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The Co-Production of Science, Technology and Global Politics: Exploring Emergent Fields of Knowledge and Policy

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For Winni

ABSTRACT

Today, it seems hard to find a global political issue that does not have a scientific and technological dimension. Likewise, global politics are deeply inscribed in techno-scientific practices and infrastructures. The point of departure for this thesis is that science, technology and global politics are co-productive of each other. Such a perspective draws our attention to the ways that knowledge and technological artifacts create and modify social order and contributes to an understanding of how the production of science and technology (S&T) themselves are shaped by social, political and cultural factors, on an increasingly global scale. Situated at the intersections of Science and Technology Studies and International Relations, this thesis explores the recent transformations in the relationship between S&T and global politics by focusing on three specific sites of their interactions. On the discursive level, it traces how envisioned sociotechnical futures are shaped by, and respond to, changes in international relations. With regard to institutions, it explores how bilateral and international relations are increasingly entering into and shaping national S&T governance and policy-making. Lastly, on the level of representations it will ask how techno-political developments and changing actor-power constellations are co-producing new forms of security knowledge. The empirical work draws on qualitative expert interviews and additional materials collected during three research projects conducted between 2013 and 2016. The thesis takes the form of a cumulative dissertation, presenting three articles published in/accepted by three international peer-reviewed publications. It is framed by an introduction section and a final discussion and conclusion section.

ZUSAMMENFASSUNG

Nahezu alle Bereiche der globalen Politik haben mittlerweile eine wissenschaftlich-technologische Dimension. Gleichzeitig sind globale politische Ordnungen in wissenschaftliche Praktiken und technologische Systeme eingeschrieben. Ausgangspunkt der Dissertation ist ein Verständnis von Wissenschaft, Technologie und globaler Politik als koproduktiv: Wissen und technologische Artefakte schaffen und verändern soziale Ordnungen, während sie gleichzeitig durch soziale, politische, kulturelle Faktoren beeinflusst werden. Aus einer interdisziplinären Perspektive, die an den Schnittstellen von Wissenschaft-und Technologieforschung (STS) und Internationalen Beziehungen ansetzt, untersucht die Dissertation aktuelle Transformationsprozesse im Verhältnis von Wissenschaft, Technologie und globaler Politik. Auf der Ebene von Diskursen wird nachgezeichnet, wie gesellschaftliche Visionen von sozio-technischen Zukünften zunehmend von internationalen Beziehungen und globalen Machtveränderungen geprägt werden. Im Hinblick auf Institutionen untersucht die Arbeit, wie bilaterale und internationale Beziehungen zunehmend in die Gestaltung von Wissenschaft-und Technologiepolitik auf nationaler Ebene einfließen. Weiter wird danach gefragt, wie technopolitische Entwicklungen und sich verändernde globale Akteurs-Konstellationen zu neuen Formen und Repräsentationen von sicherheitspolitischem Wissen führen. Der empirische Teil der Arbeit besteht aus qualitativen ExpertInneninterviews und Dokumentenanalysen, die zwischen 2013-2016 im Rahmen von drei Forschungsprojekten durchgeführt wurden. Als kumulative Dissertation baut die Arbeit auf drei Artikeln auf, welche in internationalen Publikationen mit ExpertInnenbegutachtung veröffentlicht bzw. akzeptiert wurden. Die Artikel werden von einer Einleitung, einem Diskussionsteil sowie Schlussfolgerungen gerahmt.

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1. INTRODUCTION

1.1. Thesis Foreword and Structure

Globalization has fundamentally changed the role of the nation state and the role of science and technology within dynamically-changing global power assemblages. Few global political issues today are wholly without a scientific and technological dimension. Likewise, global politics and international relations are deeply inscribed in scientific practices and technological systems at the national, international and transnational levels, on both the individual and collective scale. The point of departure for this thesis is that science, technology and global politics are not only strongly intertwined but are co-productive of each other. Co-production, as Jasanoff has outlined, is a shorthand for the proposition that “the ways in which we know and represent the world (both nature and society) are inseparable from the ways in which we choose to live in it.” (Jasanoff 2004: 2). Such a perspective draws our attention to the ways that knowledge and technological artifacts create and modify social order. Equally, it contributes to an understanding of how the production of science and technology themselves are shaped by social, political and cultural factors, on an increasingly global scale. Or as Felt (2017: 253) has it, the analytical lens of co-production “invites the analyst to move beyond unidirectional, often deterministic thinking and to reflect on the complex global and local choreographies through which science, technology, and society are brought into being”.

There are seemingly countless examples of the co-productive relationship between science, technology and global politics. From the role of science and technology during imperialist projects and the First and Second World War, to independence movements among former colonies, from the Space Race during the Cold War, to the processes of European integration, national prestige and ideological systems have been closely related to scientific and technological progress. However, we can also look at three examples from recent news headlines to see how science and technology continue to shape and to be shaped by global politics, and how they reconsolidate, reinforce, and even realize shared or contested visions of international relations. In April 2015, the Huffington Post ran this headline: “Iran And World Powers Agree On Framework For Nuclear Deal”.¹

¹ www.huffingtonpost.com/2015/04/02/irannucleardeal_n_6993060.html?utm_hp_ref=uk&ir=UK

The article refers to an agreement made between Iran and six major world powers forming a common framework for the final deal on Iran's nuclear program, which had been subject to years of debates and sanctions imposed by the international community. In July 2015, the agreement on the Joint Comprehensive Plan of Action was concluded in Vienna. Almost three years after adopting an interim agreement in Geneva, Iran agreed to limit enrichment levels, to cut its stockpile of low-enriched uranium and to reduce the number of its gas centrifuges.

At the same time, the overall scope, intensity, and methods for monitoring and verification were widened. In return, the nuclear-related sanctions by the US, the European Union, and the UN Security Council were to be lifted once the International Atomic Energy Agency (IAEA) verified that Iran had implemented key nuclear commitments in January 2016. From a science and technology studies (STS)-informed perspective, we can understand the foundation of such an extensive political agreement to be a reconciliation of differing socio-technical visions that have shaped the processes of inter-governmental negotiations.

While an informed public debate seems to have been hampered by the highly technical language of the negotiations, which mainly focused on aspects of the monitoring and management of uranium enrichment, the negotiations nevertheless led to the formation of non-involved bodies of concerned experts who, as epistemic communities (Haas 1992), were entrusted with authoritative knowledge and who expressed strong views on the details and preferred outcomes of the negotiations. Many of these communities welcomed the negotiations and the technical solutions under consideration. They pushed politicians on both sides to conclude a deal by publishing open letters arguing that such an agreement would also benefit international scientific exchange and collaboration. Among other things, the deal meant that, after years of isolation from the international scientific community, Iranian scientists were now able to participate in scholarly exchange and to take part in international collaborative projects again. Thus, by engaging in the debate as well as in the political negotiations with their specific technical expertise, scientists and engineers helped to establish common political ground where none had been thought to exist. The result was an agreement that provided the basis for a diplomatic breakthrough through detailed and exhaustive discussions of technical particularities. This, in turn, enabled a reconciliation of visions regarding nuclear technology and power. This primacy of the technical experts and their respective epistemic communities, both within and outside of the negotiations, is among the most obvious manifestations of the ways in which science, technology and the making of global politics are co-productive.

Yet another example can be found in the current migration crisis and the formation of European border regimes. Irregular migration has become one of the most intensely contested issues in European policy, constituting a severe test of the European political integration project. The partial suspension of the Schengen regime, which was manifested by the hardening of surveillance and controls at Schengen area borders and the introduction of controls at national borders within the Schengen area, has shown the fragility of cooperation, solidarity and eventually, common European identity formation. It led member states to retreat to the national level and unilateral decision-making processes. Moreover, public fears and concerns have led to and were inspired by increasingly nationalist, anti-immigration movements and policy discourses. The current refugee crisis has also shed light on how an idealized vision of the EU as a borderless single market – allowing for the free flow of goods and persons – is juxtaposed with the socio-material practices of external border controls and fortification (Armstrong & Anderson 2007; Djistelbloom & Meijer 2011). The appearance of barbed wire fences and military and police patrols along national borders within the Schengen area are concrete representations of how innovation in security technologies is increasingly being framed as the “technological fix” for coping with immigration.

So-called smart borders, which grant technology the agency to decide who should be allowed in and who should be kept out, have become a key element of European border politics in recent years (EC: 2011). With regard to science, the latest Framework Program (FP7) has had a strong focus on and was heavily utilized to support the research and development of situational awareness technologies for border control measures (cf. Hoijtink 2014). In the case of European immigration policy, we can thus understand science and technology as being co-productive of state-making projects in that they, at least partly, underscore and reinforce the political, economic and social practices, infrastructures, and institutions of integrated border regimes.

The last example points to the ways in which different identities are constructed with regard how societies envision the internet, and how these visions are also shape and are shaped by global politics through the design and governance of socio-technical infrastructure. A recently-published article in *Foreign Policy* is entitled “China and Russia Join Hands for Internet Censorship.” It refers to the “Seventh International Safe Internet Forum” that was held in Moscow, where Chinese and Russian policy makers met “ (...) to share ideas on controlling their citizens’ access to the internet” (Eades, 2016). The article

contends that one of the central aims of Russian policymakers at the forum was “to harness Chinese expertise in internet management to gain further control over Russia’s internet, including foreign sites accessible from there” and concluded with the statement that China was “happy to help” with exporting internet censorship technologies to authoritarian countries around the world (Eades, 2016). This common view on Russian-Chinese visions of the internet is well established by their joint efforts in the United Nations (UN), where both countries jointly back the Code of Conduct on Information Security (UN: 2015), which subscribes to a different view of the internet than the one commonly held in democracies. The “sharing of ideas on how to control internet access” between Russia and China embodies a joint vision of science, technology, and social order that is diametrically opposed to the conception of the internet typical in the US and most Western nations.

From an STS perspective, Felt has convincingly shown how visions of the internet are centered around the shared understanding of “a networked technology spanning the world, transgressing boundaries of existing geographies and knowledge orders, a vision of the internet as profoundly engaged in the reimagining of social life and social order on a global scale” (Felt 2015). However, the ways in which collective identities are formed around a shared understanding varies and these are also subject to change due to geopolitical transformations. Rather than envisioning the internet as a tool to advance human freedom and participation in political discourse, Russia and China are often perceived as being more interested in the internet’s possibilities for furthering social control in their respective societies. This shared Russian-Chinese imaginary of the internet as “a tool for rule” rather than as a “tool of the ruled” has manifested itself in the countries’ desire to help reinforce each other’s dominant narratives of a specific technical-political order through the transfer of specific social-technical knowledge. Thus a common vision of the internet and its implications helped inform the technical aspects of access control and censorship that these two authoritarian countries were willing to share.

These three brief examples illustrate how visions of science, technology and social order can co-produce each other through differing processes of realignment, reinforcement and realization. In the case of the Iran deal, a common political vision for how to deal with risks posed by nuclear enrichment was enacted by reconciling previously differing technological futures, regardless of how deeply this common vision was embedded in longstanding geopolitical power struggles. In the context of the Russo-Chinese efforts to

reinforce each other's ability to monitor and control how their populations use the internet, the common vision shared by both countries has been underpinned by their ability to share socio-technical knowledge as a way of enacting it. And within the realm of border security, we can see that an implicit common political vision is realized through the formulation of explicit technical solutions, the common denominator of the highly contentious political debate on common immigration policy.

Surprisingly, these kinds of entanglements and emerging spaces of interaction between of science, technology and global politics are rarely considered in the intellectual dialogue between the two disciplines that are most concerned with these issues – STS and International Relations (IR). Here, the former is primarily concerned with how science and technology shape and are shaped by society, whereas the latter concentrates on questions of how science and technology affect and transform power relations between states. While we could understand both research fields as potentially having many intersections and overlapping interests – be it in the areas of international institutions and expertise, governance of emerging technologies, democracy, risk assessment and techno-security, the entanglements of science and the nation state, environmental issues, technological infrastructures, or international cooperation – they currently seem to face each other with hesitation and are rather slow to develop interdisciplinary debates.

Only recently has a small community of constructivist IR scholars begun to criticize and try to overcome the discipline's neglect of the role of S&T in international politics and to develop conceptual approaches that go beyond a deterministic understanding of technology as merely increasing power among states or as a technological fix to (global) societal problems (cf. Fritsch 2011, Hansen & Nissenbaum 2009, Herrera 2006, 2013).

For instance, an analysis conducted by Mayer et al. in 2014 of 21,081 articles published in the 13 major IR journals between 1990 and 2007 has shown that only 0.7 % explicitly dealt with science and technology, and that an even lower percentage tackled questions about how to theorize or conceptualize technology in international politics (Mayer et al. 2014: 14). These results indicate that IR is only beginning to explore and theorize the various ways in which science and technology are foundational to the field's central categories such as power, conflict, statehood, national identity, governance and citizenship. (See Mayer et al. 2014: 14ff., also Fritsch 2011). For Mayer et al., one of the central problems

for IR analysis of S&T lies in the “messiness and complexity inherent to science and technology that tend to slip easily through the interstate-matrix structuring much of IR thinking and research” (2014: 15). Interestingly, Jasanoff’s statement about the ways that political science discourses approach science and technology points in the same direction, as she states that these often seem to “lack vocabularies to make sense of the untidy, uneven processes through which the production of science and technology becomes entangled with social norms and hierarchies” (Jasanoff 2004: 4). Indeed, during a panel on Actor-Network theory and International Relations at the ISA, a major political science conference in 2016 in Atlanta, one panelist stated that “STS gave me the language I never had before”. This might also be the reason why some scholars in IR, and in particular in the subfield of critical security studies, started to draw upon and import approaches, concepts and methodological tools from STS. Recently, a few accounts in IR have begun to make use of STS’s sensibilities towards the role of technologies in processes of social ordering, for instance when addressing issues of knowledge practices and expertise-shaped power relations between different actors in the international systems and to explore the role of material objects and devices in shaping public policy, authority and discourses (Amicelle et al. 2015) and practices of state-making (Muller 2011, Breckenridge 2014).

Although STS emerged as an interdisciplinary field from the start (cf. Jasanoff 2010; Nightingale et al. 2012; Casper 2016), work here does not seem to be inspired by or even borrow from IR to the same amount. In particular, when it comes to addressing recent moments of global (geo)political and humanitarian crisis, the structures and acts of violence from governments and non-state actors against civil societies, few STS scholars seem to be engaged with issues of international (techno)security and international conflict.² In his editorial for the EASST review, entitled “STS and Human Drama,” Farias (2016) took up this issue by reflecting on his experience of being asked as an STS scholar during an interview to comment on the current refugee crisis, stating that: “I stumbled and didn’t know how to respond, even though during the last weeks I’ve been shocked by stories and images of unfortunate human fates (...) I certainly wanted to say something about these issues, but it was hard for me to connect them with the theories, questions and problematizations (sic!) in our field.”

² Valuable exceptions from STS are the work of Kathleen Vogel, who explores the role of tacit knowledge in the assessments of bioweapons proliferation (2006 & 2013) and intelligence practices, as well as Brian Balmer’s (2012) contribution on the co-production of science and secrecy the field of chemical and biological warfare.

So, is Michael Brown, himself working at the intersections of STS and political science, correct in stating that most STS scholars have paid more attention to the conceptual scrutiny of science and technology than they have to politics or democracy (cf. 2014: 4) and even less to international relations and issues of international security? Also, to which extent does this allude to similar struggles in IR to address the role of science and technology in global politics?

The aim of this thesis is to explore the interfaces between these two research fields in order to promote possible conversations between them. This seems necessary in order to understand the current entanglement of science, technology and global politics – not only for the sake of interdisciplinary collaboration, but also as a way to gather knowledge about the pressing global techno-political challenges of our time and to engage in a reflexive debate, both at the academic as well as at the policy level, about possible ways to achieve responsible and democratic forms of global governance of science, technology and innovation.

The next section will lay the conceptual groundwork for this thesis' three papers, which address the co-production of science, technology and international politics from different perspectives, namely by focusing on the levels of policy making, discourses and security-related knowledge practices. It will be structured as follows: Section 1.2 will provide a contextual framing of the topic and give an overview of the major debates on the mutual shaping of science, technology and global politics in both disciplines and suggest a variety of promising sites for an enhanced interdisciplinary exploration. Section 1.3 will then present the overall research questions of the thesis that will be addressed by the three papers. The papers will each be introduced in detail in section 1.4. Section 1.5 addresses relevant working definitions for how notions of the national and the international are addressed in each paper. Section 1.6. also provides and introduces the empirical material and analytical methods used for answering the research questions of each paper. The articles will be presented in section 2. Finally, Section 3 concludes the thesis by first drawing together the findings of the three papers and then addressing how each of them contributes to answering the overall research question of this thesis. This is followed by a discussion (3.1.) of those questions that require further exploration.

The conclusion (3.2.) will then outline three “moments of transformation” that grasp the ongoing interactions between S&T and global politics on the discursive and institutional level, as well as on the level of identities and representations.

1.2. Conceptual Framing and Current Theoretical Approaches

This section structures the literature overview on the key work in both fields into six categories that describe where science, technology and global politics become relevant to each other. These have been suggested by International Relations scholar Charles Weiss, who was among the first to urge researchers in his field to pay more attention to science and technology as influential features in international affairs at the theoretical and conceptual level.³ In his recently published paper Weiss suggests six patterns where science and technology interact with and influence international affairs (2015: 411):

01	as a juggernaut or escaped genie with rapid and wide-ranging ramifications for the international system
02	as a game-changer and a conveyer of advantage and disadvantage to different actors in the international system
03	as a source of risks, issues and problems that must be addressed and managed by the international community
04	as key dimensions or enablers of international macro phenomena
05	as instruments of foreign policy or sources of technical information for the management of an ongoing international regime
06	as the subject of projects and institutions whose planning, design, implementation and management provide grist for the mill of international relations and diplomacy.

³ There are also earlier accounts to be found in IR on the role of technology in international relations. However, these were mainly inspired by the Second World War, focused on the role of nuclear weapons, and lacked a conceptual approach that went beyond technology as just another element conferring power towards nation states. See for instance Ogburn (1949), Herz and Brodie (1949) and Skolnikoff (1994).

I have chosen to use Weiss' categorization (instead of developing my own) for two reasons: first, his paper has a very broad focus, covering the most general interactions between science, technology and international politics, so that my own categories would not have been that different, at least with regard to the topics mentioned. Second, and more importantly, Weiss' categorization offers a way to use the mainstream IR perspective as a lens to examine issues of science and technology that are most likely to be addressed differently in STS. In other words, when I first read Weiss' paper it quickly became clear to me that it lacks many key STS conceptualizations and insights while, at the same time, it is one of very few accounts that explicitly address, on a conceptual level, the role of science and technology in international affairs. Adding to, reframing and rearticulating his categories thus provides a way to build productive avenues for an interdisciplinary conversation between STS and IR. This is particularly true since for every pattern, (beyond the examples that Weiss gives), we can already refer to a large body of research in STS.

Therefore, each pattern addressed by Weiss will be complemented by a selection on relevant studies from STS as well as additional work from IR and beyond. Based on this, for each pattern, I will make some suggestions for promising perspectives that are shared by STS and IR alike and through which they can jointly address current challenges in globalized techno-societies.

Before going into a detailed analysis of Weiss' categorizations, it seems necessary at this juncture to clarify how the terms "international system" as used by Weiss and "global politics" as is used in this thesis are frequently employed in the literature. First of all, there is no common definition for either of these terms. Instead, different schools in International Relations have put forward different analytical approaches that are, like all theoretical concepts, also deeply rooted in the political and historical context of their origin. "International system," was the main term used since the 1950s and throughout the Cold War, although understandings as to what this should refer to were rather contested and lacked clarity. It is also a term that was inspired by the increasingly realist perspectives in the discipline of IR, a trend which was itself influenced by its proponents' experiences of World War II. Scholars of that era conceptualized international politics as a system, which from a realist perspective refers to "an assemblage of units, objects, or parts united by some form of regular interaction" (Mingst & Arreguin-Toft 2010), with no authorities above the state, comprised by a fundamental anarchic structure (see also Bull 1977, Waltz 1965 (2001)).

During the postwar period, spreading processes of decolonization led to an increased focus on global interdependencies, hierarchies and structural inequalities between different regions of the world, captured most prominently by Wallerstein's notion of the socio-economic world-system. In his world, this is understood as "a unit with a single division of labor and multiple cultural systems" (1974), a system in which regions are divided into the world's core, semi-periphery and periphery (cf. Chase Dunn & Grimes 1995).

With the end of the Cold War, however, and the disintegration of the bipolar world order, "international regimes" (Keohane 1982) and "global governance" (Rosenau & Czempiel 1995, Dingwert & Pattberg 2006) emerged as equally prevalent terms, taking into account the increasing global connectedness and the growing influence of international institutions and organizations. Although international system(s) (cf. Buzan & Little 2000) is commonly used in IR, I will mainly use the term "global politics" as it acknowledges the multi-sitedness of those processes through which science, technology and politics are co-productive of each other. I will elaborate on this in more detail in section 1.4.1.

1.2.1. Technology: An Escaped Genie Driving History? — Technological Determinism and the Social Construction of Technology

The first pattern through which Weiss sees science and technology as influencing and shaping international relations is termed "Technology as an escaped genie" which can "create fundamental change in the international system" (414). Here, Weiss argues that "the speed of technical change and the unforeseen impacts of new technical capabilities stay well ahead of efforts by governments, the international community, and the private sector to manage, and via competitors with legacy technologies, to suppress or control" (Weiss 2015: 414). The main argument here is that progress in science and technology, first and foremost with regard to nuclear weapons and information and communication technologies (ICT), has implications for the architecture of the international system itself, and that social actors are lagging behind in finding adequate ways to govern emerging technological systems (cf. Rosenau & Singh 2002, Keohane & Nye 2011). This correlates with what Winner wrote some 40 years before, namely that technological developments seem to "continually outpace the capacity of individuals and social systems to adapt" and that enhanced technological complexity makes it increasingly hard to carry out the "most basic activities of contemporary social life: planning, design, and functional coordination"

(1977: 3). Weiss argues that “the advent of nuclear weapons revolutionized geopolitics, creating a world of two and only two superpowers, conferring huge advantages on nuclear powers by defining the mastery of nuclear technology as the prime measure of national power” (Weiss 2015: 414).

In this rather techno-deterministic narrative, nuclear weapons operate as the mythical genie. Although STS would hardly conceive of technology as a genie, we can nevertheless stick with this metaphor for a moment, asking ourselves what magic lamp has been rubbed in order to release the genie? Furthermore, what might this technological genie look like?

Here, Weiss pays little attention to the complex constellations of geopolitics, scientific ambitions, the entanglements of science and processes of state making and ideological competition or regimes of secrecy (Wellerstein 2008) that accompanied the development of nuclear technologies. As Sims & Henke (2012: 326) have shown in their work on the maintenance of nuclear weapons during the Cold War and the role of discourses and social relations, the “socio-technical systems and institutions, just like conversations, are dynamic processes that must remain under constant repair in order to maintain their coherence and boundaries.” However, in his attempt to urge IR scholars to acknowledge the role of technology, Weiss falls short in including the social, techno-political, scientific and cultural factors that significantly shaped every aspect of nuclear weapons in his analysis. Although he sees nuclear technology as subject to “*social construction*” (414), he uses a mainly economic explanation for this, arguing that the pressurized water reactor has become the dominant technology for civilian nuclear power because it had already been tested in nuclear submarines and thus was ready for introduction to the market (Weiss 2015).

If we follow McCarthy’s definition, technological determinism argues that “technology develops according to a single linear rationale which causes outcomes of social development” (2013: 472). In other words, technological determinists in IR see that those who possess nuclear weapons are more powerful in the international system than those who do not (see Heilbroner 1967, Waltz 1979, Keohane 1984) and that power relations between nation states also change according to increases in technological power. Such an approach towards technology is thus primarily interested in the effects that technologies have on the diffusion of power in global politics (see e.g. Singer & Friedman 2014, Walters 2014 Bolton & Mitchell 2014).

We could juxtapose this determinist understanding of technology with a social-constructivist approach from STS as was outlined prominently in the article “Computers, Guns and Roses: What’s social about being shot?” written by Grint and Woolgar in 1992. From a strong anti-essentialist perspective, they argue that how gunshots and even death are perceived or reacted to differs according to social and cultural context: for example, with regard to the gender of the person that has been shot.

Here, they point to the example of female Israeli soldiers who, when wounded by gunshots, would evoke different reactions from their male colleagues than men would have (Grint and Woolgar 1992). When it comes to the material effects of nuclear bombs, they argue that “The capabilities of nuclear bombs are not a ‘reflection of the actual technical characteristics of the bombs but the result of various agencies’ (scientists, military experts, historians, victims, and so on) constructions. Our ‘knowledge’ of what bombs can do is not based simply on our looking at them or watching them go off. It depends, instead, on a complicated variety of factors, including our reading or listening to the accounts of others, our susceptibility to persuasion by authoritative sources, our willingness to credit claims to expertise, and so on” (1992: 371). This is certainly not a recent example of social-constructivist accounts in STS (and beyond), and much has happened since then. However, it points to some of the fundamental differences in how traditional IR thinking and STS understand technology.

STS came into being during the 1970s/80s with an explicit social constructivist approach towards science and technology (Pinch & Bijker 1984; 1986; Pickering 1984; Stewart 1986; Bijker, Hughes & Pinch 1987, Jasanoff 2010). Since then, it has provided research in that field (and beyond) with three important reminders (Sismondo 2010), all of which we also find in Grint and Woolgar’s argumentation: first, that science and technology are socially constructed and shaped by various social actors, second, that S&T have their own agency, as active rather than static entities, and lastly, that there is no such thing as a “direct route from nature to ideas about nature” (Sismondo 2010: 57), and that instead, what we find are socially constructed representations and realities (cf. Knorr Cetina 1981, Latour 1987, Hacking 1983). While IR’s determinism and STS’s social constructivism are certainly strong counterpoints, we can also find work in both fields that facilitates a convergence between them.

For instance, from an STS perspective, Sally Wyatt argues that the discipline should take technological determinism more seriously because it is still considered an important explanation by a variety of actors (mainly outside of STS). Wyatt distinguishes between different types of determinism that considers to be, in one way or the other, still present in STS accounts of the role of technology in society. She discusses justificatory technological determinism, which she frames through an example of employers justifying downsizing or reorganizing work processes due to new technological capabilities and increased automation through the introduction of computers or any other kind of machines that take over human work (2009: 174). With the term methodological determinism, she refers to a form of determinism that is also related to what STS does (she calls it the “guilty secret in STS”) – taking the role of technology in society seriously, attempting to understand its place in history and using it as an object of analysis. Provocatively, Wyatt concludes that in STS “we are all technological determinists. If we were not, we would have no object of analysis, our *raison d’être* would disappear” (2008: 175). Furthermore, she identifies normative determinism, which views autonomous technologies (Winner 1978) as being so complex that they cannot be socially controlled anymore. This is also closely related to what Bimber has labeled the “Unintended Consequences account,” deriving “from observations of the uncertainty and uncontrollability of the outcomes of actions” (Bimber 1994: 87). Weiss’ metaphor of the technological genie leans strongly in the direction of this view of technology as an uncontrollable and, at least to some extent, autonomous agent.

However, by nudging STS to take technological determinist accounts more seriously, Wyatt concludes that one of the main challenges in doing so is “to understand how machines make history in concert with current generations of people; to conceptualize the dialectic relationship between the social shaping of technology and the technological shaping of society” (2008: 176). I tend to agree with Wyatt’s line of thinking. As long as determinist explanations of technologically-induced change persist, they cannot simply be rejected or ignored.

In IR, neorealist approaches have been challenged by constructivists in the field, who argue that IR’s traditional variables e.g. military power, trade relations and institutions, are also always socially constructed and shaped by a diverse set of ideas, norms, identities and beliefs as well as history, which are all seen as necessary to explain the behavior of states (Ruggie 1975, Onuf 1997, Wendt 1992, Finnemore 1996). Alexander Wendt, one of the most prominent proponents of social constructivism in IR, has argued that while social

structures are always also material in that they include resources, tanks and, yes, nuclear weapons, they nevertheless acquire meaning only through common structures of knowledge. As an example, Wendt notes that “500 British nuclear weapons are less threatening to the United States than 5 North Korean nuclear weapons, because the British are friends of the United States and the North Koreans are not, and amity or enmity is a function of shared understanding” (Wendt 1995: 73). This short statement nicely illustrates the shortcomings of neorealism’s purely materialistic understandings of technology as it alludes to the entanglements of science, technology and global politics as constituting an arena of interaction, shaped by and shaping the identities, discourses and practices of its actors while simultaneously being subject to changing normative and institutional structures.⁴

This easily lends itself to work in STS, which sees science and technology as inherently political (Winner 1980; Latour 1987; Pinch, Bijker & Hughes 1987; Haraway 1991; Star 1995; Itty 1998 & 2006; Collins & Evans: 2002; Hecht 2006; Jasanoff 2004, 2010; 2015; Miller 2007, 2012, Brown 2015). In fact, STS has made us understand that nation states are entities that are not as clear cut as large bodies of work in IR suggest, but rather heterogeneous assemblages of actors and power relationships with multiple layers of meaning and stabilization.

When it comes to nuclear power, STS has shown that the ways in which societies relate to the “nuclear” are closely related to their specific socio-technical cultures and technopolitical histories. In her extensive account on nuclear ontologies, Hecht (2006) has argued that the “*nuclearity* of a nation, a program, a technology, or a material – that is, the degree to which any of these things counts as “nuclear” – can never be defined in simple, clear-cut, scientific terms”. Instead, she offers an understanding of nuclearity as a much broader technopolitical configuration; as a “historical and geographical condition, *as well as* a scientific and technological one” (320). Such an approach towards nuclearity permits a grasp on how it is embedded into structures of global control that shape and affect its regulations and articulations of resistance.

⁴ See for instance Heuser (2008) on the role of beliefs and cultures in the use of nuclear weapons and Walters (2014) on drone strikes and *dingpolitik*.

In their seminal contribution on the socio-technical imaginaries of nuclear power in the US and South Korea, Jasanoff and Kim have shown that while nuclear power and nationhood have been imagined together in both countries, they largely differ in the ways these imaginaries are constructed, building upon different techno-political histories and identity formations (Jasanoff & Kim 2009). Socio-technical imaginaries were originally defined as “collectively imagined forms of social life and social order reflected in the design and fulfillment of nation-specific scientific and/or technological projects” (2009: 120). In the US, as their study has shown, the main strategy after the Second World War was to contain the dangerous potential of nuclear energy through the construction of a new entity, “atoms for peace.” Here, the state is represented as “a responsible regulator of a potentially runaway technology” (2009: 121), while simultaneously delegating much of its responsibility to the private sector. For South Korea, on the other hand, nuclear power is not so much seen in a context of regulation and containment, but rather as a technological system that allows for and symbolizes self-reliance, which translates into the vision of “atoms for development.”

