of the societal and scientific partners and the broader effects taking place in terms of societal development and scientific advancement. We then propose a typology of SSH impact pathways, where different models of impacts are identified and described in terms of the typology of these three elements in the respective case studies. On that basis, we then reflect on value of these results in terms of contemporary debates seeking to better theorise SSH research's societal impacts.

3. Operationalisation

To address this question, we conducted a narrative meta-analysis of impact case studies drawn from the social sciences and humanities, gathered within the context of the working group (WG) of the COST ENRESSH network (European Network on Research on Evaluation of the Social Sciences and Humanities). This network draws together interested scholars in research evaluation, including 55 who are primarily committed (through the WG) to understanding societal impact in SSH research evaluation. The network carries out all its activities in English (including this data gathering exercise). The focus of this study is on the impact of academic research, thus we required that at least one researcher participating in the activities leading to societal impact to be within an academic institution (higher education institution, national academy of science research centre or research council research centre). We defined scientific research, broadly, merely requiring the originating researcher to have a material link to a university/research centre related to the impact production. Empirically, our data covers a range of cases from the exploitation of decades of research experience in expert settings to publishing a scientific book to popular acclaim.

The instrument used to collect data on the impact cases was a qualitative survey form, a 'fiche' (see Appendix I), which aimed to provide SSH researchers with the opportunity to explain how impact had resulted from research activities in their own words. To ensure the fiche provided respondents with that opportunity, in April 2016 an expert group of 10 lead participants met to identify 13 key questions regarding definitions of SSH impact; this was distributed amongst all WG participants, receiving 29 responses. These responses were analysed and discussed at a second meeting in July 2016, leading to the identification of the main questions and prompts to be included in the circulated fiche. The final fiche instrument consisted of nine open questions for recipients, covering a general description of the case along with more specific elements, including identifying key actors, interaction modes, stimuli, barriers and hurdles of impact generation and evidence of relevance of the research at hand. These 'fiches' were circulated to network participants who identified suitable cases from their own study and completed the fiche

according to the questions and prompts provided, on the basis of their prior knowledge as SSH impact experts. The respondents undertook these research synthesis and authorship activities as part of their duties for ENRESSH network membership. Respondents were provided with an example of the narrative style suggesting that c. 1-200 words per question would be sufficient. A pilot example was produced in September 2016, and with its successful completion, the first round of data gathering took place in the autumn 2016, resulting in 47 completed fiches; a second round in spring 2017 produced 18 more impact cases, giving a total of 65 fiches.

We subsequently excluded 5 of these 65 cases, two for lacking an academic input, one because it was a prospective analysis of research that might create impact, and two that were provided outside the fiche format in a language other than English. Cases included (n=60) are from 16 different European countries and they cover a wide range of SSH fields, including arts and examples of SSH researchers collaborating with STEM (see Table 1). Case studies are approximately two pages, but they vary a lot in relation to how detailed they are. There is a big variation from lengthy and rich descriptions to summaries using bullet points.

Table 1. Overview of the cases analysed by country and discipline (n=60)

Countries (16)	Social Sciences	Arts and Humanities	STEM
Finland, Iceland, Norway	public finance, administrative law, human geography	history, philosophy	medicine, chemistry, entomology
Belgium, France, Germany, Netherlands, Switzerland, UK	sociology, criminology, religion studies, political science, educational sciences, psychology	archeology, ethnology, cultural anthropology	industrial engineering, ICT, ergonomic science
Croatia, Estonia, Serbia, Slovakia	journalism, communication sciences, science studies, gender studies, cultural studies	linguistics, philology, music, musicology, theatre studies, classical studies, documentarism	

Italy, Portugal, Spain	multidisciplinary/interdisciplinary research	
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4. Implementing the meta-analysis approach

4.1 Type of knowledge

We began our meta-analysis and typology-building with content analysis concentrating on the mode of knowledge playing a key role in the different phases of research processes (Table 2). Making an impact starts right from the beginning of the research process (D'Este et al., 2016). Researchers and research funders are making statements by choosing which *research questions* are worth to ask (Ronkainen et al., 2014). The decision to study some topic can make an impact on society, for example studying neglected minorities or knowledge on untold experiences on abuse and neglects within child care system (case 10: Child abuse and neglects). In some cases, impact is based on the *content* of research, like research telling that social background is more crucial for school achievement than ethnical background (case 1: Young descendants of African immigrants). Impact can also be about the *product* (case 8: Voice passport) or new *methods* dealing for instance with terrorism (case 7: 11 M Mourning archive). Sometimes research opens up new ways to look at things, new *approaches*, like suggesting sign language as equal to spoken language (case 11b: Sign language). Typically impact derives from decades of research experience (case 4: Professor of philosophy). Especially typical for impact generation in social sciences is also *conceptualisation* of different phenomena (case 3: All male panel). Against the common believe, impactful research is not always applied or problem oriented, but also *theory* oriented research benefits society, like applying the Hegelian idea of evilness in the present day court cases (case 4: Professor of philosophy).

Table 2. Meta-analysis of the narrative impact cases (n=60)

Type of knowledge	Modes of interaction	Beneficiaries
research question	scientific publishing, publishing for wider audience	citizens, NGOs
content	media engagement, public engagement, research engagement	professionals, practitioners

product	policy	business, industry
method	legislation	policy makers
approach	regular interaction with stakeholders and other disciplines	cultural industry
expertise	epistemic training	
concept		
theory		

4.2 Interaction modes and beneficiaries of SSH research

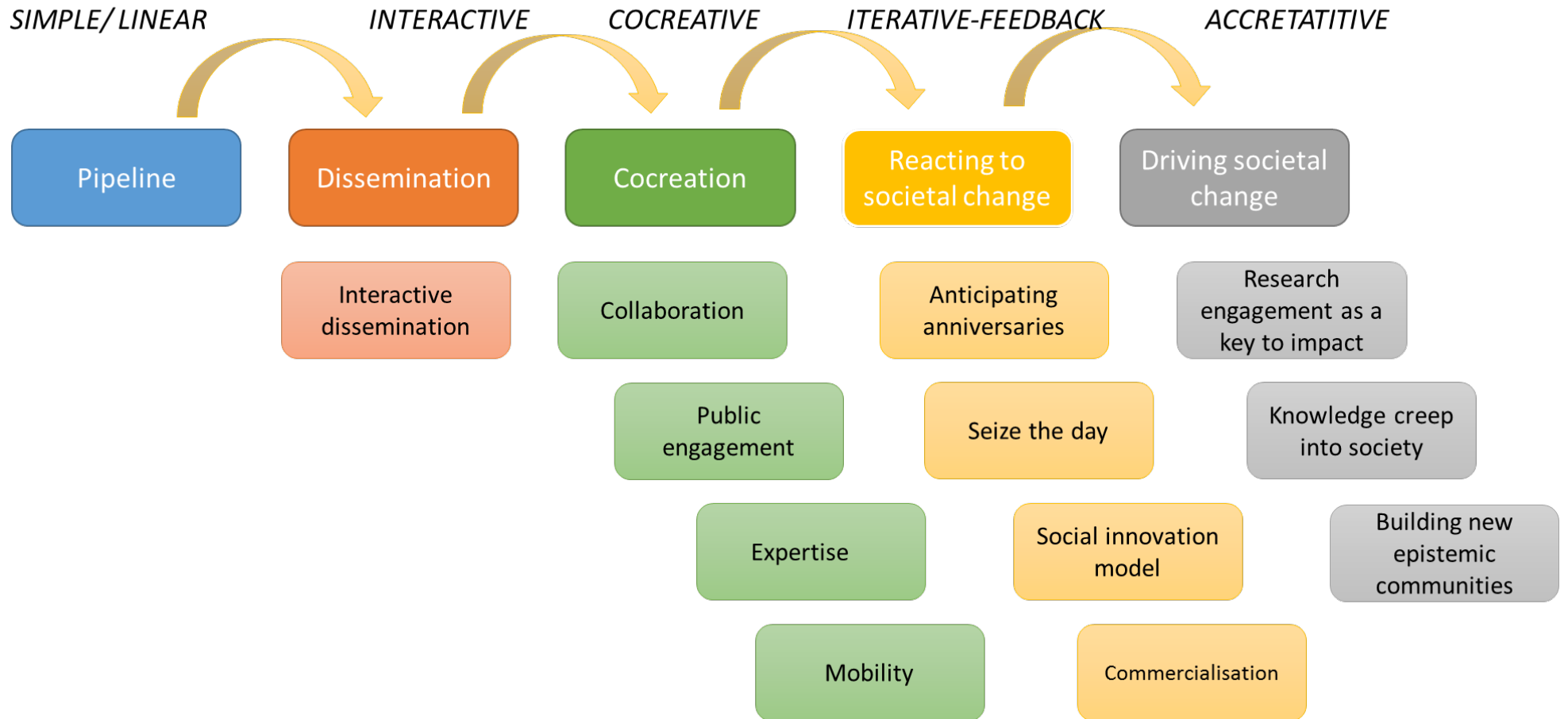
Impact creation in SSH cases take place through scientific and popular publishing, media and public engagement, interaction with different stakeholders and disciplines, policy, legislation and epistemic training (Table 2). Although commercialisation is not typical for SSH impact generalisation, we have cases where impact emerged through commercialisation (e.g., case 9: Natural tincture techniques). There was a great variety of beneficiaries in the examples ranging from citizens (e.g., theatre audience in the case 2c: Theatre) and professionals (e.g., Spanish scientific police in the case 8: Voice Passport) to business and industry (e.g., fashion industry in the case 9: Natural tincture techniques).