Such visions form the basis, Jasanoff and Kim argue, upon which policies are built, powerfully influencing how technologies are designed, funded and embedded in national techno-political histories and futures alike. With a view to IR’s emerging interest in the ways that national and international policy-making are related to technological development (see Mayer et al. 2015, Fritsch 2011, Herrera 2006), Jasanoff and Kim’s work on varying socio-technical imaginaries allows for an understanding of the countries’ very different responses to a variety of nuclear shocks and challenges, such as Three Mile Island, Chernobyl and the spread of the anti-nuclear movement (Jasanoff & Kim 2009). In a recently published edited volume, they have further refined the concept in order to appreciate the ways that imaginaries are developed by social actors beyond the level of the nation state, for example, by organized groups, corporations and social movements. Imaginaries, in this broader and more inclusive approach, are now framed as “collectively held, institutionally stabilized, and publicly performed visions of desirable futures, animated by shared understandings of forms of social life and social order, attainable through, and supportive of, advances in science and technology” (Jasanoff & Kim 2015: 9).

With a view to Weiss’ image of technology as an escaped genie, a perspective on socio-technical imaginaries would likely contribute to a more fine-grained understanding of technology as being shaped by the specific socio-political context from which it emerged, including an acknowledgement of local differences and particularities. Moreover, it has

been shown how such a perspective illustrates the ways that nations, communities and other collectively organized groups and networks commonly envision, rehearse and stabilize techno-political futures.

I suggest broadening the scope of socio-technical imaginaries in order to make them more applicable to processes of global politics as well as to the central categories of IR analysis. While some more recent accounts in this field have already developed the notion of global imaginaries (Miller 2015; Lakoff 2015), surprisingly little attention has been paid to how national imaginaries can be constructed about *others*, be it organized groups or nation states. I would argue that such an up-scaling of imaginaries on the global level could contribute much to understanding how visions of science and technology are related to global social order and thus how specific national imaginaries are a response to the changing global power relations related to science and technology. Furthermore, this would provide a way to explore how imaginaries travel between different regions, political systems and cultures, carrying (or losing) different values and visions about attainable social development on their way (cf. Pfotenhauer and Jasanoff 2017).

Engaging with such a perspective could also add to constructivist work in IR on the role of technology in global politics, as it would open up new ways to address issues of identity, representation and power embedded within the shared perceptions about other countries and their respective S&T systems and politics. More precisely, work in STS and IR alike could benefit from such an approach when applying imaginaries as kind of a connecting device to understand international cooperation and conflict as both are always related to matters of science and technology.

The first paper in this thesis is an attempt in this direction. By linking social-constructivist approaches from STS and IR, it uses the concept of socio-technical imaginaries to trace how Austrian stakeholders in science and technology policy relate to China by drawing on a specific and shared narrative about Austrian techno-political history and culture. In the concluding chapter, I will suggest three ways in which to conceptualize the international character of socio-technical imaginaries.

1.2.2. The Materiality of Science and Technology and their Embeddedness in Global Power Relations and Politics

The second pattern outlined by Weiss sees “science and technology as a game-changer in the international system.” It describes the role of S&T in international politics in at least two ways: first, as changing how the international system operates, and second, in changing how power is distributed among different actors within the system. While the delineation of the former pattern seems a bit blurry, Weiss suggests that approaching S&T as game changers raises more detailed and complex issues and questions about how advances in science and technology affect the ways that military operations, diplomacy, war and commerce are done (Weiss 2015). By pointing to these particular areas, Weiss implicitly addresses a specific set of questions that are quite prevalent in IR theorizing about technology: how does technological change impact power relations between states and how does it *change the global power structure?*

Weiss illustrates how technological innovations have transformed the relations between states not only in regards to the possession of nuclear weapons (or what Hecht calls the nuclearity of a nation) but also taking into account the role of smart bombs and network-centered warfare. Employed by the US army during the first Gulf War, this new kind of wired warfare (cf. Singer 2013) has “cemented the position of the United States as the world’s only superpower in the 1990s and the early years of the 21st century” (Weiss 2015: 415). Pointing in the same direction, the evolution of the internet is mentioned by Weiss as one of the most fundamental socio-technical disruptions of contemporary society, that introduced an entirely new domain – cyberspace – within which states and civil society actors were forced to (and are still struggling to) establish new rules of behavior for cooperation and conflict (cf. DeNardis 2014, Hansen & Nissenbaum 2009).

The “revolution in information technology” (Weiss 2015) is understood to have fundamentally changed global orders of power. Scientific-technological advancements have created entirely new capabilities – ranging from communication, global financial transactions, and new business sectors, to novel forms of surveillance and intelligence gathering. For Weiss, ICT has thus conferred an advantage in power to those able to manage them effectively. The power shifts between governments, civil society and non-state actors, private companies introduced by ICT, he argues, lead to a “counter-reaction from those whose relative power has been affected by the change in technology, and to an effort to restore the previous relative power or competitive relationship” (2015: 416).

Yet, given the obviously strong impact of these scientific and technological innovations on global power configurations, a deterministic perspective of the role of technology in international affairs seems to some extent justifiable. These technologies, like many others, did induce change, did they not? Materialist approaches in IR, most prominently those found in neorealist and neoliberal accounts, would argue that, yes, it is precisely the material objects such as bombs, the internet and natural resources like oil and gas at specific geographical sites that directly influence the making of global politics, regardless of the ideas, values, beliefs or visions that people attach to them (cf. Waltz 1965, Mearsheimer 1995, Goldstein & Keohane 1994). As Hurd (2008) points out, these accounts try to explain “international patterns and behaviors as the result of purely material forces, particularly the military hardware, strategic resources, and money that they see as constituting ‘power’” (2008: 300).

How to deal with the materiality of technology has also been a central concern in STS. As Orlikowski and Scott (2008: 455) have argued, a focus on socio-materiality offers “a move away from focusing on how technologies influence humans to examining how materiality is intrinsic to everyday activities and relations.” Instead, research in this realm allows us to understand how “meanings and materialities are enacted together in everyday practices” (Orlikowski 2010: 135). Here, material-discursive approaches are especially helpful in grasping the mutual agential entanglements of intra-acting human and nonhuman practices (Barad 2007, Weber 2015, Williams 2011). Wilbert’s analysis of the intra-active worlds of avian flu provides a particularly insightful analysis of these entanglements. Understanding the virus as a natural-cultural phenomenon, he shows how it is deeply embedded in geopolitical and economic relations, where in the words of Haraway (2009, unpagged), “[i]ndustrially produced meats, international veterinary practices, biosecurity practices, international trade agreements, transport networks, increased density of human populations, and more are among the various agential apparatuses at work” (cf. Wilbert 2006).

His starting point is that in the course of the avian flu, institutions like the World Health Organization (WHO) and national governments claimed that it was necessary to put the wild birds concerned, as well as chicken producers, under governmental surveillance. However, these claims were not backed up by researchers and their empirical data: on the contrary, analyses showed that the disease outbreak was the result of globalized large-scale poultry production chains (2006: 4). Wilbert thus understands the avian flu not as an object in itself, but as a phenomenon with shifting and diverse materialities (2006: 106)

that are always a part of “various bodies, ecologies, networks of (in-)adequate technologies of surveillance and biosecurity, which include all kinds of rules, veterinary techniques, forms of production, transport networks, slaughtering practices, laws, and more” (2006: 8).

Mitchell’s extensive analysis of the intersections of coal, oil and democracy in the Middle East provides another promising way for scholars from both fields to approach the entanglement of techno-political materialities with different and related forms of social order, in this case in the field of energy exploitation. Mitchell sets out to criticize previous accounts of the relationship between oil and a lack of democracy for focusing mainly on the decision-making organs of the producer states and on the processes by which the oil flow is converted into energy, political power and profits. Instead, Mitchell proposes to “follow the carbon itself” as a way to account for the techno-political histories of oil-producing states and their degree of democratization, as well as the specific materialities of oil and coal (Mitchell 2009: 400). Inspired by an STS perspective, Mitchell puts forward the notion of the socio-technical system (see also Hughes 1989) that has evolved around carbon. Here, he suggests tracing the entanglements and complex actor-power constellations in order to understand the socio-technical arrangements of fossil fuels and democracy that connect “energy and politics, materials and ideas, humans and non-humans, calculations and the objects of calculation, representations and forms of violence, and the present and the futures” (2009: 422).

In the same vein, Schouten examines the socio-material aspects of technologies as shaping global power relations by studying colonial legacies and the role of “infrastructural absences” in the Congo. He suggests that by developing infrastructures such as roads and railways, Belgian colonizers were “exponentially able to add machinery to their relations to the Congolese soil and population” (Schouten 2014: 560). When the country reached its independence in 1960, it was crowded with vast technological and bureaucratic infrastructures of governance and exploitation. The legacy of Belgian colonization of the Congo (as with that of other colonial powers) is therefore also highly material in terms of removal (of resources and people) and what was left: buildings, prisons, roads and railways, as well as extraction infrastructure, all of which can be understood as socio-material entanglements significant for governmental power (see Schouten 2014: 560). Schouten’s analysis can therefore also be seen as an attempt to broaden the scope of work in IR examining issues of state failure and governmental power in Africa by adding an STS-inspired sensitivity to social-material relations and socio-technical assemblages of power and governance.

All three examples illustrate that it is necessary to take into account the networks, entanglements and assemblages of politics, economics, society, technology and science in order to understand how technological change and social order co-produce each other. Moreover, each example points to the transgressions of spaces and the overlapping and entangling of different social, cultural and political entities, while at the same time taking materiality seriously. Here, Barry's framework of technological zones provides a promising way to theorize the above-mentioned phenomena via the perspectives of IR and STS.

A technological zone can be understood "as a space within which differences between technical practices, procedures or forms have been reduced, or common standards have been established. Unlike the territories of nation-states and empires, technological zones cannot be marked on a map, yet they do have limits. Moreover, they may also imply particular demands on the identity of objects and persons that exist within them" (2006: 239). Such a perspective emphasizes how different political entities consist of various technological zones that form networks around particular technologies, typically characterized by flexible and contested boundaries. It opens an avenue to studying how technological assemblages, their interconnection of politics with both human and non-human elements (Latour 2005, Mitchell 2009, Barry 2001, Agnew 2005, Birch & Calvert 2015) and the ways they are constructed are related to and entangled with broader processes of global politics.

1.2.3. Science, Expertise and Risk in Global Politics

With this pattern, Weiss refers to the ways in which S&T constantly create new issue agendas for international policy making and discourse, by pointing to large-scale socio-political and economic transformations that are understood as direct consequences of technological and scientific advances and discoveries. For instance, Weiss states that globalization was made possible by advances in transportation, information and communication technology and that nuclear proliferation was driven by the international diffusion of technology. Other examples mentioned here include the exploration of space and the depths of the oceans that have been made accessible by technological developments, as well as the dependence of terrorists on "simple but effective technologies like suicide vests and car bombs."

In the second part of this pattern, Weiss refers to the role that science and technology play in creating new issues and challenges for social actors when what he describes as the “issues of environment [are] brought to the attention of the international community as a result of knowledge and understanding developed and supplied by the scientific community” (Weiss 2015: 420) – a topic that speaks directly to the core interest that drives much work in STS. One of the most prominent examples that has attracted the attention of political scientists and STS scholars alike is the International Panel on Climate Change (IPCC), which functions to bring together scientists from different disciplines and provide policy advice in the contingent field of environmental governance. This is one of the few cases where we can already draw on a large body of work that explicitly aims at integrating conceptual approaches from STS and IR to address the ways that knowledge is created, validated and contested in the field of global environmental governance (Beck et al. 2014, Forsyth 2012, 2011, Jasanoff 2011, Grundmann 2006, Jasanoff 1996, Hilgartner 2000, Miller 2001 & 2004).

In IR, the term “epistemic communities” is a key concept of regime theory that was coined by Haas and is commonly defined as “network[s] of professionals with recognized expertise and competence in a particular domain and an authoritative claim to policy relevant knowledge within that domain or issue-area” (Haas 1992: 3, see also Cross 2013a, 2013b, Dunlop 2009, Zito 2001, Radaelli 1995). In recent years, the epistemic communities’ approach has regained attention in IR since it is seen as a promising way to study emerging expert groups and professions in transnational governance that also emerged as a consequence of technological advances, related technical and political uncertainties, and possible technology-related threats to security (Davis Cross 2013, Aday & Livingston 2009, Mitchell et al. 2007). One of the most recent accounts in this vein is the study by Lidskog and Sundqvist (2015) on the science-policy relationship in international climate governance.

The authors aim to show how IR approaches that explore the nexus of knowledge and policy could benefit from an infusion of co-productionist perspective from STS. Epistemic communities, particularly in the field of environmental governance, provide a good example of both the similarities and the differences between IR and STS approaches to the science-policy nexus. While they share an emphasis on “the importance of context for understanding how science works” (Lidskog & Sundqvist 2015: 15), including the role of experts and expertise in creating credibility and authority, they differ from one another when it comes to the specific processes of knowledge production, an often-neglected but

distinctive characteristic of epistemic communities. Lidskog and Sundqvist describe how these accounts differ, arguing that IR approaches are more interested in (or limited to) the formalized interplay of science and policy in international negotiations—the organizational design or, as they call it, the front-stage activities (2015: 16). On the other hand, work in STS allows for a broader consideration of how actors in science and policy relate to and interact with each other in the “backstage regions” of knowledge production (2015: 16, cf. Hilgartner 2000).

While I agree with their description of the differing approaches in both disciplines, it would certainly be fruitful to look beyond those intellectual dividing lines and focus on what may be a productive opportunity to merge their respective insights. I therefore suggest linking the concept of “epistemic communities” with what Knorr-Cetina has framed as “epistemic cultures” (1999). This notion refers to the “(...) sets of practices, arrangements and mechanisms bound together by necessity, affinity and historical coincidence which, in a given area of professional expertise, make up how we know what we know. Epistemic cultures are cultures of creating and warranting knowledge” (1999: 363). This approach, grounded in the sociology of scientific knowledge, draws our attention to the various practices, institutional arrangements and techno-political contexts guiding the production of knowledge that make epistemic communities what they are.

This connection would also allow us to take into account how uncertainties are permanently negotiated and deliberated upon within the complex backstage regions of knowledge production in international policymaking. In addition, and as suggested by Lidskog and Sundqvist, concepts such as civic epistemologies (Jasanoff 2005) or stage-management (Hilgartner 2000) provide valuable contributions to the work in IR on epistemic communities.

Civic epistemology aims to grasp how forms of collective knowledge increase the robustness of knowledge claims in society. Lidskog and Sundqvist suggest employing the concept as a way to understand how knowledge claims are regarded as reliable by the public within different political settings and cultures. Rather than focusing on the assessment of technical details, civic epistemologies refer to the public as posing larger questions about the risks and benefits of, for example, emergent technologies as well as questioning how we know what we know (Jasanoff 2003).

Stage-management, in turn, attempts to grasp those processes through which actors from science and policy work together to represent scientific knowledge as the authoritative

source for public deliberation and decision-making (Hilgartner 2000). Hilgartner further distinguishes between backstage management and front stage management as the two ways by which scientific advice on policy is produced. While the backstage area refers to those sites where knowledge is uncertain, contested and mostly hidden from the public, the front stage describes scientific knowledge that is conceived of as certain and pure, and free from political cooptation. Using theatrical metaphors is an apt way of characterizing scientific advice as a form of drama and performance, where “expert authority is constituted through strategic impression management and very deliberate control over what is displayed publicly and what is concealed from the audience” (Derksen 2001: unpagged). Addressing, for instance, international negotiations like those surrounding the “Iran Deal” through the perspectives of both stage management and epistemic communities could allow for a better understanding of the concrete sites where performances of science and policy are co-productive in the arena of international politics. These conceptual approaches contribute much to an increased understanding of the role that expert bodies play in risk governance (cf. Jasanoff 2013) and of the ways that science constantly puts new issues on the policy agenda while simultaneously responding in various ways to issues set by the policy community.

1.2.4. Identities and Global Inequalities in Science and Technology

By using this pattern, Weiss describes how technological advances in infrastructural technologies and politics have paved the way for globalization (see also Jasanoff and Martello 2004, Bayly 2004, Barry 2001, Sassen 2006) by referring to the pattern “science and technology as a key dimension of international macro issues and as a source of understanding or an enabler of new macro phenomena” (Weiss 2015: 411). More precisely, he refers to the social, economic and political changes that have been brought on by information and communication technologies (ICT) and their role in power struggles among various actors (Singh 2002). A recent example of this is the web of complex and contingent architectures, infrastructures and institutions that are concerned with internet governance and their impact on nation states and international treaties (De Nardis 2014).

More generally, Weiss sees the international division of labor as shaped by the “relative capacity in different countries to manage technology” (2015: 420). This is one of the very few references he makes to global inequalities and the uneven distribution of (technology-related) power and influence. Nearly absent from all of the examples given in his paper is a perspective that takes into account the role of the places and spaces where these emerging

international macro issues are played out, in particular with regard to the ambivalent relationship between developing and developed countries, or what is often termed the “Global South.”

Relevant questions to ask here also include how technological advances themselves impact social orders in developing countries as well as in relation to other, technologically more advanced, parts of the world. What does the notion of “a globalization of knowledge” or the concept of global knowledge economies actually mean for non-Western countries? While on the one hand science is constructed more and more as something global or transnational, the location or spatiality of scientific knowledge production is still an issue of major importance, especially if we think of its validation in terms of publications or patents or the reputation within the international scientific community. In their profound analysis of the internationalization of the social sciences, Kuhn and Weidemann found that the mainstream research agenda is still created in the West “from and for the intellectual needs of Western societies” (2010: 390).

They argue that since the scientific progress of the science communities around the world is measured with respect to its contributions to “science fashions of this Western mainstream agenda, the participation of academics from non Western-societies [...] results in the alienation of major parts of national science communities from their own research priorities” (2010: 390, see also Scott 2011). For this reason, they argue, major parts of scientific communities from non-Western locations are excluded from what is termed the “global scientific community.” Or, as Abraham has stated, “in the metropolis they ‘do theory’ and in the colonies they gather data” (1983).

This is also in line with what the UNESCO World Science report concluded in 2010, stating that the concept of knowledge societies is “one that looks very different depending on one’s regional perspective (where) global divides reproduce themselves in each generation, in our institutions and in our methods of creating and using knowledge” (UNESCO 2010: 4). As Anderson and Adam pointedly remark in their contribution on postcolonial techno-science, in Latour’s claim that “we” have never been modern, we “may have missed the real action: those of us outside Paris have never had so many ways of being modern, so many ways of being scientific!” (Anderson & Adams 2008: 183).

In general, postcolonial approaches to science and technology offer important insights that address the issues of universal knowledge claims, the geographies and global power relations in which scientific knowledge production is embedded, the contact zones of

different forms of knowledge and the ways in which knowledge and ideas travel from one context into another (Keim 2010). Here, two issues were and are central in postcolonial approaches to science and technology. One stream of work focuses mainly on the histories of Western science and technologies in colonialism, as well as on the role that colonialism played in the histories of Western science and technologies (Harding 2011: 5, Adas 1989, 2006; Anderson 2002; Anderson and Adams 2008; McNeil 2005; Seth 2009). Another stream of work explores the role that science and technology policies play in countries that gained independence from their colonizers. Work in this realm is particularly interested in how to integrate S&T into programs and concepts of state-making.

Abraham (1999) provides an invaluable account of the making of the Indian atomic bomb. Combining insights from science and technology studies, international relations theory and history, among other fields, he analyzes the various narratives that different Indian governments have created regarding the civilian purposes of the Indian nuclear program. Abraham draws on Nehru's vision of science, most notably civilian nuclear physics, as helping to constitute the new nation state.

In the cases of France and the Soviet Union, respectively, an extensive nuclear program was envisioned as being the proof of relative ideological superiority (1999:101), showing again how visions and articulations of social order and technological progress are not only entangled with each other but are also created together in processes of state-making and identity formation. Others have focused on development cooperation, reminding us of the crucial fact that the former colonial powers are now the main funders of development programs in the fields of science and higher education (Kothari 2004). More recently, postcolonial STS scholars have drawn the field's attention towards the "contradictory tendencies" in techno-science, that are simultaneously seen as being at path towards "national scientific and commercial autonomy" and increasing the "dependence on global knowledge networks and foreign capital" (Benjamin 2009: 341; cf. Pollock & Subramanian 2016: 955). Postcolonial studies, as they speak to both STS and IR, offer a fruitful approach to bringing these two fields into closer conversation, contributing in particular to opening up spaces for alternative knowledges and their transnational circulation in multiple forms.

1.2.5. Knowledge and Governance in Global Politics

With the notion of “science and technology as an instrument of foreign policy, or as a provider of technical information as an input to the management of an ongoing international regime or problem,” Weiss refers primarily to their role in improving otherwise-strained relations between nation states and in (re)-establishing trust (cf. 2015: 422). Both of these are also key to initiatives assembled under the umbrella term *science diplomacy* (cf. Flink and Schreiterer 2010). Science diplomacy has been most prominently embodied by a joint publication of the Royal Society and the AAAS since 2010, which points out three distinctive characteristics: first, *science in diplomacy*, which refers to how scientists can (or should) inform foreign policy objectives by offering scientific advice; second, *diplomacy for science*, which alludes to support for international scientific cooperation from non-scientific institutions usually located in the field of foreign policy and lastly; *science for diplomacy*, the use of cooperation in science to improve international relations between countries (Royal Society/AAAS: 2010), which is mainly how Weiss uses the term. More generally, these different aspects of the interaction between science and foreign policy are often understood as an element of “soft power,” a concept well established and referred to in IR (Nye: 2004). Soft power differs from traditional conceptions of power in that it emphasizes attraction over coercion or payments in order to achieve desired outcomes, where this attractiveness is informed by a country’s values, policies and culture (Nye 2004).

Rather than getting others to do something they would not otherwise do, soft power stresses a co-opting effect aimed at “getting others to want the outcomes that you want” (Nye 2004: 5, see also Goldsmith & Horiuchi 2012: 555). This approach to power is deeply rooted in regime theory, which understands the international system as being dominated by actor networks like multinational corporations and non-governmental organizations (see also Guzzini 2012: 14) instead of solely by nation states. Inspired by and reflecting globalization processes, such approaches understand “the world political system as also fractured into a series of issue areas where no clear hierarchy can be established. Had the military sector and military resources been the main defining features for the establishment of a world hierarchy and order in the past, so has the appearance of ‘low politics’ (here mainly economics) now done to international politics what the extension of more and more policy fields did to domestic politics” (Guzzini 2012: 14).

Although Nye does not refer to Foucault in any given sense, we can nevertheless relate Foucault's work on governmentality to Nye's understanding of power as exerting influence on others by making them "feel attracted" to specific values, norms or lifestyles and eventually attached to one's own aims and goals in the arena of international politics. Foucault sees governmentality as "the ensemble formed by the institutions, procedures, analyses and reflections, the calculations and tactics that allow the exercise of this very specific albeit complex form of power, which has as its target population, as its principal form of knowledge political economy, and as its essential technical means apparatuses of security [...]" (Foucault, 1991: 102). Following Fournier (2014), biopolitics, as an element of governmentality (cf. Oksala 2013), inhabits "a vision of power as a creative and productive force" that, in the words of Foucault again, "traverses and produces things, induces pleasure, forms knowledge, produces discourse" (Foucault, 1980: 119). This is somewhat similar to Nye's notion of soft power as having a coopting rather than coercing effect, as a kind of governmentality that stresses the pleasing aspects over direct repression or the exertion of prohibitive power.

When we scale governmentality up to the level of international politics, it is primarily "associated with 'liberal' political regimes where the rationalities of rule seek to produce political and economic freedoms" (Fournier 2014). The concept of soft power thus seems to resemble some of the core aspects of governmentality when applied on a global scale. More precisely, we can understand the soft power of science, or science diplomacy, as also being an element of governmentality that becomes significant in international scientific cooperation and is related to and entangled with foreign policy objectives.

However, although profoundly well-equipped to address these issues, work in STS has thus far been less engaged in addressing the critical dimensions surrounding the notion of the "soft power of science." Nor has it properly addressed the ways in which this concept is increasingly employed in current policy-making processes, particularly in the field of international cooperation in science and technology. This is somehow surprising since insights from STS could definitely contribute to a refined understanding of how science and technology are themselves inherently political. For instance, Collins and Evans (2002) saw STS's key contribution as being the establishment of the notion that politics is intrinsic to science, whereas Jasanoff states that "the making of science is political" (Jasanoff 1998: 409) and Latour claims that "science is politics by other means" (1987). Shapin and Shaffer mention three respects in which they understand science to be political: first, that the scientific community is also a political community, second, that science plays a role in

politics *outside the laboratory*, and third, that there is a conditional relationship between the polity of scientists and the wider polity (see Shapin and Shaffer 1985: 332).

Understanding soft power and science diplomacy this way would allow for the further exploration and understanding of the role of scientists within global/local power-assemblages, their possible agencies in supporting or rejecting political objectives and strategies or in setting the agenda for international political negotiations. However, Brown justifiably argues that a view of politics as “everything that affects the common world” does not do much to contribute to an enhanced understanding of what political activities might entail (2014: 23). Here, a closer look at the concept of soft power would allow for a study of how science and scientists are exploited by government actors. This seems particularly important since science diplomacy initiatives are becoming more and more relevant in policy strategies and frameworks. Thus, a more nuanced and critical analysis of their aims, strategies and actors is needed, especially with regard to how they shape and influence identities, representations and power relations in international scientific collaborations.

1.2.6. Scientific-Technological Institutions and Co-operation in Global Politics

The last pattern outlined by Weiss is termed “science and technology as the direct subject of cooperative projects and institutions whose planning, design, implementation and management provide grist to the mill of international relations and diplomacy.” This notion particularly addresses international institutions, which were established either to enable large scientific-technological endeavors, to govern and control technologies (like the International Atomic Energy Agency), to regulate scientific output (like the World Intellectual Property) or to generate new scientific knowledge (for example, to advise on climate policies like the International Panel on Climate Change [IPCC]). Weiss sees the emergence and formation of these new institutions first and foremost as a reaction by policy makers and an attempt to find new ways of dealing with the challenges and risks that have resulted from scientific and technological advances. For him, it is here that the domains of science and technology policy and international politics meet. This is particularly the case when it comes to global cooperation involving conflicting visions of different communities, namely that of a geopolitically-oriented diplomacy that aims to protect national interests versus the international scientific community opting for international cooperation and knowledge exchange (cf. Weiss 2015: 423, Stein 2002).

Although he refers to the European Organization for Nuclear Research (CERN) as a primary example of this pattern, Weiss does not relate the establishment of CERN to the specific global political context of its time. Since this context strongly shaped the way that CERN came into existence, a focus on the co-constitution of (global) politics and the creation of these kinds of scientific-technological infrastructures allows for a more profound understanding of the history of their emergence, and the specific intersections of international politics and transnational cooperative projects. When CERN was built in the post-World War II era, trust between former adversaries needed to be re-established. Here, scientific and technological cooperation offered a venue for this, partly because science was understood to as be a neutral but also because it formed a key element in the context of European competitiveness policy vis-à-vis the US – as it still does, if we consider the current conceptualizations of science employed in science diplomacy activities (see previous section). Physics, a fundamental natural science, was considered to be a particularly apolitical or non-ideological starting point at that time, and nuclear physics, an area where European scientists had already achieved outstanding results, was considered a starting point for this large-scale European scientific-technological cooperation (see Delanghe et al. 2011: 24). However, in order to grasp CERN's importance as a solely civilian infrastructure for nuclear physics, it is important to note that at that time, many European countries had ongoing programs to develop atomic bombs. From an STS perspective, Strasser (2012) provides an interesting account of the co-production of neutral science and the neutral state in Cold War Europe, investigating Switzerland's role during the negotiations that led to the construction and future orientation of CERN. Here, Swiss politicians and researchers alike “pushed hard to depoliticize and demilitarize the CERN project, fearing that CERN might embody the larger member states' military and political interests” (Strasser 2012). Moreover, they opted for scientific knowledge production and sharing, which was considered possible only if the military was explicitly kept out.

With regard to the role of science and technology and (the establishment of new) institutions, both disciplines offer conceptual approaches that would benefit greatly from enhanced mutual engagement. In IR, it is discursive institutionalism in particular that has begun to pose more profound questions about the nature of institutions themselves, including how they are created, negotiated and subject to change. Scholars in this field have also shown an interest in the epistemological aspects of institutions, asking for instance what we can know about institutions and how they are entangled with interests and norms (see Schmidt 2008: 313). In contrast to older versions of institutionalism that gained relevance in the 1980s (see Powell & DiMaggio 1983), discursive institutionalism sees

institutions as simultaneously structures and constructs. Institutional change is here understood as dynamic and introduced by the ideas and discourses – which are seen as neither objective nor material – belonging to relevant actors rather than being path-dependent.

In general, such an approach takes ideas and discourse seriously (cf. Schmidt 2008: 322), thus making it a promising avenue for addressing the mutual and complex shaping of science and technology as institutions in the context of international policy making. However, despite strongly acknowledging the role played by ideas, these approaches do not yet sufficiently take into account the role of technology and materiality in general. Here, institutionalism in IR could benefit from an infusion of STS research on the relationship between technology and institutions, asking for instance if technology itself is an institution (Pinch 2008: 461). Pinch argues that materiality and technology should be given far more attention in the field of institutional analysis in order to understand the social world as “a world built of things” where “social action is through and through mediated by materiality” (Pinch 2008: 479). Although approaches from new institutionalism in both fields (and beyond) share a common awareness of how ideas become material reality, work in IR mainly concentrates on the macro level, whereas STS accounts focus instead on the micro level of knowledge production within these institutions. For instance, Miller (2004) suggests that large political institutions like the UN, the World Health Organization or others are more than mere producers of global environmental knowledge and “constitutional foundations of global governance.” Instead, in his analysis of the International Research Institute for Climate Prediction (IRI), he argues that we should understand such “Specialized Agencies” as newly-emerging networks of public and private, formal and informal institutions of science and technology that classify, standardize and organize knowledge and people globally (Miller 2004: 81).

Investigating how institutions like the IRI represent and are embedded in global-local knowledge power relations, Miller also asks how it might be possible to achieve mutual political accountability between mainly Western-based institutions of global governance and their concerned audiences in the global south. A combination of both perspectives seems necessary to understand the role of institutions in international politics, their evolution, transformation, failure or success as related to discourses, expertise and materiality. Here, in particular Big Science projects (cf. Aronova 2014, Gallison and Hevly 1992, De Solla Price 1982) could serve as a promising common field of investigation for STS and IR. Today, Big Science projects are causing scholars to pose new questions about international cooperation

versus competition as also closely related to global geopolitical power shifts. For example, such questions are raised by the European integration process as well as by the emergence of new S&T powers like China, India and Brazil (cf. Barry 2001, Wilsdon 2011), which is reflected by the structure and agency of the particular institution or infrastructure.

Both IR and STS have a longstanding intellectual history of discussing and conceptualizing infrastructures and infrastructural politics, albeit from different vantage points. Only a few scholars have so far made the effort to trace how current infrastructural projects are entangled with, shape and are shaped by global politics.⁵ Here, perspectives from critical geopolitics could serve a valuable mediating function in understanding the role of infrastructures. Infrastructures are socially constructed and shaped, negotiated by a variety of social actors and their specific materiality, and have agency in state-making processes (cf. Scott 2009). They are simultaneously sites for resistance and objects of resistance that are embedded into concrete current geopolitical tensions (Agnew 2009; Bauder & Di Mauro 2008; Dalby 2008, 1992; Beijer 2006; Campbell 2005; O'Tuathail 1996, O'Tuathail & Dalby 1994).