We structured each of the case studies according to the productive interactions that took place, their effects on the status of the societal and scientific partners in their respective networks, and the broader effects that took place in terms of societal development and scientific advancement. For each of the 60 case studies, we produced a case architecture, characterising the case on the basis of these conceptual classes. We then grouped the cases together on the basis of patterns of similarity in which these elements were present as well as their interactive dynamics. This results on a total of 13 distinct case study architectures for the interaction modes, and ordered them on the basis of the complexity of the architectures. We then looked back at the original case studies comprising each architecture type and assigned that architecture type a name on the basis of the features of the case studies comprising that type. The starting point for the typology of SSH pathways was the simplest of the architectures, something we give the nomenclature of the classical *pipeline model* where there is a scientific development, a productive interaction, and a transfer to society that produces a discrete societal benefit. The remaining 12 SSH impact pathways each reflect an increase in the relative complexity of the networks within which the

overall impacts emerge. We then grouped those according to the intensity and depth of the interactions, the dominant mechanisms by which impact has been produced, and identified four high-level groups for the ways SSH creates impact in society, namely *dissemination*, *cocreation*, *reacting to societal change* and *driving societal change*. The overall structure of this is shown in Figure 1 below.

Figure 1. The pipeline model and other SSH pathways to societal impact

COMPLEXITY OF THE RELATIONSHIPS



5. SSH pathways to societal impact

The main details of the 12 impact pathways are presented in the Table 3 below, and more information is provided in this section stylising the ways SSH creates impact in society (dissemination, cocreation, reacting to societal change and driving societal change), along with providing more information on impact exemplars from which the pathways have been derived.

Table 3. SSH pathways to societal impact

SSH PATHWAYS TO SOCIETAL IMPACT			
General model	Model	Mechanism	Example case
The pipeline model →→			
Dissemination	1. The interactive dissemination model	Stakeholders become aware of the results of research through publications, social media, websites, databases, television or radio.	Young descendants of African immigrants, Portugal
Cocreation	2. The collaboration model	<ul style="list-style-type: none"> a) a researcher collaborates regularly with stakeholders b) impact is gained through open access ideology (or citizen science) c) impact is gained through interdisciplinary or transdisciplinary approach 	History Lab, Portugal Brussels Studies Institute, Belgium Theatre, Spain
	3. The public engagement model	Results of research are taken into action by using society as a laboratory. Publicity is a necessity for impact.	All male panel, Finland

	4. The expertise model	Researcher plays a role as an expert, makes policy recommendations, conducts an evaluation study or other kind of contract research.	Professor of philosophy, Norway
	5. The mobility model	Knowledge and skills of a researcher are taken into use in a new context.	Myanmar, UK
Reacting to societal change	6. The ‘anticipating anniversaries’ model	Researchers are preparing themselves to coming issues discussed in the media.	Holenstein, Switzerland
	7. The ‘seize the day’ model	Something happens ranging from ongoing policies and hot topics brought up in media to coincidences like, natural catastrophes and terrorist attacks, which makes <i>suddenly</i> some topics more relevant than others.	11M Mourning archive, Spain
	8. The social innovation model	Work starts independently and then at some point two sides come back together.	Voice passport, Spain
	9. The commercialisation model	Research results are taken into use by developing the product based on the idea research brought up and making the product available on the market.	Natural tincture techniques, France
Driving societal change	10. The research engagement as a key to impact	Research process increases awareness of the topic at hand. Targets of the study get recognition and sense of empowerment through the research process.	Child abuse and neglects, Finland
	11. The knowledge ‘creeps’ into society model	Research results ‘creep’ into daily life and political arena. In parallel or later on, some changes take place in relation to a) public opinion or	Nation State, Iceland

		b) legislation.	Sign language, Iceland
	12. The building 'new epistemic communities' model	Researcher introduces a new way of thinking and this changes institutional practices (like curriculum) and provides professionals with new resources to cope with.	Pfenninger, Switzerland

5.1 Dissemination

In the first model, a keyword is dissemination (Table 3). *The interactive dissemination model* represents cases where stakeholders become aware of research results via various dissemination channels, including publications, social media, websites, databases and broadcasts, with typically, no other interaction being reported. In this model, there is a sequencing of developments, with scientific progress preceding societal progress there is a feedback loop in which the societal outcome validates the scientific research. The case demonstrating the first model comes from the field of sociology (case 1: Young descendants of African immigrants). The research aimed to relaunch a debate on social inequalities in secondary education and to challenge local cultural perspectives that regarded ethnicity rather than social inequality to be a major determinant of non-white students' educational performance. The scientific study demonstrated that when controlling for social class and gender, ethnicity was not a significant determinant of education outcomes. The channels used by the actors to generate societal impact from the research conducted were mostly scientific articles. No other interactions were reported.

5.2 Cocreation

The next four pathways in our typology concern *cocreation*. What the cocreation models all had in common was that there were repeated points of contact (productive interactions) between the scientific and societal partners which mediated the wider changes. There is a mutuality of the relationship: on the scientific side there is the appearance of new practices and the playing of new roles which are not always strictly defined scientific roles. In all cases, wider changes driven by productive interactions are visible within science in terms of creating new infrastructures and

concepts which open new avenues of scientific exploration, whilst the societal changes were visible by changing the way that societal partners understood a particular situation.

The collaboration model is divided into three versions: (a) the first stresses the regularity of collaboration; (b) the second open access approaches including open access publications and citizen science; and (c) the third multidisciplinary, interdisciplinary and transdisciplinary approaches. Our example of regular collaboration (case 2.a History Lab) is the History Laboratory of the Institute for Contemporary History (IHC), NOVA University of Lisbon, founded to create impact more applicable to secondary school students. The unit forms part of the IHC's communication and dissemination strategies, and developed a regular programme with schools, local libraries and other institutions engaging students and other stakeholders in historical research and history contents dissemination. After two years, IHC collaborates with Escola Secundária de Camões (involving around 200 students and 2 history teachers), about 20 researchers, with two new schools having joined the collaboration. The Laboratory mediates with the academics to help them work with teachers and deal flexibly with the schools' needs, calendar and particularities.

In the *public engagement model* there is regular collaboration along with the active participation of the public in creating impact, using society effectively as a laboratory and spreading ideas through publicity. Our example (case 3: All male panel) is drawn from political science and gender studies, where a Finnish feminist researcher sought to increase societal awareness of gender issues in society, particularly 'a problem of men dominating the conversation'. In 2015 she began the blog 'Congrats, you have an All male panel' to publicise scientific and expert panels, board of trustees and committees, which consist only of male members. Whenever she encountered such a panel, she published a picture of the panel along with an insert photo of the white male actor, David Hasselhoff, giving a 'thumbs up' sign. Her work spread quickly via social media, and the story itself spread rapidly from Finnish into international media including the Guardian, The Times, Telegraph and Al Jazeera. Her blog attracted a total of 180m page views, and turned into a space where people could themselves publically denounce all-male panels, spawning a number of country-specific sites. Her work did much to make all-male panels in academia and policy circles unacceptable, with many conferences adopting a no-male panels rule.

In the *expertise model* a researcher plays a role of an expert in wider societal contexts on the basis of expert knowledge that the researcher has already developed in scientific contexts. This may be in a range of roles, from open-ended roles such as a public intellectual to more specific projects, committees and working groups supporting policy makers, professionals or other stakeholders. Our example case was a professor of philosophy who had a crucial impact on the Norwegian

discussion of the legal concept of mental sanity and accountability (case 4: Professor of philosophy). The court trying Anders Breivik for the mass slaughter on Utøya received two conflicting psychiatric reports regarding the extent of the defendant's criminal culpability and fitness to stand trial. The government established a committee to explore this issue of evil and criminal culpability with the professor being appointed to it, studying the case from the Hegelian perspective, taking stands based on his own philosophical research and ultimately contributing significantly both to the report and the resultant societal healing.