Thus, an infusion of approaches from critical geopolitics would allow both fields to explore issues of identity, space, representation, security, nature and specific techno-political histories and cultures, all of which come to matter within globalized infrastructural projects. Coming back to the statement at the beginning of this introduction about STS and human drama to give an example of its potential impact, such an interdisciplinary perspective would allow us to address the role that technological infrastructures play in processes of inclusion and exclusion of migrants and refugees, thereby adding valuable insights to current policy discourses and practices.

The aim of this section was to juxtapose approaches from STS and IR towards the various forms of interactions and mutual shaping of science, technology and global politics by highlighting particular issues and relations. In a broad sense, it was shown that work in STS has developed and can draw upon conceptual approaches and *sensibilities* (Law: 2008), allowing us to understand science and technology as not only socially constructed and

⁵ For valuable exceptions see Mayer & Acuto (2014) who understand infrastructures as Large Technical Systems (Hughes 1986) that are embedded in and influence global governance. See also Barry's account of energy infrastructures like gas pipelines, which he sees as being more than physical infrastructures in that they are constituted in and through a vast informational infrastructure as different forms of expertise. Finally, see Gabrielle Hecht's outstanding work on the entanglement of nuclear politics with the apartheid regime in South Africa.

embedded in social structures but to develop a reflexive perspective on what it means to study social order in a proper way (cf. Epstein et al 2016). Contrary to most work in international relations, such a view does not take the existence of social orders subject to political change for granted, but rather considers them to be shaped by a variety of means, with science and technology as key elements (Law, 1992). Tracing the continuous processes of economic, political, discursive, and technical ordering, as Epstein et al (2016) have pointed out, is what inspires and drives research in STS. While this is also the main lens of this thesis, it aims specifically to bring the various discourses and partly-disparate perspectives in STS and IR into a productive conversation.

This is to say that, despite differing understandings, categorizations and priorities, there are vast areas, uncharted areas between the two fields that are worth exploring together. With regard to the challenges of interdisciplinary thinking and collaboration, Jasanoff reminds us that “underlying any definition of inter-disciplinarity is an ideal-typical map of the relationship among pre-existing disciplines”. She uses the metaphor of “disciplinary” islands as “oddly and idiosyncratically bounded formations, haphazardly scattered across a sea of ignorance, with unexplored waters in between” (Jasanoff 2010: 204ff). While there are already some bridges built between the islands of STS and IR, much more construction work is needed to allow for a productive exchange between the islanders and, eventually, to create a shared inhabitable space in between.

1.3. Overall Research Questions

The following research questions and subsequent papers represent more detailed and empirical suggestions on how to build interdisciplinary bridges and engage in a dialogue between STS and IR. While the specific questions that occupy the three papers emerged at different times and in different working contexts, the overall questions raised in this thesis can be seen as the framework that continuously guided my research while I was working on each of the papers. Some questions are more relevant than others for each paper, however, they will all be addressed through the specific questions and the empirical research conducted for the articles. Of course, the papers can only be snapshots that aim at answering, from a specific perspective and through a specific case study, some of the relevant aspects of the overall questions. The questions are as follows:

<p>1. Emerging Actor Constellations at the Nexus of Science, Technology and Global Politics</p>	<p>1.1 How do new actors and actor constellations envision the nexus of science, technology and global politics? How are these new actors themselves envisioned and how do they become entwined with the nexus of science, technology and global politics?</p>
<p>2. Changing Imaginations of Sociotechnical Futures in Global Politics</p>	<p>1.2 How do international relations come to matter in the redistribution of knowledge and power among different actors in the field of science and technology?</p> <p>1.3 How do actors in S&T policy-making see international and bilateral processes entering into and shaping national S&T governance? How do they conceive national S&T policy-making as a response to global politics?</p>
<p>3. Interdisciplinary Engagements between STS and IR</p>	<p>2.1. How are particular socio-technical imaginaries constructed and employed at the national level and how can they also be understood as responding to the international level?</p> <p>2.2. How do relations between states enter and shape national imaginaries? How are socio-technical imaginaries engaged as a way of relating to other countries?</p> <p>2.3. How do internationally constructed “global challenges” come to matter towards and become embedded within specific national socio-technical imaginaries?</p> <p>3.1. How can insights and concepts from STS open up new perspectives into the role of science and technology in the making of global politics? Which aspects of global politics become particularly visible when addressed through an STS perspective?</p> <p>3.2. How can work in STS find ways to engage more explicitly with questions of international relations, e.g. foreign policy or security issues? How can the discipline of STS become more visible as a contributor to discourses on international relations?</p> <p>3.3. Which concepts and approaches from STS and IR seem most suitable to commonly addressing and understanding the co-production of science, technology and global politics? How and in which ways can each discipline contribute to addressing and potentially overcoming blind spots of the respective other?</p>

1.4. Introducing the Articles

The three articles that build this thesis address the co-production of S&T and international affairs through different perspectives and using different empirical case studies. However, they all investigate the various patterns of interactions as outlined above. They do so by addressing S&T as an instrument of foreign policy-making, referring to the internationalization of S&T and the ways that policy makers in this field create narratives of a specific techno-political culture as a way to relate to countries with vastly different technological, social and political histories and presents.

On a theoretical level, the papers all aim to integrate concepts and approaches from STS and IR. The first paper draws on constructivist approaches in both research fields by using socio-technical imaginaries as its conceptual perspective. The second paper refers to the concept of National Innovation Systems, which is then linked to IR's conceptualization of science as a soft power in international relations. The last paper employs a co-productionist perspective towards techno-political change and social order in the field of satellite imagery, which is specified by using the concept of visual securitization from security studies. In what follows, each paper will be introduced in more detail and with regard to its particular contribution to answering the overall set of research questions.

1.4.1. Notions of the National and International

The terms “national,” “international” and “global” are important points of reference in all three papers. However, they open up questions about how to deal with these constructs and how to approach the various processes by which science and technology, here understood as central to questions of global politics, are constantly transcending borders, oscillating between the global and the local, between national institutions and regulations, and between territories and (epistemic) cultures. As Jasanoff and Martello wrote in 2004, “The world today is in the grip of globalization. Networks of economy, technology, politics, and ecology have encircled the Earth, weakening the historical claims of nation-states, sovereignty, and cultural identity” (2004: 1).

So how to analyze processes of S&T policy-making that take place on the national level but at the same time are a response to globalized S&T systems? How to understand the inherently transnational character of science while at the same time accounting for local particularities, be they the specific techno-political histories of nation states or regions or

the ways science and technology are used as an instrument of soft power, thereby becoming embedded into the context of foreign policy and transferred to different cultures and political systems? And how do global politics affect national epistemic cultures of knowledge production, since the institutions of global governance are neither domestic nor international?

One way of approaching these questions has been suggested in the edited volume “Earthly Politics: Local and Global in Environmental Governance” by Jasanoff and Martello in 2004. Focusing on different aspects of environmental politics, the authors argue that in a globalized world where distances between places are decreasing and where problems caused by climate change become everyone’s problem through the interconnectedness of ecologies, economies, knowledge production processes, technology and politics, we need to find ways to bring the “local back in.” One of their main arguments here is that a stronger acknowledgement of situated knowledges (Haraway 1988) in global environmental governance is necessary in order to balance the local and the global within policy frameworks and (expert) institutions of global governance (cf. Jasanoff and Martello 2004). While their contribution helps us to understand the interplay of the local and the global with regard to the diverse agencies, institutions, knowledge practices and decision-making processes that come to matter in the field of global environmental governance, there may also be other ways to approach the multiplication of different levels of analysis caused by processes of globalization. Here, I draw on the work of Saskia Sassen, who suggests the notion of “global assemblages of bits of territory, authority, and rights” as a way to exit the national institutional frame (2008: 61).

The focus on territory, authority, and rights aims to encompass the diversity of institutions, actors and legal frameworks that constitute these assemblages. Sassen outlines four types of assemblages that contribute to changing territorialities. First, there is the changing geography of legal frameworks for rights and guarantees (which could probably be applied to patents and the current TTIP negotiations as well) in the course of globalization processes. While these were originally developed during the formational processes of nation states, they are now increasingly being shaped by international or transnational requirements and agreements – sometimes pushing nation states to go beyond their own financial or political interests (cf. Sassen 2008: 64). However, the subordination of national law to transnational agreements has brought about institutions with as transnational jurisdictions, such as the International Criminal Court and the European Court of Human Rights. Second, there are the ways that nation states construct

and shape standardized global spaces to facilitate economic globalization, e.g. through intellectual property rights and standardized accounting principles (Sassen 2008: 65).

The third assemblage is closely related to the previous one, namely the formation of global financial centers that “are part of global financial markets as constituting a distinct kind of territoriality, simultaneously pulled in by the larger electronic networks and functioning as localized micro-infrastructures for those networks” (Sassen 2008: 65).⁶ Here, we can think of the City of London as a primary case in point, that is, as a global financial center, physically located within the national territory of the United Kingdom but at the same time largely denationalized in its functions, thus resembling a new form of “multi-sited territoriality” (Sassen 2008: 66). The last assemblage is constituted through the configuration of a global civil society. What Sassen sees as the localized involvements of actors is quite similar to the local forms and situatedness of knowledges outlined by Jasanoff and Martello as being central to the formation of a global civil society, regardless of their universal knowledge and/or political claims. What is more, all three authors see that global communication networks have facilitated forms of participation even for people in remote areas, be it by taking part in international negotiations or in constituting different and locally embedded areas of expertise that are (potentially) recognized on a global scale.

Understanding the interconnectedness of fields previously attached to the realm of the nation-state as a global assemblage allows one not only to grasp the multi-sitedness of institutions, actors, knowledges and politics but also to conceptualize them as cutting across a dualistic understanding of the national and the global. Although assemblages are still embedded in national institutions and territories, we can conceive of them as no longer being a part of what was historically constructed as the national. For this thesis, this opens up the opportunity to focus on the level of national policy-making and global politics without stepping into the trap of deciding whether things are national or international, as this is no longer a question of neither-nor.

⁶ See also Knorr-Cetina’s work on transnational epistemic communities and global financial markets (2007).

1.4.2. Ruth Müller & Nina Witjes: Of Red Threads and Green Dragons: Austrian Sociotechnical Imaginaries about STI Cooperation with China

Published in: Mayer, M., Carpes, M., Knoblich, R.:
The Global Politics of Science and Technology: Perspectives, Cases
and Methods (Volume 2). Springer, Berlin/Heidelberg, pp 47–65.

The first paper of this thesis asks how Austrian STI policymakers envision and enact alignment and cooperation with China in the field of Green Technologies. It draws on the concept of “sociotechnical imaginaries” as proposed by Jasanoff and Kim (2009: 120), which attempts to grasp how visions of social order and technological development become entangled in the processes of science and technology policy and international politics. Due to China’s emergence as one of the key global players in STI, the country is being intensely courted by numerous countries seeking international collaboration and market access to this huge economy. The Chinese national Five-Year-Plan, a series of economic and social national initiatives, introduced a focus on environmental sustainability to complement economic growth for the period 2012–2015. This paper shows how Austrian STI stakeholders aim to connect their national positioning activities to this recent focus on sustainability. Austria was chosen as a case study because stakeholders here are attempting to find common ground for relating to China by drawing on a nationally accepted narrative about Austrian techno-political history and culture that casts the country as a pioneer in environmental awareness and green technologies.

The paper endeavors to understand this process as being part of a broader Austrian sociotechnical imaginary in the making that constitutes a situated response to an increasingly globalized STI system, while building on and reaffirming central elements of Austria’s local techno-political culture and history. Our analysis shows that the co-production of science, technology and international politics can be traced in any kind of techno-political constellation if we focus on the discursive identity formations that underlie the specific narratives employed in policy discourses—in this case, enhancing international cooperation.

This paper contributes to the overall research questions by conducting an argumentative discursive analysis (Hajer 2003) to reconstruct the coalitions of actors from academia, business and politics that emerged during the process of constructing a proximity between the very different countries of Austria and China. Furthermore, it points to the role of

science and technology in transformations of global power relations. China is now framed as one of the most important political players because of, but not only because of, the economic, technological and scientific progress it has achieved during the last decade. In analyzing the ways that Austrian stakeholders construct a narrative of longstanding relations and cultural connections with China, our paper also shows how national STI policy making is a dynamic and flexible situated response to power changes in international orders. In drawing on the concept of socio-technical imaginaries, this paper further argues that nation-specific identities – in this case, that of Austria as a sustainable country that “has always been green” – come to matter quite a bit in international politics – the rise of China as a global STI player – and vice versa.

1.4.3. Nina Witjes & Lisa Sigl: The internationalization of Science, Technology & Innovation (STI): An Emerging Policy Field at the Intersection of Foreign Policy and Science Policy?

Published in: Franzmann, A., Jansen, A. & Münte, P (2014):
“Legitimizing Science: National and Global Public, 1800–2010”
Campus: Frankfurt/New York. pp. 245–272.

The second paper focuses on STI internationalization policy-making as an arena in which STI policy and foreign policy have increasingly started to interact over the past decade. It asks if and how STI internationalization has led to a new policy field in the making and how STI stakeholders assess the interrelation between STI policy and international relations. Since 2000, national governments have increasingly invested in new infrastructures for their STI internationalization. More or less strategically, they aim at maximizing participation in EU funding schemes and developing a complementary internationalization framework. A range of European countries are in the process of creating science policy networks somewhat akin to embassy-like institutions that would be responsible for international STI relations, suggesting that STI internationalization policy is much more entangled with issues of foreign policy-making and international relations than is currently appreciated. This paper uses the STI internationalization policies of Germany and the UK as case studies for exploring the different ways that EU member states actively build a global STI internationalization infrastructure. It contributes to the research questions by tracing the actor configurations that emerge in this new policy field and, in building on qualitative interview work, analyzing their contingent approaches towards the role of the nation state as a central category of international policy-making in

the field of science and technology cooperation. The analysis in this paper contributes to the understanding of how science, technology and the respective policies are also co-productive of nation states' foreign policy-making.

One of the key arguments of the second paper is that one can trace the co-production of science, technology and international politics within STI internationalization strategies and initiatives: STI is seen as providing solutions for tackling global challenges. For this reason, cooperation in STI and coordination among the different ministries is being framed as a necessity for acting responsibly in a global environment. The paper attempts to understand the efforts of policy actors from both fields concerned as responding to international changes and transformations.

How they relate to countries that they seek enhanced collaboration with is also always a response to the dynamic landscape of scientific and technological innovation. Comparing the cases of Great Britain and Germany in the context of the different histories of their national innovation systems and international relations will also make it possible to address issues such as how national identity formations shape these specific responses.

1.4.4. Nina Witjes & Philipp Olbrich: A Fragile Transparency: Satellite Imagery Analysis, Non-State Actors and the Making of International Security Issues

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Author's Original Version

The last paper of the thesis will focus on the production and use of satellite imagery by non-state actors in the context of international security policy-making. It asks whether the narrative that technological advancement combined with decreasing governmental influence has led to more transparency and access to information for non-state actors actually holds true in the case of satellite imagery and its analysis. The commercialization of satellite imagery during the last decade has opened up spaces for new actors to play an influential role in international security policy. Previously a state domain, a broad range of non-state actors has become interested in the new possibilities of monitoring and observing hitherto undisclosed physical areas. Together with commercial imagery providers, they are contributing to an enthusiastic discourse on the manifold opportunities that satellite imagery ostensibly provides to achieve "global transparency." Linking insights

from STS with the concept of visual securitization from Security Studies, this paper tries to understand these processes as co-producing a fragile transparency. It contributes to the overall questions of the thesis by identifying the major current actor-constellations and socio-technical arrangements in the field of satellite imagery and the power shifts that are taking place between state and non-state actors.

Going further, it challenges the division of roles that are commonly attributed to state and non-state actors in generating, validating and circulating security knowledge. It thus makes the processes of co-producing a fragile transparency visible. With regard to the second research question, this paper investigates how the lifting of national restrictions on the availability of satellite images has been and is a response to increasing international competition in the satellite technology sector.

Our analysis also examines the resulting increase in relevance of satellite surveillance of areas such as North Korea or the South China Sea, which is understood as a reaction by non-state actors to regimes of secrecy and classification that surrounded satellite imagery for a long time. Since satellite technologies are intimately linked to notions of national independence and prestige, this paper investigates another site where identity formations and science and technology are shaping and co-constituting each other.

1.4.5. Research Materials and Methods

For all papers, the core of the empirical material consists of expert interviews that have been supplemented by extensive literature and document analysis. All interviews were conducted within research projects at the Austrian Institute for International Affairs that were funded by the institute's core funding. Informed consent was obtained before each interview. The fieldwork for the last paper on satellite imagery was challenging because some of the interviewees did not want their institution mentioned and did not allow the conversation to be recorded. Here, access to interview partners was more difficult than with the other papers, sometimes literally, on a physical level, since security checks had to be passed more than once since some interview partners were working with intelligence agencies or on issues that involved classified information. Therefore, these interviews are not directly quoted since this was a precondition for being able to conduct the interviews. How to deal with the conflicting paradigms of doing science – with the aim of making things publicly known – and the intelligence field – with the aim of keeping things secret –

is a challenge that cannot be dealt with within the scope of this thesis, but I plan to address the topic in my future research.

For the papers presented here, different analytical methods have been applied to analyze the empirical material based on which method best fits the research question. Paper 1 builds on thirteen semi-structured interviews with Austrian STI-stakeholders who had experience with China and were or are in charge of STI internationalization at their respective institutions in the fields of research, business and diplomacy. The interviews were conducted between 2012 and 2013 by the then-project team at the Austrian Institute for International Affairs. The interviews were supplemented with an extensive analysis of media articles in Austrian newspapers (published from 2006-2013), policy documents and material on collaboration with China from the Austrian green technologies export sector. The paper investigates with China. To trace how a national socio-technical imaginary (Jasanoff & Kim 2009) has been formed by multiple Austrian actors involved in STI cooperation a constructivist argumentative discourse analysis, as suggested by Hajer (1995), was chosen as the analytical approach. This approach allows for an understanding of the specific conditions under which a particular narrative becomes the dominant discourse. In particular, his concept of “storylines” as simplified articulations of the discourse’s key elements (Hajer 1995: 47) has proven helpful for understanding why one particular socio-technical imaginary has emerged and not another. This seemed particularly fruitful since it helps to reduce the inherent methodological vagueness of the socio-technical imaginaries concept.

The second paper involved eight semi-structured interviews with staff from science policy and research funding organizations in Germany and the UK as well as Skype interviews with staff in their respective offices abroad, specifically in Russia, Brazil and India, which were conducted by the project team in 2014. Five expert interviews were also conducted with academics in both case study countries, which provided a scholarly perspective on both countries’ internationalization policies. As in the first paper, interviews were supplemented by an extensive document analysis with a particular focus on government strategies published by the different ministries concerned with STI internationalization.

On a conceptual level we were confronted with two main challenges: the respective national techno-political histories, cultures and institutions in both countries are quite diverse, which calls for a context-sensitive analytical framework. Also, the term ‘policy field’ lacks a clear definition (Dunn 2004; Dye 2004). Originally developed in the context

of assessing climate change as an emerging policy field, Massey and Huitema offer a three-pillar model that attempts to grasp the central characteristics that make a policy field, namely substantive authority, institutional order and substantive expertise (Massey and Huitema 2012: 343). A policy field, they suggest, is thus “a unit of governing within the socio-political system of a country where there exist three pillars working in tandem to support each other in the management of a public issues or set of issues” (2012: 343). These pillar models provided the framework within which the empirical material was then analyzed for each country, allowing for a comparative approach that also takes into account the institutional and political diversity of the cases.

For the last paper, eight semi-structured expert interviews were conducted between 2014 and 2015, in person and via Skype, with active satellite imagery analysts from non-governmental institutions in the US. Further interviews were conducted with staff from intelligence agencies (three interviews) and international organizations (one interview) that use satellite imagery, as well as with staff from a commercial satellite imagery provider (one interview). Due to the confidentiality of the information, only the interviews with non-state analysts will be directly quoted. The interview data has been complemented by a document analysis of official policy documents, international legal code and secondary literature on commercial satellite technologies. Methodologically, we have chosen an open coding process as this seemed to account for the diversity of the interviewees with satellite imagery analysts, policy makers and staff from the intelligence and business sectors.

Here, sensitizing concepts guided both the fieldwork and the analysis of the interview (cf. Blumer 1954, Chamaz 2006). Initially, these were *transparency* and *secrecy*, and *state actors* and *non-state actors*, but during the course of the research project, *networks* and *collaboration* became central terms. All the interviews were transcribed and analyzed using the qualitative data analysis software, ATLAS.ti. A coding scheme (Miles and Huberman 1994) was created by the project team in order to identify the exchanges and interactions between the different groups of actors involved, their respective notion of transparency, embedded knowledge practices, their role within the network of satellite imagery analysis, as well as the ways that they refer to other actors.

Now the stage is set for the three papers, which investigate the co-production of science, technology and international politics from three different, but interrelated angles. Following the three papers, a conclusion will integrate their findings and discuss three moments of transformation that became visible during my work.

2. THE ARTICLES

2.1. Article 1

Ruth Müller & Nina Witjes: "Of Red Threads and Green Dragons: Austrian Sociotechnical Imaginaries about STI cooperation with China"

Published in: Mayer, M., Carpes, M., Knoblich, R.: *The Global Politics of Science and Technology: Perspectives, Cases and Methods* (Volume 2). Springer, Berlin/Heidelberg. pp 47–65.

ABSTRACT

In this chapter, we address intersections of Science and Technology Studies (STS) and International Relations Theories (IR) by looking at how Austrian science, technology & innovation (STI) policy makers and related stakeholders envision and enact a close relationship between China and Austria in the field of green technologies. Analytically, we draw on the concept of ‘sociotechnical imaginaries’ as proposed by Jasanoff and Kim, which attempts to grasp how visions of social order and technological development become entangled in the processes of science and technology policy and politics. China is currently arising as one of the key global players in STI. It is intensely courted by numerous countries seeking collaboration and market access. China’s most recent Five-Year-Plan has introduced a focus on environmental sustainability to complement economic growth. Based on interviews, participant observation and document analysis, we show how Austrian STI actors connect their national positioning activities to this recent focus on sustainability. We trace how they attempt to find common ground for relating to the rising and ever so dynamic People’s Republic by drawing on a nationally accepted narrative about Austrian technopolitical history and culture that casts the country as pioneer of environmental awareness and green technologies. We understand and analyze this process as part of a broader Austrian sociotechnical imaginary in the making that constitutes a situated response to an increasingly globalized STI system, while building on and reaffirming central elements of Austria’s local technopolitical culture and history.

Keywords: Socio-technical imaginaries, techno-political culture, Austria, China, Green technologies

1. INTRODUCTION

To commemorate the 40th anniversary of diplomatic relations with China in 2011, the Austrian Economic Chambers commissioned a short film entitled “The red thread”⁷. Drawing on a Chinese mythological saying that explains that everything and everyone in life that belong together are bound together by an invisible but powerful and unwithering red thread, the film attempts to invoke a longstanding and somehow ‘destined’ connection between Austria and the People’s Republic of China. The film centers on the unfolding love story of two young middle-class Chinese people, who are in their lives not only connected by the magical red thread but also surrounded by Austrian products, culture and opportunities. Austria, it seems, is not a small, far away country, but already and almost indispensably part of growing Chinese middle class wealth and China’s future economic and social development.

As we watch Xue and Jianguo slowly fall in love with each other, the suggested omnipresence of Austrian goods in Chinese daily life is pointed out through pop-ups of Chinese characters, giving information about the products that are visible in the scene or the Austrian invention that gave rise to them – sun-roofs, fire trucks or the fact that the AB0 blood group system was developed by Austrian scientist Karl Landsteiner. Just as Xue warms up to Jianguo, the young lovebirds are separated for a year, when Jianguo is awarded a fellowship to study at a technical University in Austria. Luckily, they meet again, when both receive awards at the Austrian Embassy in Beijing, Xue for her performance of a Mozart sonata and Jianguo for his achievement as an exchange student in Austria. When receiving his award, Jianguo tells us that being back in China now, his mission is “*to help my country with clean, renewable and efficient solar energy*”, which he aims ‘*to bring [...] to China*’ by working for an Austrian company. The film ends, when Jianguo proposes to Xue on a ski slope, after he has tested that she is adventurous enough to try this new sport and hence, in his eyes, adventurous enough to take on this new changing world and its global connections, challenges and transformations with him.

Why are we telling this story? We are leading our paper about the ways in which science, technology & innovation (STI) collaboration with China is currently imagined among key Austrian STI stakeholders with this brief recount of ‘The Red Thread’, because this

⁷ Muh, V. (Dir.), (2011). The Red Thread. 30 min. short film, commissioned by the Austrian government to commemorate the 40th anniversary of diplomatic relations with China.

promotional film already includes many of the elements that are significant for the ongoing efforts to expand into and work with China in this sector. It entails the invocation of a long-standing history and exchange; it shifts the attention from a focus primarily on Austria's culture and history towards its technoscientific present and future; and within this area, it particularly emphasizes Austria's knowledge and innovation capacities in the field of 'green' technologies; technologies that enable sustainable societal development – something that, as the movie suggests, China needs and wants. What we are interested in this paper is how this narrative is constructed.

What are the strings that Austrian STI stakeholders use to spin this 'red thread'? Which images of China and of Austria are created, contested and engaged within this process? Which aspects of Austria's techno-political history and culture are mobilized to craft this connecting yarn?

The paper takes the example of 'green technologies / sustainable development' (a key aspect of China's current Five-Year-Plan) as a case for how Austrian policy makers envision and enact alignment between the two otherwise very different nation states of China and Austria. It analyses this process as part of a specific Austrian sociotechnical imaginary (Jasanoff and Kim 2009) in the making. An imaginary that constitutes a situated response to an increasingly globalized STI system as it builds on, expands and reaffirms central elements of Austria's techno-political culture and history (Felt et al 2010; Felt and Müller 2011). This culture is characterized by attempts to "*keep technologies out*" (Felt 2013) that are perceived to be 'unnatural', such as nuclear power or agricultural biotechnologies. It is grounded on past and present discursive practices that have, over nearly four decades, since the initial rejection of nuclear power plants on Austrian territory, added to creating an understanding of Austria as a nation committed to preserving 'nature' as well as acting as a pioneer in biocompatible technologies, e.g. in the area of 'green energy'. It is based on this assumed role as a 'bio-pioneer' that Austrian STI stakeholders find common ground for 'approaching China together'.

2. THEORETICAL PERSPECTIVES

2.1. Bringing IR and STS together

This paper builds on theoretical perspectives from both International Relations Theories (IR), and Science & Technology Studies (STS). In IR it is particularly constructivist approaches (Wendt 1992; Debrix 2003; Ulbert 2006) that allow for integration with key assumptions of most contemporary STS scholarship, which we subsume on the heading of material-discursive (Barad 2007) or, more simply, 'co-productionist' (Jasanoff 2004) approaches. Social constructivist approaches in IR can be understood as a "critical reflection on the limits of neo-utilitarianism" (Ruggie 1998: 856), which dominates the mainstream of IR in the form of neo-realism (e.g. Waltz 1979; Keohane 1986).

As Herrera (2003) points out, the relations between neo-realism and constructivism in IR are somewhat similar to what the relations between technological determinism and social constructivism have been in the shaping of the field of STS. While neo-realism understands states as pre-existing entities, whose identities and interests are exogenous and given or can at least be clearly derived from the assumed conditions of anarchy between them, technological determinism (e.g. Heilbrunner 1967) assumed technology as 'outside' the social, but acting upon it in certain given ways. In both fields the 1980s brought a critique of these approaches, arguing that both states (Onuf 1989) and technology (Pinch and Bijker 1984) are constructed in social processes and are constantly subject to social interpretation. In both fields, constructivism proposed a shift towards the social becoming of structures, entities and artifacts formerly assumed as pre-existent. In Foucauldian terms, they proposed a shift towards the study of the multiple discursive practices through which states and technologies come into being and remain in existence.

In STS this proposition was soon met with a call for symmetry: yes, technology is constructed and related to in social processes, but its own agency cannot be neglected either. The material world, and with it technology, is not just constructed and acted upon, but it is itself an important actor co-constituting the social. Today, a number of articulations of this basic stance exist in STS: Actor-network-theory (Latour 1987 & 2005; Law 1992) the material-semiotic/material-discursive approaches of feminist

science studies (Haraway 1988, Barad 2007) and the co-productionist framework (Jasanoff 2004). Similarly, in the field of IR, today many “constructivists hold the view that the building blocks of international reality are ideational [i.e. discursive] *and* material”⁸ (Ruggie 1998: 879). When it comes to understanding the role of science and technology in international relations, there is hence potential for fruitful synergies between those two approaches in IR and STS.

Today, technology is at the same time a condition, a means and a topic of international relations (Herrera 2003). For the analysis of these complex relationships, we believe one more perspective shared between constructivism in IR and STS to be of great importance. That is a commitment to specificity and context. Analysis in these frameworks understand that no argument can be made about the role of technology *in general*, but only about a *specific* technology in a *specific* social and historical context (Hecht 2001). Today, these contexts are increasingly shaped by both local and global elements, even if the context studied is referred to as ‘national’ (Martello and Jasanoff 2004).

With regard to the national, constructivist approaches in IR shift the attention away from a focus primarily on states and their governments towards analyzing the agencies of multiple government and non-government actors that are contributing to the formation of what is then called “the state” and its “international relations”. These actors might or might not be located within the limits of the particular nation state under analysis. An analysis of international relations then hence always becomes an analysis of processes on the multiple local and global levels (Rosenau and Czempiel 1992; Messner and Nuscheler 2003; Dingwert and Pattberg 2006). Thus, although we draw on the specific socio-technical histories of *Austria* as well as the perception of China by *Austrian* actors in the field of science, technology and innovation policy, our analysis necessarily oscillates between the national (local) and the transnational (global) level – or between what Martello and Jasanoff term simultaneous processes of *localization* and *globalization* (2004). In our cases, this means that while processes of Austrian STI strategy coordination are governed by national institutions and echo the interests of specific national government and non-government actors, they are at the same time responding to and integrating a variety of transnational initiatives and discourses.

⁸ Emphasis by the authors

2.2 Socio-Technical Imaginaries

Given this multitude of actors, how then do seemingly ‘national’ positions in STI politics and policy emerge? Positions, which might be contested, but are nevertheless shared and supported by enough heterogeneous actors to allow for action? To address these questions, we turn to a conceptual approach outlined by Jasanoff and Kim (2009). Drawing on their comparative work on the roles of nuclear technologies in different national contexts, they propose the framework of ‘socio-technical imaginaries’ as a tentative answer to the above posed questions. Jasanoff and Kim define national sociotechnical imaginaries as ‘collectively imagined forms of social life and social order reflected in the design and fulfillment of nation-specific scientific and/or technological projects.’ Imaginaries, in this sense, at once describe attainable futures and prescribe futures that states believe ought to be attained. (2009: 120).

Their notion of state is – as in constructivist IR – one that assumes that it is being co-constituted by a multitude of actors. To understand the relationships between a specific kind of technology and a specific national context, they propose to attend to the multiple negotiation processes between these actors, to distinct national socio-technical histories and discourses as well as to global dependences and interdependencies. Importantly, the concept of socio-technical imaginaries attempts to grasp how visions of *social* and *technological* progress and order become entangled within the processes of science and technology politics and policy. In their empirical work, Jasanoff and Kim trace how specific imaginaries about the relationship between the social and the technological and their futures become dominant in a specific national context. They show how narratives about the types of knowledge and technologies that should be embraced or rejected and how they should be employed, promoted and regulated are always also narratives about specific social forms and not others, about specific versions of societal organization, governance and well-being. Sociotechnical imaginaries are value-laden constructs that envision possible societal and technological futures, attempt to order their contested presents and in the process both draw on and recreate a nation’s socio-technical past.

As STI systems become increasingly global, national sociotechnical imaginaries include increasingly complex narratives about other countries as well, about their techno-political pasts, presents and futures; narratives, which can be contested and ambivalent but nevertheless meaningful within national attempts to achieve shared positioning towards other actors in order to be able to move forward. In this sense, national sociotechnical

imaginaries have to be understood as participating both in processes of globalization and localization, as they are forms of discursively relating the local and the global. In the case of China, Pan (2004) argues that the idea of China as a threat to Western countries' political and economic dominance and welfare is a particularly powerful framework shaping national positioning work towards the People's Republic.

While we find that the narrative of the 'China-threat' is clearly also the background against which our story about China, Austria and green technologies develops, in this context it appears to somewhat break down and translate into a narrative about China as an 'unavoidable opportunity' (Bruijn et al 2012: 16).

While the notion of China being 'unavoidable' still contains elements of threat and suggests that not engaging with China would come at (potentially high) costs for the reluctant nation state, at the same time focus shifts to questions of opportunity and hence of how to relate beneficially. It is in this context and as a response to it that Austrian stakeholders develop the narrative of the metaphorical 'red thread' instead of 'threat' to invoke a grown, benign, progress-oriented, mutually beneficial and almost self-evident connection between Austria and China.

2.3. Technopolitical Histories and 'Culturally Appropriate' Technologies

To understand the knitting of this thread in the specific Austrian context, we turn to the few available studies of Austrian technopolitical culture. In line with Jasanoff's and Kim's approach, Felt and co-authors draw our attention to the importance of detailed analysis of the distinct *technopolitical history and culture* of a country for understanding contemporary positioning work towards new technologies and within global STI systems (Felt 2013; Felt and Müller 2011; Felt et al 2010). Their work offers a historically grounded analysis of how 'Austrian' positions towards novel technologies, such as nanotechnology, build on prior negotiation processes regarding nuclear power and agricultural biotechnologies. In her most recent work, Felt (2013) particularly shows how discussions about new technologies in Austria, e.g. in focus groups with lay people, draw strongly on a version of Austrian technopolitical history to which attempting and achieving to '*keep [certain] technologies out*' is elementary:

In all [focus] groups, [...] the strong opposition to nuclear power plants on Austrian territory since the 1970ies (e.g. Nowotny 1979; Torgersen 2002) as well as the rejection of genetically modified food/crops about two decades later (e.g. Seifert 2003) served as a shared frame of reference. A tacit agreement seemed to exist about their importance for Austrian (technopolitical) culture. [...] Keeping these specific technologies out created the imagination of a well delimited Austria, in its sociotechnical practices different from ‘the others.’ [...] with it emerged a particular kind of “imagined community”: of Austrians as being “naturally” opposed to nuclear energy, as refusing certain interventions into nature and food, short as being close to specific values. (Felt 2013: 4; 16).

Connecting this specific Austrian “*repertoire of sociotechnical resistance*” (2013: 6) to Benedict Anderson’s (1984) work about *imagined communities* as being foundational to the formation and cohesion of nation states, Felt shows how the rejection of certain technologies gets “*woven into partly mythical narratives that participate in the formation of a specific kind of national technopolitical identity*” (2013: 3). This identity however is only partly defined by the absence of certain technologies; rather the emergent narrative space becomes filled with counter-images, which, as Felt indicates, constitute an “*alternative innovation space with at the core a clean energy production through hydroelectric and solar power as well as an organic food culture caring for its environment.*” (2013: 17) These ‘green’ technologies can be understood as “*culturally appropriate technologies*” (Martello and Jasanoff 2004, 8) in a country that likes to think of itself as a pioneer in and ambassador of environment-friendly technologies and lifestyles; an “*organic food nation*” (Felt 2013: 4), in which the only nuclear power plant that was ever built never went online due to a public vote, its ruins serving today as a symbol of citizens’ power to reject.

In Austria, ‘green technologies’ hence offer the opportunity to promote mid- and high-tech Research and Development (R&D), while at the same time keeping the likelihood of public dissent and controversy very low. In their study of ‘sustainable energy regions’ in Austria, Späth and Rohrracher (2010) show how initiatives to create such regions met with surprisingly little resistance both within local communities (including local entrepreneurs) and on different levels of government.⁹ Combined with the simultaneous basic and applied character of this research field, ‘green technologies’ thus present an attractive case for policy

⁹ However, they also show how this striking level of consent is based on avoiding too controversial topics in the first place, e.g. the sensitive topic of switching from cars to public transport in rural regions. Felt et al 2010 also indicate that Austria technopolitical culture show strong conflict-adverse elements.

makers and others, who are interested in getting many actors aboard their enterprise of promoting Austria as a country of science, technology and innovation. For this endeavor it is not necessary that Austria 'is' a pioneer in green technologies or a particularly environment-friendly country; indeed Austria has been repeatedly criticized by environmental activist groups, such as Green Peace, for upholding the "*myth*" of being environment friendly, but at the same time not even coming close to meeting the Kyoto Protocol climate protection goals (Greenpeace: 2011).¹⁰ While such criticism can gradually crumble a sociotechnical imaginary¹¹, in the Austrian case, to date, the myth manages to outshine parts of the reality. It is based on this well rooted conviction that Austrian STI stakeholders are constructing an imaginary on how to relate to China at this moment of change and uncertainty.

3. MATERIAL AND METHODS

3.1. Project Background

While Felt and co-authors built their work on Austrian sociotechnical imaginaries mainly on focus group and interview work with lay citizens, this paper offers insights into ongoing discussion processes from a different end of the spectrum of involved actors. The analysis in this paper draws on interview work, participant observation and document analysis in two projects of the Austrian Institute for International Affairs (oiip), funded by and performed in cooperation with the Federal Ministries for Transport, Innovation and Technology (bmwif) and for Science and Research (bmfw)¹². In both projects, the project team accompanied and analyzed multi-stakeholder-processes of discussions and coordination pertaining to Austrian STI-internationalization beyond the EU and its associated states. While one of the projects is focused on STI-internationalization more generally, the second project was specifically focused on the possibilities and challenges of STI-cooperation with China.

¹⁰ www.greenpeace.at/uploads/media/Facts_Klimaschlusslicht_Oesterreich.pdf

¹¹ See e.g. changes in the US imaginary regarding nuclear technologies (Jasanoff and Kim 2009)

¹² Project 1) Wissenschafts- und Technologiekoooperationen mit China: Hoffnungen, Möglichkeiten und Herausforderungen. Project team: Heidenwolf, C. / Müller, R./ Rampke, B. / Sigl, L. Project duration: 01.2012–03.2013. Project 2) Analytische Unterstützung der FTI-Arbeitsgruppe 7a Internationalisierung. Project team: Müller, R. / Heidenwolf, C. / Sigl, L. Project duration: 03.2012–06.2013.

3.2 Material

As part of the analytical input for stakeholders within the Federal Ministry for Transport, Innovation and Technology concerned with strategy development regarding China, the project team conducted a series of interviews with a broad range of individuals with different types of expertise pertaining to China. The team conducted 13 semi-structured interviews with experts from the fields of basic research, applied research, economy/business and diplomacy. All participants either have experiences of working with/in China in the field of STI and/or are in charge of the broader internationalization activities of their institution, for which China is a reoccurring topic. Further, the project team was present at, contributed to and documented a number of stakeholder and working group meetings, some of which engaged with STI-internationalization activities in general, while others focused on STI-cooperation with China in particular. In addition, the project team conducted a document analysis of a range of written texts. These included 1) media articles concerning the relationship between Austria and China in the field of technological co-operation and sustainability in three different Austrian newspapers¹³ from January 2006 to March 2013; 2) policy documents and public accessible official statements by Austrian ministers and other relevant actors on the topic and 3) announcements, promotional material, and reports from Austrian export-oriented business actors.

3.3. Method of Analysis

While Jasanoff and Kim propose an intriguing conceptual framework, their work offers less insights into how to engage with sociotechnical imaginaries methodologically. Here, we turn to Hajer's approach to argumentative discourse analysis and particularly to his work on discourse coalitions and the institutionalization of discourse. In line with constructivist approaches he proposes to analyze discourses at a concrete-political level (Ulbert and Weller 2005) and aim at understanding, how and under which conditions a specific discourse becomes dominant within a national setting. In a Foucauldian tradition, Hajer understands discourses as "ensemble[s] of ideas, concepts and categories produced, re-produced and transformed within a specific set of social practices and thereby giving meaning to the physical and social reality." (Hajer 2003: 279). Discourse coalitions are groups of actors that participate in the formation and propagation of a specific discourse.

¹³ Analyzed newspapers (online versions) were "Der Standard", "Die Presse" and "Profil"

As they might be quite diverse, ‘storylines’, simplified and condensed articulations of the key elements of the discourse, serve as media to organize the actors themselves and to further ‘impose their view of reality on others’ (Hajer 1993: 47) until it seems like the only possible and appropriate perspective on the topic.

Hajer’s methodological approach is helpful for analyzing complex processes of knowledge negotiation between multiple actors, in our case in order to understand the formation of national sociotechnical imaginaries. Multiple stakeholders within ministries, academia, business and diplomacy take part in the processes of negotiating a common position towards China, contributing different sets of knowledge and at times diverging agendas from their specific areas of expertise and activity. In order to create mutual understanding and political relevance, knowledge from these specialized discourses has to be transferred to the level of broader social understanding (Hajer 1995: 61f.). As in other cases (Hecht 2001, Jasanoff and Kim 2004), this is achieved by drawing on familiar elements of Austria’s national identity and socio-technical history.

3.4. Confidentiality and consequent limitations

Austria is a small country. The number of individuals with STI expertise regarding China is hence obviously limited. Thus, while this article builds equally on the analysis of expert interviews, field notes from participant observation, policy documents and media articles, we decided to only quote directly from the latter two kinds of official documents to ensure the anonymity of our interview partners. These quotes however are indicative of broader discursive storylines pervading the entirety of the collected material.

4. THE DISCURSIVE KNITTING OF THE RED THREAD

4.1. The Red Dragon Rises

In this next chapter we will trace how Austrian STI actors discursively enact green technologies as an obvious and timely connection between Austria and China. While a number of countries, such as India and Brazil are currently emerging as increasingly influential players in the global STI system, no other country has undergone remotely as radical a transformation in the field of Science, Technology and Innovation as China. Having been considered mainly a center for the industrial production of low-level technological goods for a long time, China is swiftly and constantly developing its STI

sector. Being known for copying innovation in this process, it increasingly shifts to original homegrown research and creation. China is now claiming a place amongst the leading nations in a growing number of scientific and technological fields. As a consequence, the interest in cooperating with China has increased significantly throughout the world, and with it did attempts to establish new relationships and intensify existing ones.

This is the case in Austria, too, where the interest in economic and technological cooperation with China has grown rapidly over the last years. As in most countries, this rising attention is motivated partially by the objective of establishing stronger ties to the growing Chinese academic excellence, but more significantly by China's potential as a rapidly growing market for export and local adaptation of mid- to high-tech products. With its steadily expanding infrastructure projects and the rising consumption of its burgeoning middle class, China currently depends significantly on imports from other countries to keep up with the pace of its own development and its people's desires. Yet, Chinese policy makers emphasize that while they seek out collaboration and are interested in importing technologies, China is also striving for advancing its economic and technological independence (Schwaag Serger and Breidne 2007).

In this short intro, we already see a number of temporalities at play that are pervading and structuring the narratives about and images of China that emerge in the discussion about STI cooperation with China among Austrian stakeholders. China is sketched as a formerly backwards country, a country that has damaged its scientific institutions and STI labor force severely during the Cultural Revolution (see also Benner et al 2012: 3ff) and has for the last decades at best been the 'work bench' of the world, but clearly not a center of technoscientific development and excellence. It further discursively emerges as a country that at some point has realized its 'mistakes' and set foot on a path of emulating the STI development of today's post-industrial countries.¹⁴ Yet, once on this path China started to travel it without necessarily attending to all the rules its predecessors had set out and allegedly obliged to (e.g. regarding intellectual property rights). Devoting significant resources to this endeavor, China is now perceived to be a country on the fast track to innovation leadership that threatens to outpace its prior role models. Its centralistic, non-democratic structure and non-compliance to international rules is perceived to enable both the speed and the determination of this development. Where this development will exactly

¹⁴ See Grundwalt (2009) for a discussion of the history of the Chinese STI system.

lead in the longer run, appears as unclear to most Austrian STI actors. With its growing STI sector, its huge domestic market and strategically ensured access to the natural resources of many developing countries of the world, it becomes less and less clear to which degree and for how long China will remain dependent on what is referred to as the Western world.¹⁵

Austrian stakeholders' imaginaries about China reflect and remake the speedy temporalities of China's recent past, bustling present and probably effusive future. Take this quote by an Austrian Professor of Agricultural Sciences, who is remembering his earlier and present academic collaboration with China:

There have been times when people were working in laboratories and offices without windows, wearing seven underpants and scarfs in the wintertime. Nowadays they have the most modern PC and better equipment than we have at [our] Institute [...].

This quote is illustrative of images of China's past – China as technological backwards country – and of its current and future direction – China as an ever more dominant technological (and political) power – that are shared in virtually all stakeholder statements¹⁶. They are almost always connected not only to a narrative of China catching up, but pushing ahead of what is perceived as its former role models. However, while in this narrative the past and the future appear rather settled, the question becomes *how to relate to China in the present*; in a present that seems utterly dynamic and multiple; in which the 'old' China still exists in so many parts and aspects of the country, while the 'new' China is arriving at what seems to be warp speed; and in which technological progress does not necessarily entail assimilation to 'Western' culture¹⁷ and hence reduction of difference, complexity and necessity for more than lingual translation.

¹⁵ See Woods (2008) for a discussion about China as an emerging donor in development assistance.

¹⁶ In interviews as well as in media articles.

¹⁷ We are highly aware of the complexity and difficulty of the term "Western culture" (as of "West" and "culture" in general). We use it here, provocatively, to indicate the implicit assumption of many stakeholders that there is but one trajectory of (technological and social) progress, which will lead to China becoming more like 'the West' in its values, economic and political model, forms of communication and social etiquette as well as cultural and lifestyle practices. We understand 'the West' not as geographical location, but as a symbolically and politically meaningful construct in the historically grounded and ongoing negotiations of power and dominance – more simply put negotiations about "who lives, who dies, and at what price", political questions that are always also "inside of technology" (Haraway as quoted in Kunzru 1996).

In the discussion among STI stakeholders, a key question thus becomes whether or not a country like Austria *can* profit from China's rise or will inevitably be part of the countries that are being ousted by its growing power. This question is the background, the foundational uncertainty against which the discursive positioning work of Austrian STI actors needs to be understood. The current situation is imagined as one in which China is highly courted and basically picks whom they want to collaborate with or give access to their markets. Why then should China pick Austria?

4.2. The Dragon Goes Green

The discursive response to this question hinges on interpretations of political, social and economic developments in China that culminated in the release of released China's 12th Five-Year-Plan (2011–2015). Since 1953, the Five-Year-Plan (FYP) has been China's most important instrument for domestic planning, as it is defining and explicating the country's main aims for social and economic development within the next five-year period. The 12th FYP defines social security as well as the ecological and sustainable development of the national economy as its key goals. In contrast to former plans it shows moderate growth targets, which are 4.5% below the average growth of the last years. The plan emphasizes the importance of reducing both China's excessive export dependence by strengthening the national potential for genuine innovation and its dependence on external resources (e.g. fossil fuels) by developing a „low-carbon economy.“ The acquisition, creation and use of 'green' and 'low-carbon emission' technologies are core aims of the plan. The 12th FYP thus indicates a significant shift in China's official narrative of what constitutes 'development', moving towards a definition that does not only include the accumulation of economic wealth, but also environmental sustainability. Clean water, fresh air, non-toxic soil and seemingly undisturbed landscapes become symbols of progress rather than relicts of a rural past and so do the technologies that promise to enable creating and sustaining such kinds of environments.

Austrian actors relate to these developments by indicating that China is now moving onto a path Austria has already been travelling for a long time – longer than most other countries. Its nature – air, water, landscapes – becomes proof and symbol of this history and ongoing practice as well as the resulting expertise. Austria's nature is, so they argue, *enabled by a certain relationship with and to technology*. Sophisticated waste disposal

systems, energy from waterpower, well-developed systems of public transport, energy-efficient constructions of buildings, all are cast as contributing to the creation and maintenance of this kind of nature. The quote below by the Austrian Federal Minister of Economy, Family and Youth about the Austrian pavilion at the World Expo in Shanghai in 2010 illustrates this argument. We do not only present Austrian history and culture at the Expo, but also our clean environment and the high quality of life. Together with the numerous personal contacts we make, we are creating an important platform for closer cooperation in the field of eco-innovations.¹⁸

In this discursive element, nature and technology are not offered as opposites: rather, the narrative suggests that in the 3rd millennium, nature increasingly depends on the *right* technologies, sustainable and green. Technologies, which as the narrative further elaborates have a long tradition in Austria, as they have a ‘natural’ fit with Austrian mentality and its people’s relation to nature. The quote below by the Austrian Minister of Science and Research is indicative for this unfolding storyline.

The ecological consciousness is, compared to other countries, particularly pronounced in Austria. To take full advantage of this is not only a touristic, but an ecological and scientific chance.¹⁹ Thus, though there has been cooperation in the field of STI between Austria and China since 1984,²⁰ the FYP 2011–2015 offers particularly suitable attachment sites for Austrian narratives about scientific and technological pasts and futures and for many of its key STI actors. In a situation of rapid change and multiple ambivalences, in which it is hard to know how to relate in the present, drawing on a culturally established narrative of Austria as a ‘green’ country allows imagining a vantage point from which to relate to China. Summing up a broadly shared consensus and impetus among Austrian STI actors concerned with China, the Austrian Federal Minister of Agriculture, Forestry, Environment and Water Management announced already in 2010:

¹⁸ www.bmwfj.gv.at/Presse/Archiv/Archiv%202010/Seiten/Mitterlehner%C3%96sterreichpunktetnChinamit%C3%96ko-Innovationen.aspx

¹⁹ www.bmwf.gv.at/startseite/mini_menuue/presse_und_news/news_details/cHash/91e173d3a8ad3690361988f1f57cdebd/article/alpbach-karlheinz-toechterle-am-tiroltag-oekologisches-bewusstsein-ist-chance-fuer-die-europaregi/

²⁰ The *Science and Technology Agreement* (April 1984) builds the foundation for bilateral STI-co-operation between Austria and China. Both partner agreed on the funding of joint research projects.

“We want to be there right from the beginning, when China’s dragon goes green!”²¹ That it makes sense to be there, or that China could be particularly interested in Austria’s presence above other nations, is argued through the narrative about Austria’s deeply rooted expertise in this field, but also through a narrative of longstanding, rather uncontroversial connection between Austria and China.

4.3. The Red Thread

China has entered the green path Austria is already travelling. This narrative creates similarity between two otherwise very different countries. It mobilizes specific pasts, presents and futures of both countries and rearranges them in ways invoking connection. To bolster this emerging narrative of relatedness, Austrian STI actors additionally emphasize on the one hand a presence of a (not necessarily STI related) *positive* history between the countries and on the other hand an *absence* of negative history. Particularly political representatives emphasize the “*longstanding diplomatic relations*”²² between Austria and China, whose 40th anniversary has recently been celebrated; their shared status as ‘nations of culture’; and the ‘positive image’ Austria enjoys in China²³. While these platitudes are of course part of the standard repertoire of any diplomatic verbiage geared at improving relations, it is interesting that in the Austrian case these accounts of positive presences are complemented by what Felt calls “*imaginaries of the absent*” (Felt 2013: 3). For example, a former Austrian Minister of Economy and Work²⁴ stated that Austria was benefiting from a “*lack of negative historical experiences*” of China with Austria. He further argues, rather mysteriously, that “*due to our history we Austrians are well able to empathize with and understand others*”²⁵, which he considers a key skill for succeeding on the Chinese market.

²¹ www.lebensministerium.at/umwelt/green-jobs/exportinitiative/exportinitiative-umwelttechnologien/Highlights.html (Accessed: 14-Apr-2013)

²² Austrian Ministry of Foreign Affairs. www.bmeia.gv.at/botschaft/peking/bilaterale-beziehungen/bilaterale-beziehungen-oesterreich-und-china.html (Accessed: 14-Apr-2013)

²³ Interview with the Austrian Ambassador to China: german.china.org.cn/interview/2012-05/16/content_25396612.html (Accessed: 14-Apr-2013)

²⁴ Austrian Ministries tend to change names quite often; areas of competence are renamed, fused or split. The former Ministry of Economy and Work was roughly what now is the Ministry of Economy, Family and Youth.

²⁵ Austrian Minister of Economics, cited in *Wirtschaftsblatt* (2007) (Link is not available anymore)

These ideas are echoed in some of the interviews. In a global network of colonial and post-colonial connections, Austria is sketched as a country devoid of such histories, a harmless country, politically neutral; its people cooperative, accommodating and adaptive; an ambassador of green technologies, who is again characterized by being *free of* something rather than by strong presences (Felt 2013:9 ff). While Felt shows us how the narrative of ‘freedom’ in Austrian technopolitical culture entangles “*the material absence of a given technology [with] the imagination of political freedom*” (Felt 2013:17) – emphasizing the people’s ability to *choose* not to let certain technologies in – here we see how in a global context this nexus becomes further linked to the absence of certain ‘negative’ histories of global relations.

As Wodak et al (2009) point out, this implies fading out certain histories, e.g. the existence and agencies of Austro-Fascism, a trope that becomes particularly visible when Austria’s international image is compared to what is invoked as the much more charged history and image of Germany. Similarly, while focusing on sustainable development and problematizing the current state of nature in China and its global consequences, questions of human rights violations in contemporary China are hardly a topic of discussion in the STI collaboration discourse²⁶. One could argue that one of the many ‘benefits’ of the discursive focus on green technologies is that it allows postponing (or avoiding) the human rights discourse altogether, as one is attending to other urgent matters.

This is but another aspect that makes green technologies such an attractive medium for relating to China discursively, strengthening the emergent discourse coalition and their storylines, and drawing new members to their cause. What are the current impacts and achievements of this coalition? First, it has to be noted that one primary achievement is the establishment of the coalition itself. It is remarkably heterogeneous, including members of virtually all relevant ministries, industrial leaders and members of their representative organizations, scientists and R&D developers. While the technology and export oriented actors are clearly pursuing relations with China more adamantly than actors related to academia, who are still hesitant regarding their benefit for strengthening Austria’s academic excellence, none of the actors interviewed objected to the basic storyline that China should be engaged and that this should happen with a focus on green technologies.

²⁶ We would like to emphasize that it is not only in STI negotiations with China that human rights questions are not being raised; yet there is a stronger expectation that China needs to be confronted. Hardly anyone however would expect Austria to address e.g. the existence of Guantanamo in STI negotiations with the US.

The storyline of green technologies as a connective thread with China was part of each interview with virtually any of the above mentioned stakeholder groups. The Austrian Ministry of Transport, Innovation and Technology is currently pushing ahead by drafting a 'China Strategy' for the resort, a move that has received attention by other stakeholders. The green tech focus of the Austrian pavilion at the 2010 Shanghai World Expo is another example for the emergent physical manifestations of the ongoing discourse.

As are a growing number of memoranda, agreements and to some extent contracts between Austrian and Chinese stakeholders in the area of low carbon construction and infrastructure. Whether these efforts will lead to more stable manifestations of the socio-technical imaginary currently constructed by Austrian stakeholders remains to be seen. This will depend on a number of factors, prominently among them China's ambitions to increasingly achieve technological self-sufficiency. As the Science Counselor at the Embassy of the People's Republic of China in Vienna states "*We are facing a strategic turn: Whereas foreign technologies were required for the previous economic recovery, Research and Development will be self-sufficient in the near future*"²⁷.

As and if this emergent socio-technical imaginary of STI independency, which currently still co-exists with China's "*extended hand*" (Bruijn et al 2012) seeking cooperation and transfer, gains momentum, it will demand new positioning work on the side of Austrian (and other) STI stakeholders, requiring the adaptation of current imaginaries or the creation of new ones.

5. CONCLUSIONS: WALTZING WITH THE DRAGON – THE TECHNOPOLITICS OF THE 'NATURAL'

In this paper, we have tried to sketch the discursive positioning work of Austrian STI stakeholders towards cooperation with China; in other words, we have attended to how they are crafting a specific socio-technical imaginary as a shared basis and strategic focus for ongoing and future STI engagements with China. We have shown how in the discursive negotiations we analyzed Austria emerges as bio-pioneer, a green country, in which 'nature' is enabled rather than disturbed by (the right) technologies. Building on the historical fact and fiction of successfully keeping certain technologies out, Austria has – at least

²⁷ profil.at/articles/0543/560/124491/china-drachensteigen (Accessed: 14-Apr-2013)

discursively – become an “*alternative innovation space*” (Felt 2013: 17) devoted to green technologies and sustainable energy. In this narrative, its ‘intact’ nature becomes a symbol of its technological capacities. Critical voices explicitly refer to this narrative as myth, and point to Austria’s failure to meet the Kyoto protocol goals (Greenpeace 2011). Austria further emerges as a harmless country, *free of negative* (imperial, colonial) history. Austrian STI actors engaged with internationalization draw these aspects together to sketch Austria as an experienced, neutral and engaged ambassador of green technologies, willing to travel east to promote its nature-enabling technologies and adapt them to the local contexts.

While China and Austria are narrated as always already connected countries (like Xue and Jianguo, whom we met in the introduction to this paper), it is the current moment in time, the moment of ‘green revolution’²⁸, that brings them, almost naturally, closer together. Through this imaginary, a moment of uncertainty in the face of China’s rapid development is recreated a moment of obvious opportunity.

We understand this very specific imaginary as part of a broader Austrian techno-political discursive landscape and as related to other, topic-specific imaginaries. Together they constitute a specific, historically grounded national technopolitical culture that needs to be better understood, both *for and through* the analysis of international relations in the area of science, technology and innovation. While analysis that primarily focuses on the national is worthwhile, analysis that focuses on the imagined and enacted relations of more than one nation allows for understanding how national sociotechnical imaginaries and their processes of constitution are at once situated responses to increasingly globalized STI systems as well as building on, contesting and reaffirming very local elements of a country’s techno-political culture and history. They are hence simultaneously participating in processes of both *localization* and *globalization* (Martello and Jasanoff 2004). These entanglements between the local and the global, and particularly their historicity and genealogy, need to be taken into account for understanding the becoming of international STI relations, e.g. in the area of science diplomacy or international cooperation. Understanding national socio-technical imaginaries, the ongoing discursive positioning work of the complex networks called nation states, requires attention to global connections and local difference and promises to be a dynamic field of contemporary research. We understand this type of analysis as contributing

²⁸ Austrian Economic Chamber (WKO):
portal.wko.at/wk/format_detail.wk?angid=1&stid=702387&dstid=8554
(Accessed: 14-Apr-2013)

to both knowledge production in the constructivist tradition in IR and to research in STS that is interested in mapping transnational phenomena or doing comparative work, as well as politically important for understanding the ever more prominent and complex role of science and technology in international relations.

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2.2. Article 2

The Internationalization of Science, Technology & Innovation (STI): An Emerging Policy Field at the Intersection of Foreign Policy and Science Policy?

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1. THE COMPLEX RELATIONSHIP BETWEEN INTERNATIONAL COLLABORATION IN STI AND INTERNATIONAL RELATIONS

You don't solve a problem of nuclear weapons and their relations to the world by saying, "Here is a nuclear core – that's scientific; here is a nuclear weapon, that's military; here is a treaty – that's political." These things all have to live with each other. There are elements that are indeed military or technological or diplomatic, but the process of effective judgement and action comes at a point where you cannot separate them out. It follows that it is also nonsense to talk about the political neutrality of science. (Bundy 1963)

Engaging scientific collaborations to transform relations between nation states as well as engaging diplomacy to make large-scale scientific projects possible has a long tradition. After WW II in particular, both governmental and non-governmental actors consciously used scientific and technological collaboration as a means of enhancing international relations.²⁹ With regard to the development, possession and use of military technology it seemed increasingly necessary to cope with the destructive potential of science and technology in an internationally collaborative way. Since science, technology and innovation (STI) were regarded as having the power to deeply influence international relations, nation states could no longer retreat to an exclusively national orientation in their STI policies. Building trust between European nation states was also one of the core reasons for creating the European Organization for Nuclear Research (CERN), a scientific endeavor that would not have been possible without international cooperation. Besides

²⁹ While the United States government proposed the 1946 Baruch Plan for the international control of nuclear energy, Russian and US-American scientists met on a regular basis with the aim of assessing the dangers of weapons of mass destruction, known as the Pugwash conferences.

this diplomatic motivation for enhancing STI collaboration, an international orientation of scientific efforts was also seen as vital for innovation systems from an economic perspective. When the Organisation for Economic Co-operation and Development (OECD) started promoting national science policies in the 1960s and the “National Innovation System (NIS)” became a dominant guiding concept for STI policies, international collaboration was understood as an important part of “national” innovation policies.³⁰ They were defined as one of five types of relationships that made up an NIS (besides relationships between economic sectors, basic and applied research, different policies and science policy and policy for economic development, OECD 1963: 26–7; Godin 2008: 488). Internationalization thus did not challenge the national framing of STI policies but was seen as compatible with, and in fact essential for, creating a national economic system based on innovation.

In the 1990s, however, international collaboration in STI had become so important that many authors observed a “denationalization” as a prevailing trend in science, particularly through increasing internationalization of funding (Crawford et al. 1993). The debate raised questions about whether and how far internationalization of STI would make national policies obsolete and challenge the NIS approach to STI policy making. “[E]mbryonic transnational systems of innovation” (Lundvall 1992[2010]: 16) seemed to become visible and indeed the European Community took steps towards creating a European system of innovation (e.g. with the Single European Act, Anderson/Brændgaard 1992[2010]). In the meantime, however, most scholars argue that national policies and institutions still play a crucial role in overall STI policies despite higher degrees of internationalization (Jacobs 1998, Dolata 2005, Carlsson 2006: 60). The two most common explanations for this are that funding frameworks have largely stayed national in scope and that in the process of building a knowledge-based economy, international collaboration has become and is used as a strategy to cope with growing global competition (Mandeville 2005: 165).

³⁰ While the term formally appeared only in 1987 in Freeman’s study of the innovation system of Japan, the nation-centric perspective on STI activities is implicit in influential OECD work from the 1960s onwards (Godin 2008: 468).