The last model under cocreation is the *mobility model*, in which a researcher themselves move into a new context and hence take their skills and apply them in that new context. Our example (case 5: Myanmar) is drawn from the field of religion studies, where research understanding the religious and social standing of Buddhist nuns in Myanmar influenced the work of the country's most influential Buddhist nunnery school and thus influenced more broadly the empowerment of Myanmar women. The researcher had published widely on this issue of religious and social standing, and whilst becoming involved in founding a nunnery school of which she subsequently became director took forward her own research findings on how structural and social changes could improve these nunneries' social standing. By providing formal monastic education for nuns via the Buddhist school, the school supports wider emancipation in Myanmar, expanding opportunities for the school's women and girls. The changes increased the number of nuns (most recently around 20 annually) passing state scriptural exams, whilst supporting increasing resident student numbers: 500 noviciates trained at the school (2008-13). Its significance in Myanmar's context comes as female access to education often increasingly depends upon these monastic schools, as well as access to socially beneficial and financially independent careers as Buddhist nuns.

5.3 Reacting to societal change

The third class of impact pathways were those in which scientists deliberately aligned themselves in a reactive way to topical themes for society that lay beyond the researcher's initial scope, covering four pathways. In these pathways, there are indirect interactions before the material interactions, as researchers seek to tune their research trajectories to be able to (be ready to) respond to windows of opportunity in society's interest in or needs for research. In these cases, wider changes often followed very quickly following the material interactions because of the preparedness created in society by anticipation of or rapid reaction to societal needs. The mutual benefit can also be quite extensive because of the preparations made, as well as the serendipity of the conjuncture.

The *'Anticipating anniversaries' model* is based on the idea of researchers being able to recognise the *window of opportunity coming ahead* in relation to topicality of their research interests. Anticipation can take place in relation to occasions like historical anniversaries, forthcoming elections or global trends stepping up at the agenda, like ageing population or climate change. Our example (case 6: Hohenstein) here was drawn from Switzerland when in 2015 the country celebrated three nationally significant centennial anniversaries in the Swiss national narrative, namely the Battle of Morgarten (1315), the Battle of Marignano (1515) and the Congress of Vienna (1815) that have latterly been mobilised by radical right nationalist parties to win votes. A researcher chose to write a history of Switzerland from a novel perspective showing Swiss neutrality was more a status decided by its more powerful neighbours than an act of defiance and independence. The book's publication and correspondence with the anniversary sparked a big public debate that showed more nuance than the nationalistic narratives allowed, and stimulated a research-council funded project on histories of migration.

The *'seize the day' model* also relates to external events where researchers who are prepared are able to react suddenly to a changed situation (whether unexpected political events or natural catastrophes) that at a particular point in time create a demand for scientific answers, *suddenly* making some topics more relevant than others. Our case (11: 11 M Mourning archive) here was the multidisciplinary research team of ethnologists, anthropologists, philologists, documentarists who reacted when on 11th March 2004, ten bombs exploded within minutes of each other on four trains at three train stations in Madrid, killing 192 people and wounding around 2000. Responding to the attacks, people left in the stations innumerable texts and objects of very diverse nature, and the Anthropological Research Group on Heritage and Popular Cultures of Spain's CSIC went to the stations to capture these spontaneous mourning demonstrations (photographs, videos) and the grassroots memorials that emerged on the railroad tracks and other nearby spaces. They proposed an urgent anthropological project to collect, protect, document and organise in an archive and analyse these post-attack signs of mourning. In 2010, once the project was completed, they handed over to the RENFE Foundation the '11M mourning archive' containing 2,482 photographs, 495 objects, 6,432 papers, 76 video and audio recordings and 58,732 electronic messages. The archive is of great importance to researchers in various fields (anthropologists, historians, psychologists, etc.) but also had value for social welfare, civil protection, policy, teachers, psychologists and pedagogues, with archival analysis facilitating channelling of individual and collective mourning.