In the following, both explanations will be discussed against the background that the European Union aims to become “the most dynamic and competitive knowledge-based economy in the world” since it sees itself as being “confronted with a quantum shift resulting from globalisation” (EC 2004: 5). Being competitive on the global market with innovative solutions and commercial products appears as a prime goal in EU-wide strategy papers on internationalization of STI (most importantly the “International Strategy for Research and Innovation”, EC 2012). But other strategic aims have also gained ground, such as international scientific collaboration for dealing with global challenges e.g. climate change, humanitarian crises and forced migration, cyber terrorism or global diseases (cp. Ulnicane 2015).

Even if the extent to which internationalization is made possible (e.g. by funding instruments) is often criticized as insufficient, the internationalization objectives are more than a statement of will. While internationalization was primarily addressed at European member state level to support the European Research Area (ERA), most recent research framework programs (FP7, Horizon 2020) reach out to facilitate collaboration with third countries to an unprecedented extent. Internationalization and cooperation with third countries is now mainstreamed, i.e. an option in all funding schemes.

For many countries in Europe, EU Framework Programmes have been an important impulse for extending their international orientation: they first opened up to other EU member states and associated states and now aim at being part of projects that go beyond Europe and build up their individual internationalization profile. For aligning and coordinating EU efforts in STI internationalization (such as those set out in the 2008 Strategic European Framework for International Science and Technology Cooperation) and member states’ activities, a Strategic Forum for International Science and Technology Cooperation (SFIC) was established. At present, it is a very important body for negotiating a common approach (e.g. in a geographic priority setting by establishing initiatives for China, India, the USA and Brazil).

The tension between the aim to build up a competitive ERA on the one hand and on the other hand, member states’ individual aims of staying competitive within and beyond Europe, make the European context particularly interesting for discussing our second argument: that international cooperation is used as a means for dealing with global economic competition.

This chapter contributes to a better understanding of this tension by exploring how policies of European member states frame international collaboration in STI. In particular, we will empirically analyze how member states are building up infrastructures for STI internationalization of their own and explore the increasing entanglements between their STI and foreign policies. In doing so we hypothesise that at these interfaces a new national policy area is developing that is becoming increasingly demarcated and starts to constitute a policy field in its own right (see section 3). This assumption builds on the observation that, since 2000, national governments are willing to invest in new infrastructures for pursuing internationalization aims in parallel – and distinct from – the transnational effort of the EU: they are creating platforms for knowledge sharing and coordinating the diverse sets of national actors that are potentially involved in such activities.

More or less strategically and in reference to EU activities, they aim at maximizing participation in EU funding schemes and developing a complementary internationalization framework. A range of European countries is in the process of creating networks of quasi-embassies that are responsible for international STI relations. These institutions create strategic alliances between policy makers and generate and disseminate relevant knowledge on regions that seem to be promising cooperation partners, e.g. the German Houses for Research and Innovation (“Deutsche Wissenschafts- und Innovationshäuser – DWIH”), the “Science and Innovation Network (SIN)” in the UK, the swissnex network in Switzerland or the FinNode Innovation Centres in the Finnish context.

Therefore, it is tempting to hypothesize that through STI internationalization a new policy field is being created that increasingly cultivates institutional and authoritative demarcations of its own. However, we have to take into account that science, technology and innovation are governed differently in different national contexts: they historically build on different political structures, industrial (technological) development opportunities, systems of higher education, etc. (Lundvall 1992 [2010]: 4). Similarly, foreign policy aims and interests naturally differ between federal states. We therefore have to assume differences in how STI internationalization is set up and framed in different national contexts. This chapter contributes first to an understanding of how STI internationalization has led to the emergence of a new policy field in the making. Second, it aims at showing the heterogeneity in the ways that STI internationalization is politically pursued in different national contexts.

For doing so, it follows a comparative approach: It focuses on STI internationalization policies in Germany and the UK for exploring two partly similar and partly different ways in which EU member states actively build an infrastructure for STI internationalization at home and abroad. In particular, we are interested in how STI policies and international relations have come to interrelate in novel ways, since national governments enhanced their STI internationalization efforts, and ask: How are nation states building up infrastructures for STI internationalization? Has STI internationalization led to the making of a new policy field? How do those active in STI internationalization policy making assess the interrelation between STI policy and international relations? This leads us to the question of whether and how far the two policy fields have come to mutually shape each other. Finally, we will reflect on implications that a new policy field at the intersection of STI policy and foreign policy could have for further studies on STI internationalization.

Germany and the UK were chosen as case studies because they are among the most active countries in developing explicit internationalization strategies. They have built up physical infrastructures – quasi embassies – for STI collaboration abroad that strongly refer back to a nation state level, involving mostly science policy and foreign policy actors.

2. THEORETICAL APPROACH: BRIDGING INNOVATION STUDIES AND INTERNATIONAL RELATIONS

Our analysis is situated at the interface of Innovation Studies and International Relations. Innovation as a field of interest for the social sciences and economics is often dated back to Schumpeter's work in the 1930s, or even to the early 1900s when "anthropologists, sociologists, historians, and economists began theorizing about technological innovation, each from his own respective disciplinary framework" (Godin 2012: 397). Innovation Studies as a distinct research field, however, only started to develop in the early 1970s after the formation of the first research units on innovation. This development was fostered by an increasing policy interest (OECD, national governments) in how societies can best benefit from innovation (Fagerberg et al. 2012: 1143). Out of the breadth of approaches to studying innovation (e.g. as change in behaviour, inventions or technological change), this period was characterized by a narrowing down of definitions of innovation and approaches

to studying innovation: Innovation became dominantly understood as “technological innovation defined as commercialized invention” (Godin 2012: 397) and the process of innovation became increasingly understood as happening primarily in the framework of “National Innovation Systems (NIS)” (Fagerberg et al. 2012, Godin 2009).

Innovation Studies in the past decades have shown how dominant the NIS approach has become in STI policies today, and how it is challenged by increasing internationalization dynamics. Since the debate on innovation-related economic and political competition and global innovation leadership is increasingly linked to the transformation of global power dynamics, we enrich these reflections with insights from International Relations.

These are in particular helpful for understanding how policies on international cooperation in STI are extended well beyond the traditional realm of STI policies and have come to touch upon important questions of foreign policy (Schütte 2008; Flink/Schreiterer 2009: 665; 2010: 69). We conclude that even though it has been long agreed that STI policies are “at the heart of international trade relations, foreign policy, economic strategy, and social interests.” (de la Mothe/Dufour 1995: 232) and situated within a longstanding debate about the implications of globalising STI processes for national policies (e.g. Ostry/Nelson 1995), the increasing entanglement between STI and foreign policy is still not sufficiently reflected in both disciplines concerned. It is an aim of this chapter to overcome this by connecting both fields of study in our analysis.

2.1. The “National Innovation System” Approach: Challenged by STI-Internationalization?

At the end of the past millennium, many authors saw “denationalization” as a prevailing trend in science policies. Despite newly emerging nation states, “transnational science” seemed to gain the upper hand (Crawford, Shinn, Sörlin 1993, Carlsson 2006). For some time this seemed to challenge the hegemonic approach of taking the nation state as a main reference point in analyzing innovation systems and in shaping STI policies. However, as mentioned above, internationalization does not contradict the basic national approach in thinking STI infrastructures, but rather is an inherent part of it: as has been argued elsewhere, internationalization is often pursued under the heading of strengthening national competitive advantage and increasing national value generation; e.g. in the

Swedish context the prime aims were to attract international competence and capital, to use science as a ticket to international cooperation and to gain international competitive advantage (cf. Hellström/Jacob 2005: 452). Thus by now, the NIS approach has remained the central category, not only for policy makers but also for STI-policy analysis.

It has to be mentioned at this point that a notable shift has taken place in how science, technology and innovation are addressed by researchers: while the research community that studied relationships between knowledge production and policy issues started out defining itself as a community of science policy research, a gradual shift has been taking place towards framing the same research interests as field of innovation studies. This is more than a terminological shift in that innovation in this context mostly reflects an integrated approach towards studying knowledge production that is reflected in the NIS approach as promoted by the OECD: the attention is shifted from the individual innovation actors (e.g. firms, universities, public research labs) to the links and interactions between the various actors making up an innovation system. The dominant notion of innovation in this framework – that has been stabilized and co-produced by STI statistics and policy frameworks – is that of innovation as technological innovation for the market and for national economic growth (Godin 2014: 38).

The stronger pace of internationalization in the past decade has provoked a new dynamic in the debate: some caution against “a global retreat into techno-nationalism” that places a priority on science for national economic development and pleads for a new cosmopolitan approach, placing emphasis on transnational networks (Leadbeater/Wilsdon 2007: 11). Others still find it legitimate that the Weberian state should remain the defining agent of the national system of innovation (Scerri/Lastres 2010: 3). In defence of the y it is stressed that innovative activity was of course never only national in scope but funding and R&D activities were nationally focused (Martin 2012: 9).

Nevertheless, the dispute over the accuracy of the y approach has established itself within the community of researchers in innovation studies. In a review of empirical studies on the internationalization of innovation systems, Carlsson pointed to the conclusion of most studies that the interdependence of national innovation systems is increasing with the internationalization of corporate R&D, technology transfer or international flow of scientific and technical personnel. National policies and institutions, however, would still play a role because many institutions relevant to innovation systems are national in scope (such as funding, education or intellectual property rights regulations).

Many thus suspect that even efforts toward European integration will not do away with the mainly national scope of innovation systems in Europe (Carlsson 2006: 63). Nevertheless, international activities on all levels of STI have caused other authors to scrutinize whether we can still accurately speak of NISS. Particularly in the context of solving global challenges, it has been argued that we should think more in terms of a Global Systems of Innovation (GSI) (Cozzens/Catalan 2008) or Global Innovation Networks (Dedrick et al. 2007). Innovation researchers have defined one of the key challenges for Innovation Studies to come to terms with its increasingly international character, arguing that key players in innovation (e.g. multi-national firms) are acting more globally due to economic globalization:

The challenge to IS researchers is to identify, map and analyse these global systems of innovation and their interactions with national and regional systems [...]. This will surely yield important policy implications, just as the development of the NSI concept originally did, not least as we are confronted by ever more urgent global challenges (economic, environmental, demographic, health, security, etc.) and attempt to respond to these (Martin 2012:9).

In the STI policy discourse however, the systems approach is more successful than ever (e.g. Perren/Sapsed 2013, Sharif 2010). The discursive construction of national systems of innovation can even become central for defining and legitimating the sovereignty of regions or national states. As Sharif describes the case of Hong Kong, the NIS approach is used as a rhetorical device for strengthening the reputation of Hong Kong's claim to be a sovereign region (Sharif 2010).

How dynamics in international relations are affected by STI internationalization, however, is hardly discussed in Innovation Studies beyond the context of closing the innovation gap for staying – or becoming – globally competitive (cp. Hellström/Jacob 2005). Many authors have stated that this gap in scientific and technological capabilities is decreasing between the former scientific and technological triad (EU, US, Japan) and newly emerging powers, e.g. in East Asia (Messner 2008). It seems beyond debate that new dynamics in international relations will develop due to an anxiety over who will take over innovation leadership in the future. In the context of new geographies of innovation, such shifts are often formulated rather dramatically, as the following quote may exemplify from the UK perspective:

The rise of China, India and South Korea will remake the innovation landscape. US and European pre-eminence in science-based innovation cannot be taken for granted. The centre of gravity for innovation is starting to shift from west to east.” (Leadbeater/Wilsdon 2007: 9)

The rhetoric of many studies oscillates between seeing a threat posed by the emerging new STI powers to the old triad (Europe, USA, Japan) and seeing opportunities for enhanced cooperation and mutual benefits. The rationale behind this is that while international collaboration clearly bears risks, e.g. intellectual property disputes, cyber security or espionage, the biggest risk of all is disengaging because of that: this would be the real “recipe for disaster”. More recently, approaches have shifted from earlier, very optimistic accounts about what STI internationalization can achieve for scientific advancements, towards a more cautious approach of “strategically balancing the benefits that can flow from increased collaboration across the spectrum of research and innovation activity with some of the risks that come with it” (UK2, 27.30).³¹

2.2. No Reason for Ignorance: STI and International Relations within Changing Geographies of Power

Science, Technology and Innovation in IR have almost always been treated as separated entities. We will first follow this approach to reconstruct how the debate around Science, Technology and Innovation and their role in global affairs has evolved within IR. However, this chapter wants to contribute to a more comprehensive understanding that will be developed along our research questions in the empirical part as well as in the conclusions. If we dive into two of the major IR theories, namely realism and liberalism, we see that first, the concern is with technology, while science and innovation are, if considered at all, peripheral. The Realist’s focus on technology as a fundamental asset in the global power distribution due to the material capabilities of nations (Waltz 1979: 131) and assume a central role of the state in the governance of technological systems.

³¹ As one exception to the latter we have to point to the political support for research on global challenges that is seen as requiring different forms of international collaborations (Edler 2010: 5; Boekholt et al. 2009).

While here technology was first of all entangled with military power in the context of the cold war, subsequent economic globalization has led to an understanding of technology as central for gaining economic power in a context of increased global competition (Rosecrance 1986, 1999; Gilpin 1987; Brzezinski 1997). As Fritsch argues, the traditional realist perspectives on concepts of national interest, power accumulation and anarchy leaves little room for elaborate technology concepts (Fritsch 2012: 36). Although the IR literature is full of examples of how technology developments like the nuclear bomb have changed and influenced international relations, this is not sufficiently reflected in theory. This has led authors like Herrera to criticize how technology is conceptualized in common international relations literature as “the great residual” (Herrera 2003: 560). However, regarding the way that we see the relationship between science, technology and the nation state, we may draw on realism’s understanding of the state’s role in shaping the governance of national STI systems as well as its understanding of competition between states as a major driving force for technological innovations. These accounts should, for the purpose of this study, be juxtaposed with the liberal approaches towards technology in the international system.

Regarding the internationalization of STI these accounts seem fruitful in their focus on an increased need for cooperation due to increased global interdependence. Especially regarding the question of whether a new policy field arises that stems from the overlap of foreign policy with science policy, liberals see that by increased cooperation of state and non-state actors international institutions as well as private actors are creating new forms of authority, policies and increasingly complex structures on the global level (Fritsch 2012, Rosenau 1990, 1997, 2003; Ferguson/Mansbach 1996, 2004).

Innovation is only rarely discussed by IR scholars or, as Taylor puts it sharply: “[...] as in retaliation, most political scientists, who discuss technological variables often neglect the enormous body of innovation research that has developed [...] in other social sciences.” (Taylor 2012: 115). Taylor is one of the very few who explicitly analyze the national innovation rates in the context of domestic tensions and external threats in order to offer a security-based explanation for national differences in those innovation rates. He points out that national innovation rates are central to the subfield of security studies within IR by convincingly relating the innovative capabilities of a nation to its “economic growth, industrial might, and military prowess”. His reasoning is that innovation rates clearly influence the balance of power between states and therefore calculations of war and alliance formation (Taylor 2012:114).

Nevertheless, as in realist accounts of the role of technology in shaping the international system, there is a huge gap regarding the general importance that is ascribed to innovation for national power (Weiss 2005) and the lack of theorizing in IR. Taylor explains this “black-boxing” of the innovation process by IR scholars’ tendency to assume “that the rate and direction of technological innovation are either 1) random, 2) scientifically & technically determined, or 3) structured solely by domestic politics and institutions” (Taylor 2007: 4).

The end result of all three approaches is that innovation is treated as exogenous to IR theory. These gaps are certainly enhanced by innovation studies’ neglect of international politics: Approaches from innovation studies conceptualize foreign science policy, if at all, as a means of enhancing international cooperation with the overall aim of succeeding in the global competition, but do not refer to the field of foreign policy. These studies often focus on explaining drivers and barriers for international collaboration in STI. In this perspective, the internationalization of science policies aims at attracting researchers from abroad, integrating international innovative corporations that conduct research, facilitating access to international sources of knowledge and leading technological markets, learning from foreign initiatives and instruments and supporting the international networking activities of researchers and companies (Kuhlmann 2008: 57).

Only more recent work attempts to bridge this gap by drawing on constructivist concepts from Science and Technology Studies to integrate STI into International Relations theorizing, starting from the assumption that STI are socially constructed and relate to social processes (Litfin 2002; Fritsch 2014; Müller/Witjes 2014; Bueger 2014, 2015). These approaches aim for a more comprehensive and nuanced understanding of how concepts of science, technology and innovation interrelate with systemic changes in international relations (Fritsch 2012). One step towards this direction would certainly be to investigate the mutual influences between STI and International Relations. For the aim of this chapter, a closer look at these variables seems promising.

One conceptual framework within which the interrelation between international STI cooperation and – more generally – power dynamics in international relations is discussed is the concept of soft power, a term coined by Joseph Nye in 1990. Soft power differs from traditional conceptions of power in the international system as it emphasizes attraction over coercion or payments in order to achieve desired outcomes. This attractiveness is informed by a country’s values, policies and culture (Nye 2004: 5). So rather than getting

others to do something they would otherwise not do, soft power stresses a co-opting effect in that it is “getting others to want the outcomes that you want” (Nye 2004: 5). Within the international system, these “others” are increasingly various civil society actors, academic communities and not nation states.

Regarding the role that science can play as an element of soft power, Nye indicates that in the future “the factors of technology, education and economic growth are becoming more significant in international power” (Nye 1990:154). In the past years the term “soft power” was used to address the role of STI in international relations in a broader sense. The Royal Society in UK and the American Association for the Advancement of Science (AAAS) refer to the soft power of science in that the scientific community ‘often works beyond national boundaries on problems of common interest’ and thus contributes to ‘emerging forms of diplomacy that require non-traditional alliances of nations, sectors and non-governmental organisations’.(Royal Society 2010). It seems to be common understanding that science diplomacy should refer to mainly three kinds of activities, namely, “Science for diplomacy,” which means that scientific cooperation can improve international relations; “Diplomacy for science”, diplomacy that can facilitate international scientific cooperation, and “Science in diplomacy,” which is science that can provide advice to inform and support foreign policy objectives.

To enhance an understanding of STI as closely related elements that should not be approached as separated entities in the field of political science, we propose to take science diplomacy as a starting point for a more integrated analysis. In the quote by Nye it is already inherent; the important factors for international power are technology, education (which includes science) and economic growth (which includes innovation capacities that are also based on the former two factors). Consequently, we will apply the term STI diplomacy in the following.

The previous part of this chapter has shown that the two established policy fields of STI policy and foreign policy have come to interact and collaborate in novel ways. Despite the common understanding of science as a transnational endeavor, science policy was for a long time focused on the national level, and foreign policy is still mostly focused on national interests.

In the course of STI internationalization, however, contact points between both policy fields increased, and this division of work is not clear-cut any more. This is why scientist and policy makers have begun to ask if it is only a stronger entanglement of both prior fields – e.g. a stronger coordination and cooperation between the two – or if a new policy field is emerging as a result of new tasks and challenges posed by an ever increasing global interconnectedness. Wagner examined the “foreign policy aspect of science” in that she investigated the relationship between the science community and the diplomacy community, and states that both systems are equipped with totally different dynamics: while the science community is working in networks and with peers, the diplomacy community works in strict hierarchies and traditions. Both communities see each other’s agendas as increasingly overlapping. Still, however, the question remains whether a new policy field of Foreign Science Policy is emerging in this context.

3. METHODOLOGICAL APPROACH: POLICY FIELD ANALYSIS

We have empirically analyzed the different STI internationalization strategies employed by policy makers in Germany and the UK, and in doing so we have followed Mayer et al. who argue that a state-centric approach is preferable for researching STI policies for different reasons: first, corporate innovation activities and scientific progress are still closely entangled with national research policies and that transnational knowledge production on the supra-national level has not yet created a uniformly structured society with a homogenous knowledge repertoire.

Second, that on the level of the European Union, the implementation of innovation strategies is still rooted at the respective member state’s national level and, most important, that knowledge-related wealth creation is still closely related to the national innovation systems and its respective priorities.

Thirdly, especially regarding BRICS, Mayer et al. claim that long-term planning and strategic orientation of research and innovation strategies are dominated by national governments through funding and subsidies (cf. Mayer et al. 2011: 8). Building on our research on STI internationalization policies we found that these arguments are true in this policy area as well, even if it has become a topic in common European STI-policy: most strategy documents in this area (see section 4) strongly refer to the national level as a reference point for coordinated efforts and activities and – as discussed above – institutionalization is mostly pursued within the framework of national STI policies. We

therefore presume that strategic objectives of STI internationalization activities are inherently based on national political interest, which can be subdivided by economic, policy, scientific, etc. motivations (cf. Fähnrich 2013). To assess whether or not a new policy field is in the making a state-centric approach seems to be promising.

In the extensive body of literature on public policy and public administration, the terms “policy field” (or “policy domain” or “policy area”) are widely employed and applied to various contexts. However, they mostly lack a clear definition and differ in their assessments of how new policy fields emerge (see Dunn 2004; Dye 2010). For operationalizing our own assessment we adopt the concept of “policy field” as developed by Massey/Huitema in their paper on climate change adaption as an emerging policy field in the UK (2012): they combine Colebatch’s (2009) concept of “policy” as consisting of three pillars (order, authority and expertise) with an approach in political sociology scholarship that also uses a three pillar construction (Burstein 1991; Knoke/Laumann 1983; 1987).

According to Massey/Huitema, the first characteristic of a policy field is that it is an entity, which has substantive authority. This means, it is an entity that is authorized to “make decisions over an issue or problem so as to produce legitimate policy outputs” (2012: 343), including, for example, policy programs and government expenditure related to a particular issue. The second pillar or precondition for a policy field is an existing institutional order, meaning institutions or organizations like ministries, offices or government agencies that are devoted to the particular issue and “legitimize the products of substantive authority” (2012: 343). As a last pillar the authors use the term substantive expertise, referring to expert knowledge on a particular issue that the former aspects – substantive authority and institutional order – rely on. This can be formal or informal and includes studies, task forces, academic papers, actors of NGOs and think tanks or policy networks. In our analysis we follow this definition of a policy field understood as “a unit of governing within the socio-political system of a country where the [...] three pillars working in tandem to support each other in the management of a public issue or set of issues” (Massey and Huitema 2012: 343).

In the empirical part of this chapter, we will apply these three pillars to discuss whether STI internationalization in Germany and the UK fulfils the so defined criteria for a policy field and how far they are similar or differ in their approaches to STI internationalization.

We do so by building on eight expert interviews with people who have gained specific expertise in STI internationalization policies for either Germany, the UK or both countries: the interviewees include staff from STI policy research institutions, offices or networks for STI internationalization, policy makers and experts for building bi-lateral STI cooperation programmes. Many interviewees had been or are currently also involved in shaping STI internationalization policies as policy consultants. The analysis of the expert interviews is supplemented with an extensive analysis of policy documents (e.g. government strategies) and related texts (e.g. conference proceedings).

4. CASE STUDIES

In the following we discuss our two case studies – STI internationalization in Germany and UK –, first, with regard to whether or not they fit the criteria for a policy field and, second, using a qualitative analysis of how interviewees assessed the character of the respective policies.

4.1. Case Study Germany

In 2008 the Ministry of Research and Education published the federal government's strategy on internationalization: "Strengthening Germany's role in the global knowledge society". The stated aims of this strategy are to strengthen research cooperation with global leaders, the international exploitation of innovation potentials; to strengthen cooperation with developing countries in education, research and development on a long-term basis; assume international responsibility and master global challenges. The main instruments for achieving this are bilateral agreements on cooperation in education and research with more than 50 countries, coordinated by the International Bureau of the BMBF and supported by the web-based information service "Ko-operation international".

A specificity of the German strategy is that it explicitly states that the German research and innovation potential (together with its international economic and political relations) should contribute to the solution of global challenges and that science and foreign policy goals should be aligned to these challenges³².

A year later, in 2009, the Federal Foreign Office launched its Research and Academic Relations Initiative. However, the declared aims of the initiative are to engage “STI to work on problems of global reach, Capacity building in developing countries and to promote collaborative research to spread civic virtues and cultural dialogue”. Its main instruments are the German Research and Innovation Houses, the Foreign Office’s main contribution to the internationalization of STI that were set up in New York, Sao Paulo, New Delhi, Tokio and Moskau as well the German Science Centre in Cairo in cooperation with the Federal Ministry for Education and Research and are carried out in close collaboration with the alliance of German science organization. Furthermore, the Federal Foreign Office aims at an expansion of the grants systems for international students and researchers.

Having in mind what the internationalization strategy has stated – that science and foreign policy goals should be aligned to find solutions to global challenges, we see this aim reflected in the initiative as well. It states that knowledge exchange helps to spread democratic virtues and that activities should target in particular conflict regions and countries in transition. If we now apply the three pillars that constitute a policy field, we see that there is, first, substantive authority in that there are at least three explicit strategies that aim at the internationalization of national STI. Although it is too early to assess how the Action Plan will fit itself into the inter-ministerial cooperation, we see that both main strategies from 2008 and 2009 explicitly refer to the importance of STI for achieving or contributing to foreign policy objectives. While developed as complementary to the

³² Only recently, the BMBF published the “Action Plan on International Cooperation” that is linked up with the Federal Government’s BMBF-led Strategy for the Internationalization of Science and Research of 2008. The *Action Plan* resulted from an evaluation of the previous strategy’s achievements. At the same time, it is an reaction to “The complex systemic changes, and dynamic economic, ecological and social upheavals and challenges which we are facing in the 21st century are altering our perspectives regarding the education, research and innovation policies that we need, at the national and international levels.” (BMBF 2014: 3). While the Action Plan indicates an even stronger political attempt to enhance international cooperation it is too early to assess how the new Plan relates to foreign policy issues.

BMBF's Internationalization Strategy it was sometimes also criticized (Flink/Schreiterer 2010) as an endeavor of the Federal Foreign Office to gain more influence and budget allocations. This would strongly indicate the substantive authority of STI-Internationalization as a policy field within which different actors may also struggle for influence and authority.

Second, we see that institutional order is provided: On the one hand we have the two ministries as well as the ministry for development cooperation, which is also partly involved. Then we have the research organizations that collaborate with the ministries in implementing the strategy and the initiative, and institutions that aim at enhancing mobility and internationalization, like the German academic exchange service (DAAD), research and intermediary organizations, and universities and their international networks. Interestingly, many of these actors are increasingly approached by both ministries, e.g. to be involved in the DWHI and as a network of expertise for the BMBF. Regarding these interrelations of STI policy and foreign policy and the emergence of a new policy field, one interviewee stated that "in addition to the traditionally outward-oriented policy fields of economic-, cultural and security policy a fourth pillar has emerged – or at least should be established – that of foreign science policy: the representation of Germany in the field of science." (DE-IP 1). One member of an intermediary organization also applied the term foreign science policy and saw it as a new yardstick for the performance measurement of a country, pointing out that foreign science policy is "a policy field with a future and will increase in significance for the 21th century" (DE-IP 4). Regarding their assessment of what this emerging policy field of foreign science policy may offer science, these two IPs saw it as central that an opportunity was created for science to gain access to the sphere of international politics (DE-IP 1; 2).

In particular, this was seen as a chance to influence funding opportunities but also international negotiations by providing scientific advice. In general, most of the interviewees referred to foreign science policy as a new opportunity for the scientific community to participate in processes of political decision making in the sense of science for diplomacy and science in diplomacy (see chapter 2.2.)

However, one employee of a huge German research funding organization criticized the high degree of political rhetoric that is employed by stakeholders when referring to foreign science policies' capabilities to tackle global challenges or as a means of science diplomacy. One example of this was the following: "I think that one should not be active in countries with dictatorship. But an institution like mine as a mechanistic system does not have such a moral approach. Given that there is a Smart City project planned in Saudi Arabia with huge amounts of money involved...they do not care if people stone women there." (DE-IP: 4).

Regarding substantive expertise German research and funding organizations provide a wide range of expertise relevant to STI-internationalization policy. Within the BMBF itself, information structures have been built up through "Research in Germany" and "Kooperation international". Another important element that informs German STI-Internationalization policy is the network of science representatives that are based at German embassies abroad and can provide country-related expertise that supports policy decision-making. Furthermore, the representative overseas offices of the German research and intermediary organisations, like the Alexander von Humboldt Foundation, Fraunhofer-Gesellschaft, German Academic Exchange Service (DAAD), German Council of Science and Humanities (WR), German National Academy of Sciences Leopoldina, German Rectors' Conference (HRK), German Research Foundation (DFG), Helmholtz Association, Leibniz Association, Max-Planck-Gesellschaft – as well as the Association of German Chambers of Industry and Commerce (DIHK) provide a highly relevant network for information and knowledge management with regard to the respective policy field. Although lacking their own strategy for the internationalization of STI, the Federal Ministry for Economic Cooperation and Development (BMZ) plays an important role when it comes to knowledge about potential cooperation countries and developments in those regions that the BMZ is active in and that are of potential interest to either the BMBF or the Federal Foreign Office. As one IP stated, the longstanding contacts between Germany and then-developing countries like China, South Korea or India have, in the context of scientific and technological development cooperation and agreements³³ established by the BMZ, provided privileged entry points for the other stakeholders to build up cooperation with these countries that are now on the fast track.

³³ Original German term: Wissenschaftlich-technische Zusammenarbeit

4.2. Case Study United Kingdom

In the UK context, an initial strategy for international engagement in research and development was published two years earlier than in Germany. It followed the setup of a coordination structure labelled “Global Science and Innovation Forum” in 2005. This forum institutionalized cooperation and the coordination of governmental actors and other stakeholders (like the Research Councils and the British Council) in the area of STI internationalization. It can thus be seen as a milestone marking a more coordinated policy approach in STI internationalization. In the years that followed a network of science and innovation officers was set up around the world, based within embassies, high commissions and consulates. This Science and Innovation Network (SIN) had reached a number of 90 staff in 25 countries and territories in 2011.

Most staff is located in Europe and the USA but the SIN is also well developed in China, Japan, India, Canada, South-east Asia and South Korea (BIS/FCO 2011: 8). SIN is still growing: in 2012 it already employed 93 staff in 47 embassies and consulates in 28 countries (UK SIN 2013). The SIN however is not the only organization with offices abroad that deal with STI collaboration: the Department for International Development, the British Council (in the field of education) as well as the Research Councils have offices abroad, often in close collaboration with SIN. The geographical priority setting reflects to some extent former colonial relations and alignment with the Commonwealth of Nations: Canada is a strong priority area and a special programme has been set up for UK-India Cooperation in Education & Research (UKIERI) in 2006.

To understand how STI internationalization policy operates in the UK it is necessary to recognize a distinctive feature of STI policy making in the UK: After a government reform in 1995 the STI internationalization agenda was transferred from the cross-governmental Office of Science to one single governmental department: the Department for Business, Innovation and Skills (BIS) (then the Department for Trade and Industry), that is also responsible for universities. The BIS started working more closely together with the Foreign and Commonwealth Office – most importantly in funding and running the SIN. In the context of STI internationalization, the cross-governmental coordination of science policies thus seems to have been strengthened. One example of this is the introduction of Chief Scientific Advisors (CSA) assigned to every governmental department, who can be said to have formed another layer of coordination; e.g. for coordinating the efforts of BIS and FCO in the SIN.

To understand whether or not STI-internationalization in the UK can be said to have gained substantive authority, the above mentioned specificity of UK science policy making seems to be crucial: the CSAs work under a Government Advisor who advises the Prime Minister and coordinates their activities in the Chief Scientific Advisors Council. Via these structures, CSAs also have a say in negotiating budgets – amongst others for SIN. One of our interviewees explained that “[t]he key things are finance – there are government reports [...] that determine finances of five year periods [...] (UK-IP4). All CSA were in contact with ministers “who created a good voice for science“ (UK-IP4).

So it seems that spaces have been created within which substantive authority can unfold and be decisive, particularly in the context of SIN and the relation to the Chief Scientific Advisors, but also in special funding programmes such as the earlier mentioned UKIERI programme. Due to these newly institutionalised structures (GSIF, SIN, CSAs) the UK is among the countries with a quite strong institutional order for policies in the field of STI internationalization, an order that still seems to be growing and evolving towards a better coordination of the different players active in the field.

In the UK substantive expertise is clearly present too: it is home to many well-known science policy research institutes (SPRU, MIOIR) as well as more recently founded institutes that have – amongst others – turned to STI-internationalization as a research focus (e.g. think tanks like Demos or Nesta). Additionally, the Royal Society has set up a Science Policy Centre that deals with topics of Science Diplomacy and regularly publishes on science and innovation systems abroad (The Royal Society 2015). Besides these institutions the SIN officers produce strategic knowledge about target countries. As a result, an interviewee said that STI internationalisation “has become an academic field of study in its own right” (UK-IP4).

Assessments of the relationship between science policy and foreign policy aims oscillated between quite enthusiastic accounts of the diplomatic power of international scientific collaborations and more sober accounts of balancing benefits and risks. One interviewee for example put it like this: “Scientists are some of the best ambassadors for improving international relations nowadays. [...] [T]hat is because science is international” (UK-IP4). A frequent historical reference for such accounts was the CERN project which – as

another interviewee put it – had made it “inconceivable to go to war again”. For him thus, “science has contributed to making the world a safer place” (UK-IP1). Other interviewees also talked about their “growing awareness of darker sides” like cyber espionage (UK-IP2) making it necessary to strategically balance the diplomatic and economic benefits and risks.

Compared to other European countries, the strong “science as diplomacy” approach to STI internationalization seems to be characteristic of the UK. This is also reflected in the terminology that most interviewees used for STI internationalization. While in Germany the term being used was “foreign science policy”, in the UK it was “Science Diplomacy” that was “certainly a new policy field” (UK-IP2).

Another specific aspect of the UK context is the obvious presence of economic interests in the area of STI internationalization. One interviewee explicitly subordinated most of activities in the area under economic interests of his country: “all the governments are interested in creating jobs and improving the economy and that is almost the number one area of political interest” (UK-IP4).

5. DISCUSSION AND CONCLUSIONS

This chapter builds on the observation that since STI internationalization became a central policy goal of the European Union’s Lisbon Strategy in 2000, national STI policies are increasingly designed to shape the EU’s external relations as well as those of its member states. We have shown that while the EU clearly sets agendas and funding frameworks for STI internationalization, Germany and the UK are one step ahead of the EU in building-up physical and virtual infrastructures for supporting the internationalization of their respective national STI portfolios. STI policies thus can be regarded as an arena in which foreign affairs are shaped on different policy levels (EU policies, national policies) and at a different pace and intensity in different member states.

Going one step further we conclude that for the analyzed cases of Germany and the UK a new policy field has emerged within the last decade where STI policies and foreign policies are increasingly entangled with each other. We suggest that STI internationalization can be understood as a policy field that features the necessary preconditions: substantive authority, institutional order and substantive expertise (cp. Massey/Huitema 2012). However, the countries analyzed apply different terms when referring to their STI-internationalization policies and activities. In Germany, these activities are labelled as

“Foreign Science Policy” while in the UK the term “Science Diplomacy” is used. Although some studies treat both terms as equivalent (Flink/Schreier 2010) we suggest that each indicates a different approach towards international relations and how this impinges on the design of STI internationalization policies.

The ways in which this policy field is structured in Germany and the UK reflects these different approaches: When it comes to substantive authority, referring to the existence of specific policy programmes and government expenditure that are related to STI-Internationalization we see a transverse policy field where issues from other policy fields, e.g. foreign policy and economic policy, are brought together.

Simultaneously, this fusion of issue areas has in both cases led to new forms of inter-ministerial co-operation and government expenditures for internationalization activities. One central finding is that the political nodes from which STI internationalization activities emanate are different in both countries due to their distinct techno-political and socio-economic histories that are reflected in the respective institutional order for STI-Internationalization. In Germany, the BMBF was the frontrunner in setting-up an official internationalization strategy for research and innovation. The Federal Foreign Office has become a second node in managing the Foreign Science Policy Initiative and works in co-operation with the BMBF, the international network of German Houses of Research and Innovation.

The central function of the BMZ is that of a facilitator due to the fact that it has the longest established and institutionalized contacts with then-developing countries that have now become global STI powers (e.g. China or India). While the agendas of the three ministries involved partly overlap, it seems that the aim of STI-internationalization demands new forms of collaboration between them while at the same time leading to an increased competition for funding, competencies and responsibilities.

In the UK, the institutional order of this transverse policy field is strongly shaped by the central role that SIN plays in STI internationalization policies. Being a much larger and more global network than the German Houses of Research and Innovation, SIN seems to have become a much stronger reference point for stakeholders concerned with internationalization. Furthermore, we see a co-operation between different stakeholders that is facilitated by the Global Science and Innovation Forum (GSIF) that coordinates governmental and non-governmental actors in the field. The existing personal and professional links between the Chief Scientific Advisors (CSAs) allow for science policy

makers to act across the government with other departments. Another remarkable difference between Germany and the UK is that the involvement of economics in international STI policies is much stronger in the UK than in Germany. The British SIN is operated by the Department of Business, Innovation and Skills (BIS) and the Foreign and Commonwealth Office (FCO).

This difference can be attributed to the overall structure of science policy-making in the UK where the Minister of Science and Universities reports to BIS, and an economic logic cross-cuts strategy papers and the overall design of STI internationalization policy-making. Thus, although both labels – “Foreign Science Policy” and “Science Diplomacy” – carry the term “science”, the way that STI internationalization is approached differs:

The UK follows a more integrated approach that is led by an understanding of “innovation” as technological innovation for the market (integrating science, technology and innovation into one overall agenda), while the approach to STI seems to be less uniform in Germany in that it is guided by understanding derived from different nodes and has a much stronger focus on the international relations dimension of science policies, in particular regarding developing countries and countries in transition.

Regarding substantive expertise, it can be stated that while stakeholders in the UK can resort to some of the oldest institutions concerned with international cooperation in STI, such as the Science Policy Research Unit (SPRU) at Sussex University or the Manchester Institute of Innovation Research (MIoIR), this cannot be said for the German case. Here the structure of institutions and organizations that inform the knowledge base for STI-internationalization reflects the three central institutions involved, with each of them having its own research foundation, organization or in-house expertise at its disposal. However, in both cases a knowledge base that provides stakeholders with the necessary expertise on STI-internationalization is present.

Concluding that STI-internationalization is a policy field and that this is structured differently between the two analysed case studies leads to three central implications for future research on STI internationalization: First, these relatively new policy fields lead to an increasing overlap between largely nationally oriented science policies and internationally oriented foreign policies: the focus of analysis in future studies has to be extended into a more holistic and transdisciplinary one that integrates approaches from IR, STS and Innovation Studies.

Second, future research would have to adapt a more refined understanding of the range of STI policy fields that set science policies, technology policies and innovation policies in relation to each other. This would allow for a more precise working out of the interrelations between STI policies and internationalization policies: Whether STI internationalization is merely understood in terms of fostering cooperation between excellent scientists, in terms of development cooperation or the opening of new markets for European products will make a difference to how priorities in foreign policies are set and international relations are pursued. However, it seems clear that the role of international collaborations in STI for global power relations manifests itself in physical infrastructures that strongly refer back to a nation's foreign and economic interest: it is an example of how nation states deal with issues of competition and cooperation in the field of STI within the changing dynamics of global power relations.

Third, such an approach should take into consideration that foreign policy goals and strategies, as well as economic policies, have implications for how international scientific collaborations are forged and what knowledge will be produced. Furthermore, it should aim to understand, how STI internationalization as a policy field might become co-productive of more trans-national innovation systems. This would call for case studies that investigate collaborations as they are facilitated by current policy frameworks: The central question would be whether these continue to refer back to national foreign policy aims or call for more transnational policy frameworks in order to meet the innovation needs of current global challenges. The latter would challenge the dominant national innovation system approach in innovation studies.

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2.3. Article 3

Nina Witjes & Philipp Olbrich: “A Fragile Transparency: Satellite Imagery Analysis, Non-State Actors and Visual Representations of Security”

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ABSTRACT

A broad range of non-state actors make use of commercial satellite imagery to monitor global security issues. Questioning the favourable narrative of achieving ‘global transparency’ through Earth observation, the paper unravels the underlying relations between the US government, commercial imagery providers and other non-state actors. Linking insights from Science and Technology Studies and International Relations, two related arguments are put forward: First, the commercialisation of satellite technology and imagery does not dismiss the influence of the state but is conducive of the co-production of shifting actor constellations and related to that, different ideas about transparency and power. Second, this leads to a less benign understanding of transparency which emphasizes its contingent emergence, limited scope and context dependence. This ‘fragile transparency’ exposes the shifting power relations inherent to commercial satellite imagery and its potential as a political practice to render certain things as visible and threats to international security.

Keywords: Satellite Imagery, Visual Representation, STS, Transparency, International Security

1. INTRODUCTION

Satellites, combined with state-of-the-art imaging techniques, offer ordinary humans something heretofore only found among comic-book superheroes: the gift of super sight. (National Geographic, n.d.)

In recent years, the South China Sea has turned into an area of interest for commercial Earth observation satellites. Chinese land reclamation activities and the construction of radar towers or landing strips are rendered visible by the use of satellite imagery on special-interest websites but also in major US newspapers (e.g. Lee 2015; Mufson 2015; Watkins

2015). The Asia Maritime Transparency Initiative (AMTI) is spearheading such efforts and was founded to monitor the on-going territorial disputes in the South China Sea. In its mission to provide ‘objective’ information and increase regional transparency, the programme is hosted by the Center for Strategic & International Studies (CSIS), a Washington-based think tank that “has been dedicated to finding ways to sustain American prominence and prosperity as a force for good in the world” (CSIS 2013). For its on-going analyses, AMTI relies on commercial satellite imagery providers, like DigitalGlobe, to oversee this area of also US security interests. Such interests are re-asserted through so-called freedom of navigation operations of US warships that sail within the 12-nautical-mile zone of China’s artificial islands and are conceived as a challenge to the country’s territorial claims.

In this example, we find a complex network of actors at work that shows how geopolitics are intertwined with the techno-political development of remote-sensing, a diverse circle of users and their knowledge claims based on satellite imagery. In this case, a non-governmental organisation (NGO) makes claims about enhancing transparency by utilising commercial satellite imagery in relation to security issues relevant to US policy. Moreover, it is an expression of more general debates about novel opportunities that commercial satellite imagery offers non-state actors in the realm of human rights, nuclear proliferation or natural disasters. Since the beginning of the new millennium, a broad range of NGOs, companies, advocacy groups and researchers have become excited about these new possibilities to observe security situations that have been virtually inaccessible before due to political or geographical constraints.

At the same time, more commercial imagery providers have been joining the field and contributing to this enthusiastic discourse in the remote sensing community on the prospects that satellite imagery ostensibly provides “global transparency” (cf. Olbrich & Witjes 2016). Central to this debate is the assumption that non-state actors’ analyses can add to, question, or verify governmental knowledge claims about security-relevant issues.³⁴

³⁴ Similar expectations of increased transparency have been articulated in for instance debates about the Internet and its implications for democracy. Felt’s (2014) study on the nexus of digital health information and socio-technical imaginaries of “the Internet” shows that although the latter was ascribed transformative influence on governance, business, normative orders and the way we live, the desired emancipatory transformations did not materialise (see also Castells 2011).

Going further, transparency itself is perceived by the AMTI as a useful tool in global security “to dissuade assertive behaviour and conflict and generate opportunities for co-operation and confidence-building” (AMTI 2014). Against this background, we suggest that a critical take on the potential of technological innovation for democratic change is required when addressing the connection of transparency and commercial satellite imagery.

In the context of commercial satellite imagery analysis, transparency can be broadly understood as efforts undertaken by mainly non-state actors to increase the visibility of activities taking place in remote areas that are perceived as threatening to international or domestic security. The idea of transparency appears as a central feature among non-governmental satellite imagery analysts, in their belief that making things visible contributes to holding actors accountable for their actions. Against this background, this paper suggests a more nuanced understanding of transparency as fragile, often delicate, incomplete and subject to constant socio-political change. In order to substantiate this argument, we will discuss how the co-production of techno-political changes in satellite technologies and the emergence of new actor constellations redraw questions about transparency and power.

As transparency in international security is strongly linked to vision, the first part of the paper presents research from different disciplines on satellite imagery and puts it into the context of the visualisation literature from science and technology studies (STS) and security studies, a sub-field of international relations. We argue that in particular these two research fields can complement each other in that they place different accentuations on visualisation: Security studies contribute to the discussion of satellite imagery from a ‘visual securitisation’ perspective that conceptualizes it as a visual representation that is influential in determining what constitutes a security threat.

While this dimension is rarely considered in STS, it provides important insights regarding the role of technology in making visual representations and associated knowledge practices. Based on this discussion, we introduce our theoretical approach that takes up Vertesi’s (2014) understanding of visual representations as ‘drawing as’ from a co-productionist perspective. The empirical part examines how civil society actors represent their work in relation to the techno-political changes of the commercialisation of satellite technologies, and how they construct transparency as a guiding principle of their work and a political practice towards more public accountability. In a second step, we investigate the role of

government actors in the process of satellite imagery acquisition and distribution, which effectively calls into question the transparency narrative of unprecedented possibilities for non-state actors in security knowledge production.

Building on these insights, we then trace the entanglements of the US government with the commercial imagery providers and their implications for civil society actors. We argue that, although they have formed close and consequential relations, they are hitherto invisible in the related discourse on transparency.

2. NON-STATE SATELLITE IMAGERY ANALYSIS: BETWEEN CHALLENGING GOVERNMENT POSITIONS AND 'SURVEILLANT WITNESSING'?

Sometimes blurred, sometimes impressively aesthetic, satellite imagery very easily enters public and political discourses and entails a mode of thinking and reasoning that privileges sight by embodying a “naturalistic objectivity” (Perkins & Dodge 2009: 2). The sense of materiality and remoteness makes satellite imagery appear as (re-)presenting obvious facts. However, in capturing objects, activities and changes from an allegedly neutral perspective, the socio-political and cultural processes of their production and ways of inscribing meaning often remain invisible. No matter how high the resolution and the quality of the images, they always represent objects that require interpretation; we still need somebody to tell us what the grey squares or green islands on a picture actually mean. Essentially, satellite imagery itself is no more than a “constellation of signs waiting to be transformed into meaningful symbols” (Olson 1999). When shown in public, it is “festooned with arrows, captions and claims designed to anchor what is otherwise [...] a blurry and imprecise picture” (Campbell 2007a). This is the result of analysts who construct meaning by detecting and interpreting the imaged objects so that they are ready to be translated into public discourses as a technologically-mediated visual representation of security threats (Jasanoff 2012).

Within the current body of literature on transparency and knowledge-power configurations in the field of satellite imagery from different disciplines, we can identify two main trends: while one group focuses on the democratic potential of commercial satellites with respect to access to and distribution of open-source security knowledge, others are more sceptical about the opportunities it provides for global transparency as well as its political and security implications.

The first group advances the notion that the state increasingly loses its monopoly on satellite imagery as a guarantee for exclusive access to relevant security data (e.g. Livingston & Robinson 2003; Wang et al. 2013; Florini & Dehqanzada 2006; Baker 2001). Research in this stream highlights that the wider availability of and access to satellite imagery leads to a diversification of security knowledge (Baker 2001; Florini & Dehqanzada 2006). Moreover, it is argued that the commercialisation of remote sensing allows non-state actors to challenge governmental threat assessments on technical grounds, as opposed to moral arguments and that “[g]reater transparency in international affairs seems likely, if not inevitable” (Livingston & Robinson 2003: 21). Aday & Livingston (2009) make a similar point when they show how satellite imagery was used to pressure the Bush administration to admit to knowing of an Iranian nuclear programme in 2002. As a result, they argue that the advancement of remote-sensing technology leads to political power shifts that favour NGOs over state actors. Lastly, in a more practical tone, Wang et al. (2013) assess the value of commercial satellite imagery in the hands of non-state actors as a tool to hold perpetrators accountable for human rights violations and mass atrocities. However, they see these efforts as being still largely in the experimental stage and face legal and technical difficulties.

However, there are also more critical accounts on the potential of satellite imagery, in particular in terms of power structures between the observed and the observers. Litfin (2002) ascribes a certain disciplinary power to commercial remote sensing that has a deterring effect on those observed and can open up new possibilities for perceptions of common security and collective identity formation. Shim (2014a, 2014b) makes the case for the potential of remote sensing to produce specific geopolitical imaginations with reference to night-time satellite imagery of North Korea which appears rather dark between illuminated China and South Korea. In this context, remote sensing works as “visual spatial imaginaries” (Shim 2014a: 152) that construct North Korea as a foreign, isolated and secretive place. In a similar fashion, Hong (2013) sees satellite imagery as being located at the intersection of technologies of militarised intelligence, and war and technologies of human rights, as both are used to reify security threats posed by an adversarial country. Questioning the neutral appeal of satellite imagery, Herscher (2014) describes how human rights NGOs have increasingly become entangled with the politics of securitisation, collaborating with the state in the production of satellite imagery-based geopolitical knowledge and power. He coins the term “surveillant witnessing” to refer to a hybrid practice that has emerged at the interface of governmental satellite surveillance and NGO’s human rights monitoring practices. Parks also identifies remnants of the state

within satellite imagery that she understands as inheriting a military view that “treat[s] the Earth as a domain of Western vision, knowledge, and control” (Parks 2005: 79). In doing so, she stresses both the remaining powerful position of governments to make claims about what can be seen on the image, but also that there is room for different and challenging interpretations (see also Kurgan 2013).

Despite their different approaches and perspectives on satellite imagery as an instrument to enhance transparency, both groups assume clear boundaries between state/non-state, transparent/secret and private/public.³⁵ On the face of it, the structure and dividing lines of these networks of state and non-state actors seem obvious: government analysts and intelligence agencies often work on matters of national security or military interventions and operate within a setting of secrecy. In contrast, analysts of human rights NGOs, universities or think tanks often share an interest in making things public. However, as our empirical analysis will show, these clear-cut categorisations of actors do not hold when investigating their actual practices. In short, they are more fluid, overlapping, context-dependent and contingent than they appear at first glance. Moreover, as a result of making such strong distinctions between state and non-state actors, the advent of commercial remote sensing is mainly depicted as a zero-sum game in which the state loses its information monopoly to some extent, while NGOs equally gain more influence. Instead, our analysis shows how and in which ways the government plays a decisive role within the complex network of actor-constellations that employ commercial satellite imagery in the context of international security. In particular, the role of commercial providers has not been sufficiently analysed to date. To address these shifting social orders, we suggest understanding the images that satellites transfer down to Earth – and how they become visual representations of security threats – as being part of a finely woven network of technology development, security practices, ideas of transparency, global economic interests, and governmental and civilian surveillance.

³⁵ For an analysis of a classified/civilian interaction between the US government and earth science community over secret satellite data of the CORONA satellite reconnaissance program during the 1960s to 1970s, see Cloud (2001).

2.1. Visualisation Technologies and the Representation of Security Threats

In the field of security studies, a growing number of scholars acknowledge the role of images in international security politics (e.g. Shapiro 1988; Campbell 2007b; Bleiker 2009; Andersen & Möller 2013; Shim 2014b). Here, one promising research direction takes images as central to processes of securitisation or de-securitisation (e.g. Williams 2003; Campbell & Shapiro 2007; Möller 2007; Hansen 2011; Heck & Schlag 2012). Securitisation theory in general refers to the idea put forward by the so-called Copenhagen School that security issues cannot be reduced to pure material characteristics but instead are constructed as a threat by means of language (Wæver 1995; Buzan et al. 1998; Buzan & Wæver 2003). In short, objects can be securitised through speech acts by particular actors who frame them as threatened, thereby moving from the realm of ordinary politics into a security context which justifies extraordinary measures in order to defend the threatened object, or attack the threatening one.

Hansen in particular provides an elaborate theoretical understanding of visual securitisation as a way in which visual representations influence security practices. According to her, *visual securitisation* is “when images constitute something or someone as threatened and in need of immediate defence, or when securitising actors argue that images ‘speak security’” (Hansen 2011: 51). She identifies three crucial differences between words and images: *immediacy* refers to the prompt relation a viewer establishes in the process of looking at an image; *circulability* emphasises the conditions for the fast distribution of visual securitisations and *ambiguity* highlights uncertainties in the interpretation of an image, as opposed to more explicit speech acts. Against this background, we can understand satellite images as visual representations of sites, places and objects that ‘speak security’ and as influential elements of security discourses. However, we suggest to also take into account the role of technology and knowledge practices employed for making these representations. Understanding, tracing, and reconstructing these processes has been of continuous interest in STS. Research at the nexus of visibility and materiality questions how ‘things are made visible,’ ‘which things are made visible’ and investigates ‘the politics of visible objects’ (Rose & Tolia-Kelly 2012: 4). Similarly, research in this field contends that visualisation technologies do not only enhance human visions but rather re-constitute the depicted objects, issues or processes by making them visible through their own socio-technological arrangements (Ruivenkamp & Rip 2014; for earlier accounts see also Haraway 1989; Latour 1986).

In his study on brain images, Dumit draws attention to images as “fluid signifiers” (Dumit 2003: 10) that easily travel between different contexts, thereby losing and picking up new meanings, allowing them to “serve different agendas and meanings simultaneously” (Dumit 2003: 4). His concept of mobile and indefinite visual representation addresses similar features as Hansen’s (2011) notions of circulability and ambiguity. Such an understanding of satellite images stresses how they are constructed, and how they travel and acquire various meanings on the way, e.g. when published in media outlets as illustrations of the South China Sea conflict as outlined at the beginning.

Moreover, said similarities often remain unaccounted for and suggest that although much of the work in STS is sensitive to the production and circulation of scientific representations, the political and social aspects have only been implicit by comparison to other fields of social sciences (see also Jasanoff 2004). More concretely, we argue that in STS there are only few studies that pay attention to the security dimension of visualization practices. Vogel’s analysis (2008) on how visual representations have been employed by security policy actors to create a narrative of threat constitutes a notable exception. Exploring the case of the US biological weapons threat assessment, she traces how images – photos, drawings, and satellite imagery – have been presented as evidence of the existence of biological weapons of mass destruction to the UN Security Council. Although many people viewed the images via television, newspapers or on various websites, only very few were able to assess their validity. She concludes that this representation of a security threat creates a “staged public display, but provides limited access to the backstage regions where the display was created” (Vogel 2008: 568).³⁶ For the purpose of this paper, it is particularly this backstage area of knowledge production that is of interest and will be explored in the empirical part. More precisely, we will trace the entanglement of notions of transparency and the actor-network constellation in which satellite images are produced, interpreted and employed for different purposes.

³⁶ See also Hilgartner’s (2000) work on science and public knowledge.

3. THEORETICAL APPROACH: A CO-PRODUCTIONIST VIEW ON VISUAL REPRESENTATIONS

A co-productionist perspective draws our attention to the ways in which knowledge and technological artifacts create and modify social order; equally, it contributes to an understanding of how the production of science and technology itself are shaped by social, political, and cultural factors. As Jasanoff states, “[s]cientific knowledge both embeds and is embedded in social practices, identities, norms, conventions, discourses, instruments, and institutions – in short all the building blocks of what we term the social” (Jasanoff 2004). Such a perspective is in particular conducive for understanding how techno-scientific knowledge and social order are being created together in the making of identities, institutions, discourses and representations (Jasanoff 2004: 6).

While our analysis also touches upon issues of discourses and institutions, we particularly focus on the notion of making representations, as this provides a promising avenue to address the politics inherent to the imagery itself as well as to the practices of interpretation and construction while traveling from one context to another. We are going to discuss how techno-political changes in the field of satellite technologies and emerging actor constellations are co-productive of each other, thereby leading to new ideas about transparency of security issues. More precisely, we trace these dynamic relationships by focusing on three aspects of representation: the historical and political developments that have shaped a benign transparency narrative of satellite imagery, the knowledge and security practices of involved non-state and state actors, and the emergence of a fluid actor constellation that is co-constitutive of particular notions of transparency.

For a complementary understanding of visual representations, we can turn to Vertesi’s (2014) study on how researchers of NASA’s Mars Exploration Rover Mission make use of large bulks of images to investigate the red planet. She develops the concept of ‘drawing as’ to demonstrate that visual representations are a theory-laden, purposeful practice. In this understanding an image cannot be conceived of as a mirroring of perception. Instead, her approach emphasizes the role of expectations and norms in the process of visual construal

as such representations rely on a certain recognisability of objects to allow for a context-flexible analysis of the image (Vertesi 2014: 17-21). By using the example of a geochemist, Vertesi lively illustrates that digital image processing is not only about extracting information but also about the representational practices and choices: In her study, one NASA researcher discovers unusual tracks after a robot got stuck in the planet's sandy surface.

In the process of digitally manipulating the images and presenting them to colleagues, the scientist not only reveals previously unseen objects, but also produces a representation of a scientific discovery as the tracks lay bare two-toned light soil as an indicator for water (Vertesi 2014: 16). Taking into account the representational choices in the making of image-based knowledge, Vertesi (2014: 20) refers to the mutual relationship of observation and purposeful representation. For the objective of this paper, this is a promising approach since it does not reduce visual representations to a result of technical manipulation and inscription but also grasps “the practical activity of *drawing* a natural object *as* an analytical tool, such that subsequent viewers and image makers will see, represent and interact with that same object the same in the same way“ (Vertesi 2014: 31 [emphasis in original]).

Understanding the practices of satellite imagery analysts in this way is a helpful avenue to trace the ways that knowledge is produced through specific, purposeful representational techniques: This includes the concrete choices made by the image interpreters about image selection, which aspects to single out and call to the attention of colleagues, and how to approach the same site from different angles. At the same time, however, Vertesi does not extensively cover the interplay and power dynamics among multiple actors involved in the processes that co-constitute the ways we produce, circulate and make sense of images. By employing a co-productionist perspective that investigates the making of visual representations by a complex actor constellation, we will attend to the representational techniques employed in the backstage regions of security knowledge production and their intimate relation to notions of transparency.

3.1. Empirical Material and Methods

In order to explore the underlying power relations in the making of visual representations, we have interviewed satellite imagery analysts working on various topics and geographical areas as well as staff from commercial imagery providers. The core of the empirical material comprises thirteen semi-structured expert interviews with active satellite imagery analysts from non-governmental and governmental institutions in the US, conducted between August 2014 and February 2015, both, in person and via Skype. In light of this material, the analysis focuses on the remote-sensing community in the United States as a case study. While the commercialisation of satellite technology is certainly a global phenomenon, the US often takes centre stage in the economic, technological and political development of a large part of the application of commercial satellite imagery by non-governmental actors (Sawyer 2015; Lewis 2002).

The interview sample of eight non-state satellite imagery analysts consists of regular contributors to various security discourses concerning a variety of countries such as Iran, Pakistan, North Korea or Syria. These analysts are employed at different institutions including private corporations, advocacy groups, NGOs, universities and think tanks, and feature a diverse educational background in engineering, nuclear physics, geography, economics and political science. Those analysts with degrees in the social sciences, have often worked on issues of disarmament, arms-control and human rights before taking up satellite imagery analysis as an additional resource for gaining knowledge. In contrast, some members of the group have a military background or were trained as governmental intelligence analysts and now continue doing similar work in a non-governmental or business capacity. The remaining interviews were conducted with staff from intelligence agencies and international organisations, which use satellite imagery, as well as with staff from commercial satellite imagery providers. All the interviewees are quoted anonymously by mutual agreement. Due to the confidentiality of information, we only quote directly from the interviews with non-state analysts. In order to offer more contextual information, the interview data is complemented by a collection of official policy documents, international legal code, historic data and secondary literature on commercial satellite technologies.

We used sensitising concepts as a starting point that guided both the fieldwork and the analysis of the empirical material (Blumer 1954, Charmaz 2006). In accordance with our theoretical focus on visual representation in the context of the commercialization of satellite imagery, we started with the dualist notions of “transparency vs. secrecy” and “state actors vs. non-state actors”. However, during the course of the research project, subtle power dynamics among those actors in relation to transparency emerged in the data so that “networks” and “collaboration” as well as “dependencies” became important terms, too. After all interviews were transcribed and stored in a shared database, we developed a coding scheme (Miles and Huberman 1994) using the qualitative data analysis software, Atlas.ti. First, we derived tentative categories such as “government”; “classified information”; “public”; “collaboration”, “seeing” and “visibility” that were also informed by the sensitising concepts and pre-tested for applicability on four interview transcripts by both authors.

As a result of that, the categories were annotated and assigned more specific codes that were representative of practices and relations in that particular category. In a second step, we could utilize these codes to identify patterns and accumulations that allowed for identifying and specifying the exchanges and interactions between the different groups of actors involved, their respective notions of transparency, embedded knowledge practices, their role within the network of satellite imagery analysis, as well as the ways they refer to other actors.

4. FROM TOP SECRET TO OPEN-SOURCE? THE COMMERCIALISATION OF SATELLITE TECHNOLOGIES

Satellite observation has met the interest of the military, commercial and civilian sectors. A diverse remote sensing community of companies, NGOs, universities and government organizations uses high-resolution satellite imagery, e.g. in the oil and gas business, to assess the development of nuclear programs, human rights situations or agricultural productivity, or to count cars on parking lots as an indicator of economic activity. In this sense, commercial satellite imagery exhibits dual-use qualities in that it can be utilized for military as well as civilian purposes. Consequently, it attracts a diverse customer base that renders it a valuable product for satellite imagery providers. The most-developed markets in terms of commercial high-resolution imagery are to be found in Europe and the United States which also host the providers the interviewed imagery analysts purchase most of their material from. With European Airbus Defence & Space and US-based DigitalGlobe, the satellite observation sectors in both markets are dominated by one major corporation.

Lately, however, the US has seen growing competition in commercial Earth observation as global market leader DigitalGlobe has been joined by start-ups such as Skybox or PlanetLabs which also build and launch their own satellites and offer their imagery products for sale. In the process of purchasing satellite imagery, potential customers often can access so-called image libraries to scan through a vast archive of satellite images filtered by location, date, cloud cover, inclination angle, resolution and other technical features. In 2013, the revenue of the space-based remote sensing market was an estimated USD 1.5 bn and the total number of Earth observation satellites is projected to double by 2021 to more than 300 (OECD 2014: 56). The focus of the paper on non-governmental remote sensing in an international security context also evokes the long history of Earth observation satellites when it was predominantly a government domain.