The *social innovation model* is also reacting to societal change in situations where both society and scientists start addressing the same social problem independently to create knowledge and develop solutions, then later recouple to collectively contribute their respective knowledge and

legitimacy to building a solution within their wider networks, exercising social power to solve that problem. Our example here (case 8: Voice passport) is based on the experience and knowledge of the Group of Variation and Cognition in Language, specialised in geolinguistics and Spanish language variation, who had characterised of Iberian Romance dialect varieties, with all word variants found in different villages expressed in phonetic transcription, generally readable by professional linguists. The group started collaboration with ICT specialists to develop a 'voice passport' capable of precisely locating the origins of speakers akin to a fingerprint. The knowledge was useful for voice recognition companies and companies running call centres to help better select more general staff. The voice passport achieved fame when it was used by the Spanish Serious Crimes Squad to help convict several leading organised criminals on the basis of voice recordings by demonstrating that recorded pronouncements had been uttered by those accused.

In the *commercialisation model*, SSH knowledge is taken into use by other parties developing the product based on the idea research brought up and making the product available on the market. Our case (9: Natural tincture techniques) is of a historian/archaeologist who had long studied medieval archives accounting for recipes of tincture techniques based on natural pigments, and was committed to preserve the memory of these ancestral techniques so deciding to create research in colour archaeology, and leading to the creation of CRITT, a research centre of technology transfer involved in the development of natural colouring techniques for the textile, cosmetic and food industries. Her 1990 book was the first comprehensive inventory of plants' dyes in the world and came at a time when synthetic tinctures were advancing rapidly, whilst CRITT sought to industrialise the extraction of natural dyes. In 1994, drawing on CRITT's applied research at the CRITT, the private company 'Bleu de Lectoure' invented a fast extraction process of a pastel from the plant *Isatis tinctoria L.* together the School of Chemistry of Toulouse, reducing extraction time from one month to 24 hours, then working together with a local agricultural cooperative to cultivate more than 15ha of feedstock crops. In 1998, Olivier Lapidus, a French designer in haute couture, developed a collection based on these colours, followed by Christian Lacroix, with later fashion house Chanel buying the researcher's 'Scottish threads' product .

5.4 Driving societal change

The last three models of our typology stress the idea of driving societal change proactively. In there are wider processes of change within society, and as a result of those changes within society, that discipline responds by changing its own direction. In these models, there are many productive interactions between scientists and societal agents, and it is hard to attribute the impacts created to individual productive interactions. There may be larger numbers of scientists and societal actors involved in these changes as the scientific and societal systems evolve in response to societal change, and those actors which help couple the two systems together appear to be

significant here in ensuring the production of the wider effects. We here distinguish three kinds of pathways, *research engagement as a key to impact*, *knowledge creep into society*, and *building new epistemic communities*.

The research engagement as a key to impact model is where the research process itself has a developmental impact on the research subjects by empowering them through recognition, and addressing structural exclusion from particular research activities. This might come through acknowledgement of past wrongs in launching an inquiry, through interview processes or public testimony in those inquiries, or offering media platforms. These effects may benefit both victims of past wrongs as well as create capacity within society at large to come to terms with those malpractices. Our specific example here was a research inquiry into failures of the child welfare system in Finland (1937-1983), where a research team with knowledge on history, ethnology, social work and sociology came together to make future recommendations on avoiding neglect, abuse and violence against children (case 10: Child abuse and neglects). Former childcare residents were provided through the research interviews with a platform to articulate their experiences of neglect, and to experience a recognition of their maltreatment being taken seriously with several residents being reunited with missing siblings through the process. The research culminated in a rare public ceremony of apology in autumn 2016, something previously limited to Finnish Holocaust victims in 2000 and civil war victims in 2008.

In contrast, the *knowledge 'creep' into society model* is much less clear in terms of the knowledge diffusion and in particular the original or the novel thinking, which is dispersed into numerous different sources and sequential occasions. There are no 'eureka' moments in pathway to impact, and these changes can take a generation to evolve to the state of shifting (a) public opinion and/or (b) legislation. Our example (case 11 a: Nation State) involved research changing the national debate about Icelandic history, the nation and the national state, comparing modern state formation processes in Iceland and France in the late 19th century. It started as a PhD project in 1991 at a time when Iceland's public discourse was relatively naïve and nationalistic, and attracted interest from politicians and journalists, as well as those involved in tourism and heritage through the professor teaching courses for tourist guides. The wider research group wrote their theses and other publications in the local language, Icelandic, and their materials were therefore more immediately accessible, particularly to those involved in spreading ideas through education, the media, and policy-makers. The professor at one point actively shaped the tone of political debate by comparing the public addresses of two consecutive presidents, highlighting how the first president's strident nationalist tone had given way to an emphasis on diversity and direct criticisms of nationalism.