In fact, the benign transparency narrative that surrounds the non-state use of satellite imagery is intricately connected to the techno-political history of satellites and their embedment in Cold War power relations. Many consider October 4th 1957 as the starting point of the satellite era when the first-ever successfully launched artificial satellite, Sputnik 1, was put into orbit by the Soviet Union. Often referred to as the “Sputnik shock,” it had dramatic social and political implications for the United States in that it displayed quite plainly the technological equality of the two opposing blocks. It may be difficult to recall the perceived threats at that time, but “for the World War II-weary world, it represented the potential for atom bombs to rain down unexpectedly from space anywhere on Earth” (Gabrynowicz 2010: 407).

Although satellite imagery was strongly connected to national security concerns during the Cold War and reserved for government agencies, remote sensing experienced a diversification in usage. The creation of the Landsat programme in the 1970s is illustrative of the opening of remote sensing for non-military applications. This first civil Earth observation programme under the auspices of the National Aeronautics and Space Administration (NASA) has provided remote-sensing data for various uses such as economic planning, resource management or environmental monitoring. However, only a few years after the end of the Cold War, about half-a-dozen US companies constituted a commercial market for high-resolution imagery. For instance, the largest imagery provider, DigitalGlobe (DG)³⁷, was founded in anticipation of the adoption of the US Land Remote-

³⁷ Then under the name of WorldView Imaging Corporation.

Sensing Act in 1992, which allowed and regulated the licensing of commercial Earth observation services. Satellite imagery experts expected to “witness a revolution which may forever change the direction of [their] profession” (Fritz 1996: 273). Since then, the US market for commercial high-resolution satellite imagery has consolidated significantly and has experienced various mergers and acquisitions which have left DG as the market leader in the high-resolution satellite imagery segment. The diversification of usage and users of satellite imagery has occurred in accordance with the on-going development of companies, availability of data and analytical tools in the remote-sensing sector:

“Now you see a lot more uses from different fields, thinking ‘what can we do with that imagery’, because it’s there, it’s free, we can use it. Before Google Earth, it was always seen as the prohibitively expensive resource that people don’t think about using” (Anonymous Interview with US Satellite Imagery Analyst, 2014).

Moreover, the analyst refers to Google Earth as a breaking point in the transfer of satellite imagery from the secret into the open domain – a precursor of shifting notions of transparency. However, despite Google Earth’s public salience and symbolic power for referring to the commercialisation of Earth observation, it is often of limited relevance for the remote sensing community that deals with up-to-date security situations and which constitutes the focus of this paper.

4.1. Aiming for Global Transparency: NGOs’ Usage of Satellite Imagery

NGOs, like Amnesty International or Human Rights Watch, can be counted among prominent emerging “imagery activist groups” (cf. Baker 2001) which are making use of the enhancement of geospatial technologies to monitor activities in conflict zones which were previously difficult to access such as Darfur, Nigeria, Syria, and others. In various cases, they enter into a co-operation with other non-state or commercial actors for access to satellite imagery or for geospatial analytics such as DG or the American Association for the Advancement of Science (AAAS). This suggests that the in-house expertise necessary for sound satellite imagery analysis is not a prerequisite for the use of Earth observation

data in human rights advocacy. In a report covering North Korea's political prison camp system, Amnesty International worked with DG in order "to circumvent the unwillingness of the North Korean authorities to allow human rights investigators access" (Amnesty International 2013: 5). By using a techno-politically enabled detour via outer space, the otherwise denied access was thus enforced on the area of interest.

With increasing frequency, advocacy groups, and also the media, refer to the importance of satellite imagery for transparency of security issues, however, less is known about the process of how they acquire and analyse the respective imagery. The preceding section already implies potential qualifications of the transparency argument in terms of independent and free access to satellite imagery for non-state actors to highlight security and human rights concerns as they see fit. In the following, we analyse NGO practices in relation to commercial satellite imagery in more detail to illuminate broader questions about the changing power configurations regarding non-state actors' access to security knowledge.

The wide and public distribution of satellite imagery and analyses is perhaps the most central issue for non-state actors, whereas state agencies are obviously much more reluctant to share their data and findings with the public. For achieving increased transparency of human rights violations or security threats, making things public is at the core of NGO activities. Moreover, for many analysts, drawing events detected on the ground as potential security threats is a main motivation for their work. In this sense, their notion of transparency does not only refer to the imaged objects and their interpretation, but is also seen as a conscious political practice.

One analyst emphasized this political function of enabling transparency by saying that

"Our point of view is that civil society needs access to information [...] in order for those societies to have a voice. If you don't know what's going on [...] then society can't have much of a say, it's all left to the privileged decision-makers with access to classified information" (Anonymous interview with satellite imagery analysts, 2014)

In keeping with other analysts, the interviewee conceived satellite imagery as "a tool to have influence in the public domain" (Anonymous interview with satellite imagery analysts, 2014) thereby buying into some of the assumptions underlying increased transparency as a force for alleviating uncertainty and fostering common understanding (cf. Lord 2006). In

effect, using satellite imagery to monitor the human rights situation in North Korea or nuclear activities in Iran were seen as an opportunity to bring about change as a result of shifts in knowledge orders and modifying the relation between information and the public, between secrecy and transparency. Operating on such an understanding, the primary objective envisioned for the use of satellite imagery by non-state actors is to

”raise public awareness of events that relate to human rights or nuclear security, communicating more effectively about these issues by the use of satellite imagery, generates new knowledge in the open domain that has previously only been in the classified domain” (Anonymous interview with satellite imagery analysts, 2014).

Hence, for many non-state analysts, commercial satellite imagery embodies an emancipatory promise located in its potential to overcome the secrecy that has surrounded satellites for the past decades. At the same time, it reinforces the assumption that simply making something visible has virtually direct implications for policy change. This conception of commercial satellite imagery as invoking opportunities to monitor, control and reveal information implicitly sets those analyses against the ones conducted by state actors.

In short, regarding the knowledge-power relations between state and non-state actors, this connects to typical narratives about the core of NGOs’ advocacy work.

Non-state analysts critically question the dominant position of states with respect to satellite technology and challenge their reluctance to release more of their available knowledge, for instance about North Korea’s nuclear program and the human rights situation (Anonymous Interviews with Satellite Imagery Analysts, 2014; 2015). As outlined above, this lack of information limits the extent to which the general public is able to assess certain political decisions. As a consequence, many analysts from civil society follow a common policy enterprise that puts transparency at its center. To a great extent, they choose open-source publications to release their analyses and reportedly write for a general audience in order to achieve wider distribution – even though it is believed that most readers are journalists, policy-makers or academics (Anonymous interview with satellite imagery analysts, 2014). So, despite the fact that the US is home to an elaborate and vast private intelligence industry (Priest & Arkin, 2010) which highly values skills and expertise in geospatial analytics, a significant number of analysts choose not to offer their services solely to private businesses, but disseminate their findings in co-operation with

NGOs and other civil society actors online and free-of-charge. Furthermore, they are aware of the important role of the media in transferring their results into more widely noticed publications. They see journalists as being attentive towards publications of various satellite imagery analysts. Especially when it comes to security-sensitive topics, such as nuclear programs or territorial disputes, remote sensing seems particularly compatible with today's news media because it not only caters to the need of a visual experience, but also constitutes a remedy for the secrecy of the intelligence community that only allows for irregular and possibly controlled access (Anonymous interviews with two satellite imagery analysts, 2014 & 2015).

With respect to governmental imagery intelligence, non-state analysts adopt a peculiar position as they operate on similar technical and analytical terms but, at times, set out to question government information. In doing so, they constitute an unofficial alternative source for governments and the public alike. When it comes to satellite imagery, policy-makers have basically two main resources, i.e. their national intelligence infrastructure, but also the work of non-governmental analysts. While the latter is unable to assess the studies of the intelligence community, they nonetheless provide additional options and opinions on the same subject matter and potentially second-guess the conclusions of military analysts without knowing it (Anonymous interviews with three satellite imagery analysts, 2014 & 2015).

So, in the process of providing security-relevant information to the general public, they coincidentally provide potentially valuable intelligence while attempting to fill in some of the blanks where governments are not willing to act and share information. One case in point is the assessment of the nature and size of nuclear weapons arsenals worldwide. As an open-source type of data, satellite imagery plays an important part in the creation of "generally accepted numbers" of weapons per country (Anonymous Interview with US satellite imagery analysts, 2014). By virtue of rendering the actual stockpiles visible, public analyses are envisioned to pressure less outspoken governments into voluntarily declaring their capabilities, since open-source information and commercial satellite imagery have practically revealed them anyway. These declarations can then constitute the baseline for further disarmament efforts and a multilateral arms control process (Anonymous Interview with US satellite imagery analysts, 2014). This illustrates the potential attributed to commercial satellite imagery as a co-facilitator of "global transparency" and as a tool to increase pressure on governments through visual representations.

However, when considering the overall distribution of observed countries in available satellite imagery analyses by non-state actors, it is striking that they largely focus on areas concerning US security interests in the widest sense which, arguably, qualifies the global appeal of transparency through satellite technology (cf. Parks 2005). As a matter of fact, despite the opportunities that commercial satellite imagery provides to non-state actors, the US government still plays a significant role pertaining to issues of access and conditions of imagery acquisition. The following section traces some of these lines of influence and relates them to the transparency narrative as developed by the interviewed non-state analysts.

4.2. Government Practices to Maintain Epistemic Authority

In an “ideally commercialised” market for satellite imagery, NGOs would approach sellers, such as DigitalGlobe, and purchase the imagery of interest. However there are quite a few limitations. Acknowledging the dual-use nature of commercial satellite imagery, the US government can intervene in the normal commercial operations of any licensee. In effect, it can demand from the “licensee to limit data collection and/or distribution by the system during periods when national security or international obligations and/or foreign policies may be compromised, as determined by the Secretary of Defense or the Secretary of State” (NOAA 2006).

This policy option is called shutter control in as much as the government can prevent any licensee acquiring or distributing satellite imagery of a specific region based on national interests. While the policy of shutter control has never been formally executed, the US government implemented a later criticised “checkbook shutter control” in 2001, during the first three months of the war in Afghanistan. Instead of taking the official route of having the Secretary of Defence appeal to the national security interest of the United States, the government used its financial means to purchase all the commercial high-resolution imagery of Afghanistan from October to December. It entered into a multi-million-dollar contract with the then commercial operator, Space Imaging, to prevent anybody else – including the media – from seeing what was happening on the ground and, at the same time, bypassed accusations for violating the freedom of speech and of the press (cf. Parks 2012). Only after the end of the contract did the company regularly release most of the imagery for free purchase. Shutter control constitutes a significant form of

intervention in that it grants the government the power to shut-down the commercial system of imaging satellites. It can also be understood as a powerful tool of the US government to preserve its epistemic authority effectively determine the permissible degree of transparency by referring to national security reasons.

Once the imagery is acquired, the close relationship between visuality and transparency implies that a higher resolution of commercial Earth imaging satellites can yield considerable political effects. Imagery of a better quality allows non-state satellite imagery analysts an even closer look at what is happening on the ground and means they can discern even smaller objects. The technological progress of remote sensing has indeed led to drastic improvements in terms of spatial and temporal resolution. While in the late 1990s the best non-military imagery provided spatial resolutions of about 1m to 1.5m, current commercial satellites can produce panchromatic imagery at a resolution of 0.31m.³⁸ Discussions about centimetres might seem a little odd, given that most Earth observation satellites are orbiting through space at heights of roughly 400 to 700 km but when it comes to the analysis of nuclear facilities, details matter in determining the exact operation of that particular plant. At the same time, the growing number of commercial satellites results in more frequent monitoring of areas of interest.

However, technical capabilities are only one part of the equation as the US government exercises its right to determine the quality of resolution free to be sold by commercial providers. For example, all the DigitalGlobe satellites only offer panchromatic imagery of sub-metre quality and three of them even better than half-a-metre. Until summer 2014, the company was prohibited by federal law from selling or distributing any imagery below a resolution of 0.5m. As the industry had pushed for a relaxation of this regulation, commercial providers are now allowed to sell panchromatic imagery with a resolution of 0.25m, and coloured imagery with a resolution of 1m (Ferster 2014). Even though this probably still cannot compete with the best military spy satellites, this change has had remarkable effects on the size of objects discernible on commercial satellite imagery.

³⁸ The spatial resolution determines the minimum size of an object to be discernible on an image. Accordingly, objects bigger than 0.31m are potentially recognizable on some commercial satellite images, however, they cannot automatically be identified as this is up to contextual interpretation. The resolution of military spy satellites is believed to be much better and, according to some sources, even usable for facial recognition (Rayner & Harnden 2011).

In any case, there are still legal measures available to governments to put certain limits on commercial satellite imagery. Since governments project their ownership claims beyond their physical territory and into space, this puts those countries hosting the most developed and prolific commercial providers in an advantageous position to exert certain kinds of censorship. In this capacity, the US, and increasingly European governments, are in a position to assert their influence on private imagery companies, obscure public vision and affect global transparency. In other words, despite all the technological innovation, governments still struggle to maintain some of their authority to regulate what is made transparent and what remains hidden from public sight.

5. THE COMPLEX NETWORKS OF STATE, PRIVATE ACTORS AND CIVIL SOCIETY

Taking a closer look at the US remote-sensing network, governmental agencies are the main customers of the commercial provider, DigitalGlobe. As such, they have a significant influence on the tasking of satellites – this means determining which areas to cover at a certain point of time. Through this privileged access to satellite technologies and resulting imagery, decisions are being made about what is worthy of being monitored and which issues are given more attention. At this moment, the US military purchases large quantities of commercial high-resolution satellite imagery to complement its national remote-sensing system. Moreover, using commercial imagery it becomes easier to share information with other governments or international organisations without revealing its own technical capabilities. In essence, the US government and DG have entered into a dual-dependency. According to its annual report, DG relied on government contracts for about 60% of its revenue in 2014, while the US government would have difficulties acquiring an equivalent quantity of satellite imagery from any other source.

The National Geospatial-Intelligence Agency (NGA) processes the bulk of US government purchases and its director, Robert Cardillo, quite plainly describes the relations with the leading commercial imagery provider as a sine qua non for the agency's operation: “[W]e’ve been in the commercial imagery business for a long time. I have a mission partner called DigitalGlobe. Essentially I can’t do my job today without them” (Scott 2015). Following from this, the alleged commercialisation of satellite imagery in the United

States is arguably carried to a great extent by government contracts and effectively represents an outsourcing of some of its intelligence data gathering to a private company. Going further, DG has also placed employees to sit on-site with its government customers working side-by-side with the government analysts.

This private extension of national intelligence is in line with the strong ties between DG and the US government that goes beyond a mere commercial provision of satellite imagery. Although this close relationship is far from being kept secret from the public – if anything DG uses it for marketing purposes – it barely appears in discourses about how the commercialisation of satellite imagery is linked to transparency. DG keeps in mind the needs of its largest customers and has established service level agreements with the US government and Google. As a consequence, they co-determine which areas of the Earth are imaged and, thereby, have an influence on the pool of data available to other non-state actors. NGOs mainly operate on archived imagery because tasking a satellite for a specific collection results in considerably higher costs than using existing imagery. Thus, these entanglements can be understood as one of the key backstage areas of knowledge production. They have repercussions for the remaining remote sensing community and the kind of transparency it can produce. Because it quietly affects the ways in which NGOs decide which areas to cover in their research as in most cases, consumers of freely available or commercial imagery do not know who has tasked the satellite that captured the imagery (see also Kurgan 2013).

Depending on various factors, such as spectral and spatial resolution or time of acquisition, prices for very high resolution imagery range from about USD 10 to USD 60 per km² and often come with minimum order areas of 25 km² for archival material, or at least 100 km² for new tasking collections.³⁹ These costs cause substantial constraints on the use of satellite imagery in the non-governmental sector and, as the funds of non-state actors often are limited, the decision to buy images is made on a case-by-case basis (Anonymous Interview with US satellite imagery analysts, 2014). Accordingly, if a group of non-state actors envisions a larger project based on regular surveillance, i.e. repeated imagery acquisition, it is probably either dependent on a sponsor, or a preferential agreement with a

³⁹ See www.landinfo.com/prices.htm

commercial imagery provider, which then also introduce their own interests to the network, such as favorable publicity etc. In case of such an agreement, any publication of satellite imagery by an NGO comes with the DG trademark and links the company to humanitarian action, disaster relief and the monitoring of human rights instead of associations with the US defense and intelligence machinery.

In light of this traditional and on-going position of remote sensing in the military sector, it can be argued that personal ties matter and have remained strong as former imagery intelligence specialists are still present in the community of non-state analysts. In many cases, they are highly appreciated due to their expertise and inside knowledge regarding both the technical process of analysis as well as the countries of interest (Anonymous Interview with US satellite imagery analysts, 2014). They play an important role for non-state actors in acquiring the necessary skills to analyze satellite imagery. In other cases, they go about it in a learning-by-doing fashion, reach out to more experienced analysts or sometimes receive advice from DG where a more stable customer relationship is concerned. These networks seem especially relevant since NGOs often lack institutionalized training and education opportunities in contrast to state or private analysts. As a result, non-state actors do, at times, face a situation in which the increasing quantity of available imagery cannot be duly processed due to a lack of trained analysts (Anonymous Interview with US satellite imagery analysts, 2014, 2015).

5.1. Co-developing Algorithms: An Example of Blurring Lines Between the Actors Involved

Since the techno-political development and proliferation of remote-sensing data is likely to continue, another way of dealing with the mismatch of data and human analysts is to turn to automatic algorithm-based analysis. Indeed, the 2014 annual report accentuates an expansion of DG's portfolio from mere imagery provision to offering a range of products that bring together geospatial big data and analytics. Drawing on its vast archive of satellite imagery, the creation of a platform is envisioned which allows users to perform Big Data analytics on their own in a self-service fashion: such developments point to emerging activities in the field of predictive intelligence for security issues.

While predictive analytics are mainly aimed at government and other defense customers, the necessary skills appear to be developed through co-operation with NGOs as well. In an illustrative case, staff from DG's geospatial analytics department collaborated with several organizations and started to document patterns of elephant poaching by, among others, the Lord's Resistance Army (LRA) in the Democratic Republic of the Congo.⁴⁰ While poaching is believed to finance military activities, local rangers have difficulties in securing their park area of approximately 5000 km². DG analysts supported efforts to become more predictive in fighting poaching and created a pattern profile based on the geospatial information of known poaching locations and extrapolated the result to areas with the highest poaching activity. Using these pattern profiles, analysts were able to predict where future events were more likely to occur and to reduce the area with the highest risks of poaching by 95%, thus allowing for more efficient patrolling by the rangers. DG employed similar predictive analytics to monitor extremist activities in other parts of Africa such as Boko Haram in Nigeria or al-Shabab activities in Somalia. One interviewee familiar with the projects enthusiastically reflected on potential areas of applications:

“So, you can imagine how valuable that type of capability is in terms of military, law enforcement or humanitarian efforts to influence where to apply the limited resources” (Anonymous Interview with commercial provider, 2015).

This quotation is illustrative of the blurred lines between state, civil society and business actors: while the analytical tools have been developed by a private company, they are tested and showcased in a context of animal protection and civil conflict in co-operation with an NGO, and then transferred to its main customer base of governments for application in the field of international security. In effect, it is increasingly difficult to distinguish between the particular actor groups, but there are new actor constellations at work in the remote-sensing community which cannot be adequately grasped by simply juxtaposing state and non-state actors.

⁴⁰ For the report called *Poachers Beyond Borders*, see www.enoughproject.org/reports/poachers-without-borders (Accessed: 22-Dec-2015)

6. CONCLUSION

The end of the Cold War, national budget constraints, and expectations of economic benefits have facilitated the transfer of the former military-intelligence technology into the public and private sector. NGOs, advocacy groups and other non-state actors have embraced commercial satellite imagery as a new opportunity to render visible events in places that otherwise are difficult to access. By that, it is envisioned to increase or add to 'global transparency' of various security issues. However, as was shown in the paper, satellite images do not constitute outright 'transparent' windows to the world, but are a product of diverse actor-constellations, political and technological choices, and analytical processes that often remain invisible to the public.

This challenges independent access to and analysis of commercial satellite imagery as prerequisites of global transparency as it reveals shifting power dynamics among the involved actors in the backstage area of knowledge production (cf. Vogel 2008). Since satellite imagery as visual representations of security threats are also laden with particular interests and expectations (Vertesi 2014) of those who purchase, analyze and circulate them, this paper has investigated how actor-power constellation play out in this field. For instance, limited budgets to purchase specific imagery and a lack of longstanding expertise in analyzing it make NGOs partly dependent on the benevolent (or self-interested) cooperation of commercial imagery companies. Moreover, contrary to the dominant narrative, we suggest that the current shifts in the US imaging satellite sector do not exclusively favour non-governmental actors at the expense of governments' security knowledge authority. Rather, the US government still is an important and powerful player in the area of commercial satellite imagery.

As by far the biggest customer and regulator of market leader DigitalGlobe as well as through policies such as shutter control, government actors can still influence the extent to which transparency can be increased by referring to issues of national security. In short, the interplay of the techno-politics of satellite technology and power dynamics in actor constellations is productive of shifting notions of transparency.

Against this background, a binary notion of transparency vs. secrecy is insufficient to address the fundamental changes taking in the satellite technology sector. Rather, we suggest the term ‘fragile transparency’ to emphasize its contingent emergence, limited scope and, in particular, its context dependence. The notion of fragile transparency exposes the shifting power relations inherent to commercial satellite imagery and its potential as a political practice to render certain things as visible and threats to international security.

More concretely, it points to the provisional and temporary character of satellite-based visual representations and their co-constitutive norms and interests: Each satellite image is a specific snapshot of time that assembles a diverse set of actors with differing security and commercial interests, expectations, norms, and claims to epistemic authority.

Changes within this satellite-imagery assemblage potentially interfere with what is publicly visible, what constitutes a security threat, under which conditions and for whom. In this sense, fragile transparency does not refer to the bounded technical functionality of remote sensing nor the normative claim that it needs to be reinforced to ultimately achieve global transparency. Rather, it points towards the power dynamics inherent to the practice of Earth observation thereby also opening up spaces of contestation to critically reflect on the visual construal of commercial satellite imagery in international security. Along these lines, the AMTI, which monitors developments in the South China Sea, illustrates the feature of remote sensing to actualise a fragile transparency. Such a perspective highlights the complex actor-constellation behind the initiative and questions the selection of the specific areas of interest, potential overlaps with US security interests and the practices of costly continuous imagery acquisition and analysis.

In this regard, combining insights from STS and international relations, and in particular security studies, has been instructive as they approach visual representations in a similar fashion albeit with different accentuations. Elements of visual securitization (Hansen 2011) such as circulability and ambiguity can also be found in STS accounts of visual representations: They constitute mobile objects that can easily travel between contexts and acquire divergent meanings along the way. More particularly, Vertesi’s (2014) approach of ‘drawing as’ adds the role of expectations and norms among different actors that produce, use and circulate the images. Reconnecting this insight to Hansen’s take on securitization brings certain types of securitizing actors to the fore and links up the

practices of visual representation with the construction of security threats. In sum, while STS features a nuanced understanding of visual practices, a combination with the visual securitization literature lends itself to introduce a more explicit security perspective that moves beyond the preoccupation with the production of scientific representations.

To conclude, as fragile transparency alludes to the constant shift of actor constellations and notions of transparency, this has variegated implications for science and technology, and security policy. The increasing reliance of the US government on commercial satellite imagery is reminiscent of broader neoliberal trends towards privatization which puts private companies such as DigitalGlobe in a role once reserved for government actors but without sufficient democratic oversight or legitimacy. While the paper has demonstrated the remaining government influence over imagery collection and distribution, the burgeoning technological innovation and international competition from Europe, China and elsewhere raise questions about the future scope and relevance of national regulations for satellite technologies. For non-state actors, the resulting drop in prices and variety of imagery providers might open up the opportunity to become less dependent on certain commercial providers and governments and more confidently follow through with their own goals. Notwithstanding these future developments, visual representations such as satellite imagery are always also the product of purposeful practices and interpretational uncertainties (see also Olbrich & Witjes 2015). This calls for a sense of caution and reflection towards satellite imagery-based knowledge claims, especially when employed in security contexts.

Taken together, in light of the projected proliferation of satellite imagery, shifting actor constellations and the complex process of the visual construction of threats, this paper can be understood as a snapshot itself – constituting a starting point for further research on the co-production of techno-political changes in satellite technologies and emerging actor constellations that dynamically enable different and contingent ideas about global transparency of security issues.

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3. DISCUSSION & CONCLUSION

This thesis explored how science, technology and global politics are co-productive of each other, and how this relationship is also currently changing, by focusing on three specific sites of their interactions. On the level of discourses, it was shown how envisioned sociotechnical futures are shaped by, and respond to, changes in international relations. On the institutional level, it has been traced how bilateral and international relations are increasingly entering into and shaping national S&T governance and policy-making. The last case study then has shown how, on the level of representations, techno-political developments and re-configurations of actor-power constellations are co-producing new forms of security knowledge.

In the following section, I will first outline how each case study has contributed to answering the overall research questions of this thesis. In a second step, I will discuss the papers with regard to those questions and conceptual issues that call for further empirical and conceptual work from a vantage point that explicitly links insights and approaches from STS and IR. I will then draw together the findings of the case studies in the concluding section and suggest four comprehensive “moments of transformation” in the co-productive relationship between science, technology and global politics. These are taking place on the discursive and institutional level, as well as on the level of identities and representations. Together, I will argue, they indicate a re-configuration of local and global socio-technical orders and to new actor-power formations in the assemblages of science, technology and global politics.

These moments will be described in the following ways: First, I will make a conceptual suggestion to broaden the scope of sociotechnical imaginaries towards the **transnational processes they inhabit** as this allows to better grasp how different national imaginaries play out in transnational settings, within processes of global governance and in particular in shaping international relations. Second, I will argue that S&T **internationalization is becoming politicized** as stakeholders are increasingly confronted with global issues of power and conflict and simultaneously provides a way to **de-politicize processes of foreign policy making** that relies on international scientific-technological cooperation. Thirdly, I will offer an understanding of STI **internationalization policies as having an inherent security component**, in they once encourage and enable international cooperation and exchange and render them controllable through the deployment of integrated international scientific-technological infrastructures.

3.1. Discussion of the Case Studies

3.1.1. De-politicizations of Technology in International STI Cooperation

The first paper of this thesis, *“Of Red Threads and Green Dragons: Austrian Sociotechnical Imaginaries about STI Cooperation with China,”* has shown that national S&T policy-making needs to be understood as a dynamic and situated response to the power changes in global orders: We have argued that the rise of China as a global player in S&T, mirrored also in its changing image – from the world's workshop for low-level technological goods towards a potential innovation leader – has created both hopes and fears among stakeholders in international S&T policy-making. On the one hand, China was (and still is) often framed as posing a threat to Western countries' political and economic dominance and welfare, a narrative that has also been a central element in the formation and stabilization of discourses among S&T stakeholders in Austria. On the other hand, Austrian stakeholders were trying to find common ground for Austria's relationship with China. This was eventually achieved by referring to the country as an ‘unavoidable opportunity’ (Bruijn et al. 2012: 16), allowing stakeholders to mainly focus on benefits. As a way of discursively evoking proximity to China, stakeholders in Austria constructed and stabilized a narrative of close ties between the two countries, envisioning enhanced bilateral STI-relations by referring to green technologies as a specifically promising field for cooperation. Green technologies, we have argued, seemed to offer a particular opportunity for promoting international technology transfer and S&T cooperation while at the same time keeping the likelihood of public dissent and controversy relatively low (see also Felt 2015).

The case discussed in this paper offers a good starting point for thinking about how different representations of sociotechnical imaginaries are harnessed for different purposes in different contexts: For instance, China's lack of successful policies for sustainable development is often portrayed in Western media through images of people wearing gas masks while rushing through smog-filled, crowded streets. In contrast, the specific Austrian imaginary of environmental expertise and success is represented in pictures of small, tidy villages surrounded by forests with clean air and crystal clear water. Austria, it seems, is thus offering a natural solution to China's problems through its obviously proven environmental awareness.

However, it is worthwhile to ask what is invisible within such an imaginary of national identity as linked to nature and sustainability, and in particular, what kind of work does such an imaginary do for certain actors? It seems prudent here to pay closer attention to the ways in which actors, in particular those involved in international STI cooperation, frame technologies for different purposes and to trace how certain technologies may be ascribed as neutral objects that foster international partnerships.

Clearly, the importance of context and specificity for understanding how societies relate to certain technologies has been a central concern for work in STS from its beginning. This is even more so when it comes to the role of S&T in state-making processes and (political) identity formations, where the same technological assemblage is likely to embody different and even contradictory political connotations. For instance, when Austrian stakeholders referred to green technologies in an Austrian context, they framed them differently with regard to how they should be applied in China. In the discourses among Austrian STI stakeholders that were part of our investigation, green technologies were related to identity formations having to do with Austria as a pioneer in this specific field. On a broader societal level, they also evoked notions of civil disobedience when it comes to the protection of (Austrian) nature from governmental politics (cf. Felt 2015). Here, one of the key narratives for national identity formations is that civil society movements fundamentally rejected the already-built nuclear power plant in 1978 through protests, occupations, and a national referendum. As a consequence, the power plant never went into operation, and today serves as a national monument to civil society's engagement in (energy) politics.

However, the sociotechnical imaginary about the strong entanglements of environmental awareness and cultures of resistance that can be found in the narratives about Austrian techno-political history does not surface in discourses on cooperation with China. In the processes of being offered and transferred to China, green technologies lose the (potentially) resistive qualities they seemed to have in an Austrian context. At first glance this may seem surprising, given the current state of environmental pollution in China and the potential local and global consequences this has for climate change and living conditions.

In particular, as green technologies are seen as improving not only living and working conditions but as a means to empower non-state actors, oftentimes in relations to the government. Green technologies in the Austrian context are also entangled with and discursively framed as related to, green politics -characterized by a focus on the local or regional level, the activities of grassroots-movements and an appreciation of participatory decision-making processes, including different forms of civil obedience. However, when it comes to China, Austrian stakeholders in the field of green technologies have rather chosen not to comment on sensitive topics such as indecent living and working conditions that are also a consequence of severe environmental pollution, the contamination of water, or forced displacements of people to make way for large infrastructural projects.

This can be read as a discursively created absence of politics in the making of international STI cooperation with China. We can see here how a certain imaginary is constructed and then reformulated and re-contextualized in order to fit certain political purposes. In these envisioned futures, bilateral cooperation between the two countries is deliberately kept free of sensitive political issues, thus constructing an imaginary that responds to global politics through a process of making some of its aspects invisible and therefore enabling cooperation.

I suggest understanding this process as the de-politicization of technologies in international STI cooperation. Of course, much valuable work in STS has dealt with the politics of technologies, and has developed an understanding of science and technology as being intrinsically political (Latour, 1992, Winner, 1986, Blume, 1974, Frickel and Moore, 2006, Collins and Evans 2002).