The final pathway was *building 'new epistemic' communities model* in which the knowledge shifts from research communities into teaching practices, as researchers introduce new ways of thinking that change institutional practices and shape professional behaviours. Our example (case 12: Pfenninger) here was the first and only longitudinal study in Switzerland (2008-16) that analyses issues regarding the amount and type of English input needed for early starters to surpass late starters and be able to retain their learning advantage in the long term. This is a field where there is a persistent professional belief that it is best to start learning second languages as early as possible in life. The study explored the effects of starting age in primary school on English learning outcomes in secondary education, showing that learning success does not depend on starting age or length of exposure. The study enabled a politically important change in Zürich Canton's education system which was out of step with other Cantons in beginning English education in Grade 2. The study legitimated amongst education professionals this harmonisation, by demonstrating that beginning English education a year later would not materially disadvantage Zürich's pupils.

6. Conclusion and Discussion

In this paper we have asked the research question what are the mechanisms of SSH research leading to societal impact? We have done this in a constructive attempt to realise the potential that Spaapen & Van Drooge's productive interactions' concept offers by addressing the wider conceptual framework for describing SSH pathways to societal impact. We have proposed a conceptual framework in which productive interactions are one element of wider coupling processes leading to effects on the level of status of societal and scientific partners and mediating wider societal and scientific development. This framework provided the basis for a meta-analysis of a wide range of narrative impact cases in the field of SSH drawn from across Europe and to develop a typology based on those conceptual elements that most came to the fore in the various examples. This has allowed the typology to capture the diversity of impact pathways in SSH, but at the same time to develop the typology on the basis of their similarities. We contend that this typology of pathways to societal impact is evident in the case of SSH, but at the same time will be applicable to other fields of science, and therefore that even if our typology is specific to the SSH, it is this broader conceptualisation of societal impact produced through the coupling effects of productive interactions that allows us to make a more substantive contribution to academic, policy and practice debates around research evaluation and societal impact.

Our focus has been to build on Spaapen & Van Drooge's (2011) contribution seeking to get beyond economic and quantitative *indicators* by generating a conceptual basis for measuring societal impact that bibliometrics has provided for measuring scientific impact. Our empirical analysis of

the 60 case studies allowed a characterisation of different kinds of pathways, reflecting different types of knowledge and research orientations, different kinds of productive interactions and different kinds of beneficiaries. The conceptual framework allowed this diversity to be reconciled into a singular framework that nevertheless captures these diverse pathways, and the more complex pathways by which impact emerge involving different kinds of academic involvement in these processes.

From a policy perspective, the typology presented in this paper is of high importance for those responsible for designing science and research policy, given the value of societal impact in legitimising the public investments made in academic research as well as those embedding evaluation of societal impact into scientific governance systems. We identify four classes of impact pathway and argue that more policy support could be given to realising these kinds of activities, specific to the needs of the pathways, to ensure that the science policy and academic practices encourages and enables researchers to answer societally valuable questions in their research activities. The typology serves as a tool to reflect the ideal research conditions for impact processes by demonstrating e.g. the meaning of researcher's ability to anticipate the window of opportunity coming ahead in relation to topicality of their research interests – or respectively to be prepared to react suddenly to a changed situation. It also reminds how sometimes acts of stakeholders, implemented policies, media attention, nature catastrophes or some other factor outside researcher's scope might be crucial in relation to the possible effects of research. We regard their to be clear policy value in further exploring and operationalising these four dimensions, in terms of 12 sub-categories to produce a more balanced suite of indicators, particularly for those kinds of research evaluation which are about improvement and peer learning rather than the allocation of financial resources (Molas-Gallart, 2014).

Notes

1. For more information see <https://www.qrih.nl/en>
2. Petersohn & Heinze at the same time also make the point that bibliometrics emerged as the application of a set of practices developed in one context to another context for which they were not necessarily intended; at the same time the scientific structuration processes that bibliometrics underwent are far more advanced than those which have taken place within societal impact measurement discussions.
3. Siampi is an abbreviation which stands for 'Social Impact Assessment Methods for research and funding instruments through the study of Productive Interactions between science and society'.

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