However, I fully agree with Brown's notion that, of course, many artifacts "have politics," but most do not all the time. Rather, the extent to which technologies are characterized as having politics is, in many cases highly dependent on how they are actively politicized. Politicization, in the words of Brown, can be understood as a "process whereby people persistently and effectively challenge established practices and institutions, thus transforming them into sites or objects of politics" (2015: 7, cf. Palonen 2006: 292). In short, without any kind of contestation, there is no politicization. De-politicization, in this context, would then refer to the absence of deliberations, debates or protests in favor of good (e.g. profitable) relations based on routine, custom, intimacy, collegiality or consensus (cf. Brown 2015). The notion of "in favor of relations" could then easily be applied to the context of international relations and international STI cooperation, too. In this sense, it

would allow for tracing how actors discursively de-politicize certain technologies in the context of international cooperation, and actively make them a means that serves the purpose of enhancing bi-lateral or international relations – or at least to keep the status quo by disregarding potentially more contested aspects.

3.1.2. International STI Cooperation as Foreign Policy by other means

The second paper, “*The Internationalization of STI: An emerging policy field at the intersection of science policy and foreign policy,*” has specifically contributed to understanding how shifting international orders enter into and shape national approaches to S&T governance. This was done by tracing how S&T policy makers develop new strategies and approaches in response to changing global power structures and by establishing closer ties to the field of foreign policy. Similar to the Austrian case outlined above, S&T stakeholders in Germany and the UK referred to the need to prepare for an increasingly international environment, one in which emerging players are entering the global stage of international S&T-based competition and collaboration.

As a consequence, current institutional capacities in S&T policy as well as in foreign policy-making were seen to be no longer sufficient, inducing the formation of strategic alliances between actors and institutions from both domains that were previously in competition for resources and prestige themselves. These new forms of institutional linkages have also affected the ways in which actors in science policy and foreign policy-making are envisioned and envision themselves as being no longer tied to rather separated political entities.

Our empirical investigation has shown that, on the one hand, S&T internationalization policy was increasingly seen as a means to shape foreign policy and, in a broader sense, international relations: whether through new funding opportunities leading to new or enhanced forms of cooperation with other countries or as a way to affect international negotiations by providing scientific advice. On the other hand, foreign policy was increasingly tasked with supporting and promoting international scientific cooperation, including novel initiatives and the development of in-house expertise dedicated to a foreign science policy in the making. The internationalization of S&T and, as a result, the increasing institutional and discursive entanglements of science policy and foreign policy, as we argued in the case of the UK and Germany, now constitute an entirely new policy field at the intersection of STI and foreign policies.

The paper gives indications that this does not only lead to the establishment of new institutions, but also to a restructuration of established institutions for and modes of *doing* S&T policy. What is more, this new policy field also seems to open a new space for – and new dynamics of – the co-production of STI and global politics.

However, while our paper has focused on the formations of new institutions and related forms of expertise, future work on this topic would benefit from developing a more actor-oriented approach. Here, particular attention should be drawn to the ways in which scientists are envisioned as contributing (and actually do contribute) to processes of foreign policy-making and to the underlying conceptions of science that are at work. While scientists as active participants in science policy-making were rather absent from the discourses of our interview partners, they were portrayed in strategy papers as a homogenous community that is perfectly suited to international collaborations. This was particularly the case when strategy papers referred to the objectivity of science and the disinterestedness of scientists with regard to political objectives. In such idealized visions of science (Wolfe 2016), scientists are envisioned as being able to transgress not only nation state borders but also political and cultural boundaries, as long as they share the same research interest.

Science diplomacy activities, in particular on the level of the European Union, are likely to increase in the future. In 2014, the European Commission stated that “further efforts need to be made in (...) addressing the external dimension of R&I policy” (EC: 2014), a science diplomacy dimension is acknowledged within Horizon 2020 and the European External Action Service states that the agency is already working closely together with the Commission “in order to enhance this external dimension of science and research policies, and develop a genuine and ambitious science diplomacy.”⁴¹ Thus, it will be relevant to explore, from an interdisciplinary perspective, the understandings of science that are employed in science diplomacy strategies, and also the capacities of scientists to actively engage with and shape international politics. Here, it is particularly noteworthy to ask what happens when scientists are indeed disinterested, but in ways that might conflict with

⁴¹ ec.europa.eu/headquarters/headquarters-homepage/410/science-diplomacy_mt

their engagement in foreign science policy or science diplomacy at all? Also, whether and how scientists can willfully circumvent the support of foreign policy aims but still take part in science diplomacy initiatives, for instance as a way to get funding? Initial studies have already attempted to address these questions.

Exploring the German science diplomacy initiative, Fähnrich for instance, has shown how researchers approached by the Federal Government have refused to act as lay diplomats because they *“did not agree with the political expectations and were not at all willing to represent German interests and to act as informal diplomats”* (2015: 12).

Instead, they demanded autonomy over their respective scientific aims and were above all interested in the funding opportunities offered, avoiding political commitments and rather pursuing their individual career strategies (see Fähnrich 2015: 12). The scientists portrayed in this case study seemed quite successful in following their own logics, trying to overlook the foreign policy agendas behind the funding opportunity in order to pursue international cooperation. Such a perspective on scientists' views about being nudged towards the arena of international politics provides a good starting point for exploring the newly emerging forms of academic and political partnership in the context of foreign policy. Borrowing Latour's term (1987), one promising way to do so would be to “follow the scientists” engaged in science diplomatic initiatives into the realm of international negotiations, meetings, advisory groups or expert briefings. Such an approach would also contribute to an enhanced acknowledgement and re-conceptualization the agency of scientists themselves as shaping and co-determining the design and operation of science diplomacy. Furthermore, following scientists who are acting or are envisioned as diplomats would also allow for a better understanding of the political and epistemological backstage regions (Hilgartner 2002) in which science and foreign policy interact with each other.

3.1.3. Technology, Security and Contingent Forms of Transparency

The third paper, “A fragile transparency: Satellite imagery and the making of international security issues,” explored the ways in which changing international orders come to matter within new forms of S&T governance and process of knowledge making as related to security. One central aim of this paper was to come to terms with the shifting power relations inherent to commercial satellite imagery and its potential as a political practice to render certain things as visible threats to international security. Here, we have shown how the transformation from a bi-polar to a multi-polar world system (cf. Munster & Sylvest

2016) has also been co-constitutive of the diversification of satellite technologies, the resulting imagery and different forms of security knowledge production. For instance, with the end of the Cold War, the US government responded to the growing international competition in space technologies by encouraging the transfer of satellite technologies to the private sector. The commercial availability of satellite images, in turn, has opened up novel opportunities for non-state actors to access and analyze the images, contributing to and potentially challenging previous – and often classified – forms of imagery-based security knowledge. Indeed, we have argued that the commercialization of satellite technologies has not simply reduced the power of government actors.

Instead, the US government remains an important player, since it is the biggest customer of commercial imagery and simultaneously its main regulator. The complex assemblage of state and non-state actors, their mutual dependencies and the changing power dynamics at play thus interfere with what is publicly visible, what constitutes a security threat, under which conditions and for whom. We have suggested understanding this as the co-production of a fragile transparency, referring to its contingent emergence and context dependence.

The notion of fragile transparency not only exposes the shifting power relations inherent to commercial satellite imagery analysis and its potential as a political practice to render certain things as visible. It also alludes to the provisional and temporary character of satellite-based visual representations and their co-constitutive norms and interests: Each satellite image is a specific snapshot of time that assembles a diverse set of actors with differing security and commercial interests, expectations, norms and claims to epistemic authority.

However, future work on the role of technological innovation for increasing the access to knowledge and information in global politics would definitely benefit from a more comprehensive approach to the concept of transparency itself. Transparency as a political practice and as a policy term is key to many fields and actors, from nuclear proliferation – which was of paramount importance for most of our interview partners – to the fight against corruption or in the field of development assistance and foreign aid. However, only recently have scholars in IR begun to develop a more profound theorization of the concept. McCarthy and Fluck (2016:20) have suggested approaching transparency in global politics with the notion of “transparency-as-dialogue.” According to them, transparency is less about the disclosure and enhanced availability of information but rather refers to the openness between different social actors as a precondition for engaging in a dialogue.

However, their approach refrains from pre-defining particular actors, e.g. governments, NGOs or activist networks as constituting (or hampering) transparency and does not assume that a dialogue between them takes place in a power-free zone. (2016: 20).

As an example, they point to the ways in which the International Monetary Fund has promoted the transparency of financial flows in order to support political decision-making processes after the global financial crisis in 2008. While the authors clearly acknowledge that information is necessary for the global financial system to operate, they also argue that a focus on the provision of information, captured by the term “transparency as information” (2016:21), might be too narrow, as it fails to reflect the broader configurations, the ongoing “structural crisis of Western economies, the politics of regulatory capture and the ideological elements of the crisis of the global financial system” (McCarthy & Fluck 2016: 21).

Instead, the notion of “transparency-as-dialogue” would allow for a re-politicization of the transparency discourse in a way that is attentive to how the global economy is constituted, instead of glossing over political differences and inequalities that are unlikely to be reduced merely by more information. Such an understanding easily lends itself to STS accounts of the role of transparency in state-making projects. In particular, Ezrahi’s account of instrumental politics has shown that the legitimacy of transparency projects relies on the (outdated) idea that truth might simply lie in the “domain of plain public facts” (Ezrahi, 2004: 106; cf. Moore 2017). According to him, more access to information will not automatically lead to more transparency, in particular when it comes to forms of governmental accountability.

Rather a refined approach to the ways transparency is performed and enacted in the making of international relations might help make visible the various power structures and oftentimes conflicting interests attached to it. Such an approach would also be highly promising for attempts to explore the current major developments in the field of satellite technologies, particularly when it comes to technological innovation in micro-satellites. Here, policy makers and start-ups in the field of satellite technologies are already envisioning a techno-political future where every place on earth can be monitored on a daily basis to increase global transparency (cf. Olbrich & Witjes 2016). Certainly, and as was shown in the paper, satellite images have always been a key resource for knowledge. As pictures and images in general, they have been a unique way to engage with world by

imagining place (cf. Shim 2015) and to come to know otherwise unknown and undisclosed areas and, through this, to make the world (more) knowable.

However, both the increase in micro (or cube) satellites that are orbiting the Earth and usage of big data analytics for Earth observation data are expected to fundamentally alter the ways in which we are able to see the world from above. These satellites, which have a size of 4 inches, are the shape of a shoe-box and can be launched into orbit for \$3000 each, are likely to be bound up with a broader socio-political current. As Garbee and Mainard (2016)⁴² stated, “the decrease in cost is allowing researchers, hobbyists and even elementary school groups to put simple instruments into LEO [Low Earth Orbit], by piggybacking onto rocket launches, or even having them deployed from the ISS [International Space Station].” While we can understand this development as a democratization of space technologies, including increasingly individualized opportunities for non-state actors to contribute to some forms of transparency, at the same time, they pose novel questions about privacy and emerging regimes of surveillance. This tension is well-captured by a quote from a journalism professor in the New York Times, who reflects on the recent developments in the field of micro-satellites, stating that “Now we can have a Godlike view, looking down from the heavens...I can understand why people would be nervous. But the cameras can make the world more transparent and open. I’m for that.” (Eisenberg 2013, August 31). In a way, this speaks to transparency as constitutive for the what Taylor has termed the “direct access society” and to the formation of an imaginary of an increasingly “flat landscape of data” (2004:157).

Exploring democratic and responsible ways to govern technological innovation that take into account privacy violations vis-à-vis transparency as a political practice calls for work in STS and IR alike. In particular, conceptualizations of socio-materiality from New Materialism in IR and material-discursive approaches from Science and Technology Studies (STS) are already constituting promising interfaces since both take into account the human-material entanglements and assemblages of science and technology, politics, economics and society.

⁴² theconversation.com/the-future-of-personal-satellite-technology-is-here-are-we-ready-for-it-58478

3.2. Conclusion

The previous section has outlined each paper's contribution to answering the overall research questions and has highlighted some of the aspects that are worth exploring in future work on these topics from STS and IR alike but which could not be covered within the scope of the respective papers. The concluding section will now move beyond the particular foci of the empirical case studies. Here, I will draw together the overall findings of the thesis and describe them as constituting three particular moments of transformations in the ways science, technology and global politics are co-productive of each other.

3.2.1. Transnational Sociotechnical Imaginaries

As I have shown throughout this thesis, S&T and global politics come to matter to each other through multiple and complex interactions and on a variety of different scales, with collective imaginations about attainable socio-technical futures figuring prominently among them. Earlier work in STS (Castoriadis 1987; Anderson 1991; Taylor 2004, 2007; Jasanoff and Kim 2009, Kim 2013; Mikami 2014) has dealt extensively with questions about how identity formations are constructed and institutionally stabilized with regard to techno-political change, mainly by focusing on the national level, asking for instance "how [do] national science and technology projects encode and reinforce particular conceptions of what a nation stands for?" (Jasanoff and Kim 2009, 120). However, the concept of sociotechnical imaginaries has also acknowledged from the beginning that national sociotechnical imaginaries are not only formed on the respective national level but also contain experiences, expectations, perceptions and imaginations about other nations or collectives, too (cf. McNeil et al 2017). Sociotechnical imaginaries are thus intrinsically international, as collective imaginations and issues of political statehood always also include an imagination of the other, of the outside of a given collective.

In a recent edited volume, Jasanoff and Kim have brought together an inspiring collection of STS contributions to further refine and extend the concept of imaginaries (2015). Here, the authors shared an enhanced appreciation of the ways that imaginaries are developed beyond the level of the nation state, for example by organized groups, corporations and social movements (cf. 2015: 4). Such an extended perspective is particularly promising for being able to grasp the variety of scales on which imaginaries are shaped and stabilized in the context of international relations.

Appadurai (1996: 33) has most explicitly addressed the globality of imaginaries by referring to the notion of “*imagined worlds*, that is, the multiple worlds that are constituted by the historically situated imaginations of persons and groups spread around the globe.”⁴³ Contributing to this stream of work, I suggest to more explicitly explore the ways in which sociotechnical imaginaries frequently emerge in response to, or at least incorporate a particular interpretation of, sociotechnical developments in other countries. In an increasingly interdependent world, it will be necessary to also investigate which kind of work transnationalized sociotechnical imaginaries might do for different actor configurations in global politics.

Bowman has already alluded to how such external influences can shape national imaginaries in her chapter on sociotechnical imaginaries about ICT in Rwanda. (2015). Here, she traces the ways in which Rwandan state planners and policy makers of the first elected government envisioned the internet after the 1994 Civil War. Pointing to the government’s ambition to become the “African Singapore,” Bowman argues that Rwanda’s ICT policy-making initially attempted to mimic the economically wealthy and technologically advanced city-state. The Singaporean approach to the internet as a medium of control, however, was eventually seen as contradictory to a more transformative vision of the internet as contributing to the Rwandan rebuilding process (2015: 96). It is precisely these intersections of increased internationalization of S&T, technology transfer and related processes of state-making that call for more attention from STS and IR in order to explore in depth how sociotechnical imaginaries respond to and incorporate visions of the “other.” Here, two interlinked processes seem particularly promising for doing so.

First, taking up the example of Rwanda, **socio-technical imaginaries have international points of reference**, which is to say that collective self-imaginings and identity-making processes take place vis-à-vis other countries, in particular as they pertain to S&T. This was also shown in the paper regarding cooperation in S&T between Austria and China, where the Austrian socio-technical imaginary of environmental awareness and expertise was

⁴³ Imagined worlds, in his understanding, are constituted by “five dimensions of global cultural flows that can be termed (a) *ethnoscapes*, (b) *mediascapes*, (c) *technoscapes*, (d) *financescapes*, and (e) *ideoscapes*.” (Appadurai 1996: 33).

constructed as a way to relate to China. Here, sociotechnical imaginaries at once support the processes by which different social actors find common ground by drawing on a shared socio-technical history and by opening up opportunities to address an envisioned future relationship.

By drawing on different repertoires of knowledge and imagination, actors can relate to the current and past techno-political development of another country as a frame of reference that is worthy of either emulation or rejection or inspires the development of alternative visions. Through these processes, the “other”⁴⁴ is actively constructed.

However, approaching imaginaries as transnational by no means assumes that these are reciprocal or homogenous: The observed society will not necessarily share this image as part of its own imagination, and indeed the imaginaries may not be universally held by members of the observing societies. Instead, different imaginations about other countries can also compete with each other as a consequence of different political views within a given society⁴⁵. As Jasanoff has argued, “multiple imaginaries can coexist within a society in tension or in a productive dialectical relationship” (2015: 5), thus a country or region can simultaneously be perceived as a positive and a negative point of reference, given the political or cultural attitudes held by different societal actors and stakeholders within the observing society. More generally, tracing these different perspectives would make it possible to understand how transnationalized sociotechnical imaginaries are co-produced through mutually stabilizing and dynamically changing communities and collectives on the international level.

⁴⁴ The term “imaginings of the other,” as I suggest employing it here, differs in a way from the processes of othering as they have been described most prominently by Said (1978) in his account of Orientalism, the discourse of colonialism and eurocentrism. I agree with the notion that processes of othering are closely entangled with issues of power and knowledge, almost always implying a hierarchy favoring those already in power. However, in the context of transnationalized imaginaries, I argue that the constructed view towards others can also be one of inspiration or admiration instead of deprivation.

⁴⁵ Of course, as Jasanoff has pointed out, the “viewer’s capacity for observation (...) socially trained in ways that delimit what she can perceive”. In this context, the state also disposes over a variety of devices, as she calls it, to determine what is visible at all. (2015: 13). In any case, such a constructed view of other countries must be seen as also deeply embedded in past and current bi- and international relations, which again closely intertwining technological and political choices. For example, the ways that emerging spacefaring nations imagine their space programs are also entangled with collective memories about the perceived space-race between the former Soviet Union and the USA and competing ideological systems. Such perceived histories and imagined futures provide the background against which societies construct and stabilize a particular sociotechnical imaginary.

Second, we might want to think of imaginaries as also being transnational because their **constituencies have an international reach**. Both Miller and Lakoff (2015) have recently pointed in this direction in their work on imagined forms of globalism as transcending older imaginaries based on the nation state. For Miller, globalism imagines “that human societies and economies, the systems they create, the environments within which they flourish and the risks and threats to security they experience are increasingly global, capable of being understood and governed on scales no smaller than the planet” (2004; 2015:277).

Lakoff, in turn, sees an imaginary of global health security emerging, constructed and stabilized by transnational institutions of global governance like the WHO (2015). Imaginaries of the global, encompassing transnational financial markets, cultural practices in the context of diasporas or the formation of political institutions and many more manifest themselves differently in different places, often without having a specific national origin. Simultaneously, such transnationalized imaginaries might also re-enforce nationally grounded imaginations of identity and territorial boundaries.

For instance, while cosmopolitanism has become a widespread imaginary among a variety of social groups in different places, at the same time, paramilitary border regimes have been established worldwide. These are regimes that often brutally distinguish between insiders and outsiders, thus very much thwarting an imagination of a shared planet. Transnational imaginaries thus link particular national and transnational responses to each other, and they are blurring, possibly also obscuring, the boundaries and contradictions between them. Drawing more explicit attention to the transnational politics of scientific-technological projects and how these connect countries and collectives at a supra-national scale would then also make it possible to more fully understand the co-production of science, technology and international relations. With regard to methodological considerations, the current concept of sociotechnical imaginaries already embraces transnational comparison and is thus more than prepared to include the multiple perspectives that are at play in transnationalized imaginaries.

3.2.2. International STI Cooperation as “extrastatecraft” in Global Politics

While modern science, technology development and innovation have always entailed international collaboration – for example, through international exchange between scientific colleagues – the increased internationalization of S&T systems has fundamentally contributed to the opening up of spaces of entanglements between science, technology and foreign policy-making. For more than a decade now, S&T internationalization policies and strategies have been tying together a globe-spanning network of international collaboration that mirrors a multilateral world order, including its institutions of inter-/transnational governance. Two particular narratives are exemplary of the ways in which S&T internationalization and changing international power configurations are co-producing such novel discourses formations.

First, within the global innovation landscape, the “center of gravity” (cf. Wilsdon & Leadbeater 2013) has started to shift from the former triad of science and technology-based power – concentrated in the US, Western Europe and Japan (Alatas 2003) – towards Asia and, increasingly, the Middle East. As a consequence, international S&T cooperation is increasingly framed as an imperative need in discourses on STI-policies (also see the first paper), that oscillate between anxieties over who will take over innovation leadership in the future and who hopes to benefit from the access to new markets and economies. This is related to the second point, namely that many of the emerging countries follow different logics of governance, or, more precisely, that authoritarian and non-democratic countries are becoming ever more important players in the field of techno-scientific innovation. Such an extended view of new cooperation partners, as the papers have shown, is thus challenging S&T stakeholders to engage in novel ways with core issues of international relations, in particular when it comes to issues of democracy, international ethics and responsible governance of S&T.

Second, our paper on the internationalization of STI has shown that common strategies and institutions have recently been developed and set up to foster cooperation between the fields of S&T policy and foreign policy, potentially leading to a hybrid policy field at their intersections. With globalized techno-scientific orders being subject to essential change, this poses a whole new set of questions regarding possible forms of their democratic governance. The most obvious aim of foreign policy is to represent national interests on a global political stage. International S&T cooperation, however, is much more complex with regard to the actor configurations and interests at stake, with governmental, private and

civil society actors involved. If the boundaries between these fields are increasingly getting blurred, as our material indicates, what does it tell us about the future relationship of foreign policy and international S&T cooperation? What does their merging mean for the relationship between S&T and the nation state?

As we have outlined, S&T cooperation can also be a way to avoid the more sensitive issues like human rights violations, which foreign policy might be obliged to respond to. Here, the question emerges about whether and how international S&T cooperation is already becoming an arena of international relations by other means. Using Keller Easterling's notion, this would be a form of extrastatecraft – a particular power and agency of infrastructural technologies that goes beyond the more traditional forms of governance. Although not explicitly concerned with foreign policy, Easterling has pointedly remarked that the most radical changes in global politics are already “being written, not in the language of law and diplomacy, but in these spatial, infrastructural technologies – often because market promotions of prevailing political ideologies lubricate their movement through the world” (2014: 15). Such an understanding of global politics as being written in the language of technology cooperation relates to the findings of all three case studies. However, there are two mutually reinforcing processes at work that point to the co-productionist relationship between S&T and foreign policy.

On the one hand, as has been pointed out in the papers, discourses in S&T policy are increasingly shaped by issues of international relations, not least through the notion of global challenges that S&T need to respond to. However, while topics like resource scarcity, transnational cybercrime or restrictions to the freedom of speech are also entering into the discourses and strategies of S&T policy making, this does not mean that they eventually affect how cooperation partners are chosen. On the contrary, international S&T cooperation is still rather framed as a series of bridge-building activities, with discourses drawing heavily on notions of science as overcoming cultural and political boundaries. Therefore, S&T policy is becoming politicized in novel ways that confront policy makers with issues of power, authority, and political representation that are played out differently in different countries. On the other hand, it provides another way to de-politicize processes of international policy making: Science and technology policy is not held accountable in the same way that foreign policy is when it comes to conflict and cooperation with authoritarian regimes.

Therefore, scientific-technological cooperation can thus be understood as a form of extrastatecraft, of making politics without political negotiations and even less public debate. Policy discourses on the internationalization of S&T are only beginning to become concerned with broader questions of international relations. For work in STS and IR alike, this provides an opportunity to explore in more depth how the co-productive relationship of S&T policy-making and international relations will be shaped in the future, in particular with regard to issues of democracy and possible forms of responsible research and innovation as applied on a global scale.

3.2.3. STI-internationalization Policies as Security Regime

The last moment of transformation in the relationship between S&T and global politics focuses on the ways in which STI internationalization policies come to matter with security. The last paper of this thesis has most explicitly dealt with issues of international security, tracing the changing power constellations between state and non-state actors in the field of satellite technologies as a consequence of the commercialization and privatization of that sector. We have indicated how the increasing international competition in the field of private satellite providers is expected to lead to changing regulations, e.g. in terms of the availability and resolution of the imagery. This in turn, can be expected to pose novel questions regarding the governance of increasingly private surveillance practices vis-à-vis issues of privacy and data protection, affecting representations about security and the making of security politics alike. Albeit in a more general sense, the other two papers have also touched upon questions of security. For instance, the first paper has alluded to the ways in which potential security issues and risks tend to become glossed over in the discourses among STI stakeholders, for the sake of international cooperation and competitiveness. Focusing on the emerging intersections between science policy and foreign policy, the second paper has pointed to the security dimension of science diplomacy, where stakeholders increasingly envisioned scientific-technological cooperation as a way of improving strained relations between nation states.

In what remains, I will extend this view on how STI internationalization policy and security politics increasingly matter to each other by arguing that the internationalization of STI is also changing the relationship between science, technology and international security policy, thus creating new institutional and discursive spaces and actor configurations between them.

However, while it is common knowledge that science, technology and innovation almost always also have a security component, the political practices by which international STI cooperation and security are intertwined with each other are strikingly absent from current narratives of STI internationalization. It seems that, contrary to the general increase in the usage of security as a point of social and political reference, notions of security are rather marginalized in governmental policy papers and discourses on STI internationalization. This is astonishing, as the mobility of people and things, the transfer of technologies and embedded political and cultural meanings, and the circulation of knowledge and money are all at the core of STI internationalization projects and are the focus of security politics. As complex global flows of human-material entanglements, they constitute both a condition of what is often termed “global modernity” and a road to insecurity and novel security frameworks. But other than prevalent notions such as the globalization of risk or the transnationalization of crime, both of which contain strong references to technology, the internationalization of STI has not yet sufficiently entered into current conceptualizations of security. At this point, however, two conceptual clarifications seem necessary.

First, claiming that the internationalization of STI brings about a new assemblage of STI and security is of course closely related to discourses on the co-production of science, technology and globalization processes (cf. introduction). Responding to the perception of emerging transnationalised configurations of insecurities, Beck has most prominently established the notion of “global risk societies,” where risk is understood as a “a systematic way of dealing with hazards and insecurities induced and introduced by modernization itself (1992: 21). According to Beck, globalized risks are blurring the boundaries of nation states, replacing mobility as a way of relating to each other with common perceptions and exposures to risk. From an STS perspective and by drawing on Beck and others, Bijker et al. (2014) have also offered valuable insights on the vulnerability of technological cultures. For them, science and technology are at once a means to address risks and insecurities and create new risks and possibilities for global social, political and ecological catastrophes. This is encapsulated in the statement that “Once we have large technological systems, accidents are inevitable; because we live in modern scientific and high-tech societies, risks are inevitable” (2014: 3).

While the focus on the globalization of risk and the role of science and technology within such configurations is highly valuable and an already well-established vein in social science thinking (cf. introduction), I suggest considering S&T internationalization politics as a key moment of transformation between S&T and security on its own. This is not opposed to a perspective on globalization but is rather a related process that is taking place in parallel, though on a different level. As was indicated in the papers of this thesis, the nation state still provides an important register for S&T policy making. Therefore, the scope of the term “globalization” appears too broad for grasping how political integration as a condition for, and brought about by, international scientific-technological cooperation similarly enables novel articulations and representations of security.

The second clarification concerns security as a term, one that has become so all-encompassing that it is increasingly hard to grasp *how* science and technology come to matter to *which* frameworks of security. As Valverde (2001: 90) has noted, for instance, the term security “enables and conceals a diverse array of governing practices, budgetary practices, political and legal practices, and social and cultural values and habits” security can be a necessary condition for any society (Der Derian 1995; Burgess 2011), a “pathological tendency that potentially undermines what it was set to protect” (Beauchamps et al 2017, cf. Neocleous 2008; Molotch 2012), or with Foucault, a means of government (e.g., Foucault 2007; 2008). However, while scholars and policy makers alike have been concerned with defining the term, filling it with ever new meanings, the opposite seems to be the case when it comes to how STI internationalization strategies⁴⁶ approach security.

If we look at national and international policy discourses on STI internationalization policies, these tend to center around issues of cooperation, competition, mobility, transfer and exchange of technologies, knowledge and people. A key element within these discourses, as the first two papers of this thesis have also shown, is the closer integration of different political, cultural and economic systems by the means of STI. In particular, when it comes to European scientific-technological cooperation, this is mainly framed as establishing trust, overcoming borders between nations, as supporting the formation of a trans-European epistemic community of researchers and as the most promising way of

⁴⁶ As both papers of this thesis have focused on the EU policy context, this is also the point of reference for the argument made here.

strengthening the EU's competitive advantage. If policy documents, e.g. on the external dimension of European STI collaboration mention security at all, the references are rather vague, pointing for instance to "the need to secure European values" or "protect European societies" by the means of advancing technological innovation (EC: 2009; 2012).

It seems that within these narratives, the various security components of innovation are rather black-boxed: There seems to be one dominant meaning of security – security against external threats – and one dominant way of increasing security – namely by investing in further technological development, in particular through massive private sector funding (cf. Jeandesbosz & Bigo 2012).

The establishment of the European Security Research Programme (ESRP) is a prime example of the co-production of an increased international competition in STI and the establishment of a dominant notion of what security should entail. Shortly after 9/11, European officials and large arms and IT companies had expressed fears about not being competitive enough in terms of innovation compared to the large R&D investments made by the US government in the security sector. In close cooperation with the European defence industry and large companies, this led the European Commission to develop and implement the ESRP. As for instance Bigo and Jeandesbosz (2010) have shown, major defense and security companies have played a key role in defining the orientation and priorities of the EU's research and development policy for security-related technical systems – and they also turn out to be the major beneficiaries of this policy.

Our paper on the commercialization of satellite technologies has pointed in the same direction, namely that shifts in the power relations between public, private and civil society actors are increasingly shaping and shaped by new forms of knowledge and technological developments in the making of security politics. As a result, private actors increasingly co-determine what and who constitutes a security threat – and what responses to that threat should look like. Through the internationalization of STI, these actor constellations are becoming even more complex, intertwining national decision making and budget spending with multinational considerations as well as internal and external security concerns. The entanglements of international technology transfer, market liberalization and international security also become visible with regard to intelligence services. As van Buuren (2013: 241) has recently argued, the international dimension of intelligence operations "does not only refer to *international cooperation* between intelligence services, but increasingly to the *internationalisation* of intelligence collection." This is due to increased international

cooperation and the involvement of private corporations like Facebook and Google. Mechanisms of national oversight are becoming increasingly difficult or obsolete, an argument we have also made in our paper on satellite imagery. It will therefore be very necessary to pay more attention to the manifold sites where internationalized and increasingly integrated S&T systems are shaping and shaped by new kinds of internationalized security regimes.

One promising starting point would be to explore contemporary liberal politics in the field of STI internationalization as at once constitutive and restrictive of different forms of mobility. As such, we could analyze how security issues enter into and shape the political practices of STI internationalization, and how these at once encourage and enable international cooperation and exchange and render them controllable through the deployment of specific scientific-technological infrastructures, in particular when it comes to travel and transportation, to business, borders and migrations. International airports are a good representation of such complex assemblages, as they are at once “national spaces that connect to international spaces, frontiers that are not at the territorial limit, and grounded sites that embody mobility” (Salter 2008: introduction). International databases, too, serve as a backbone of international STI cooperation and as integrated networks of control and surveillance. The interoperability of IT systems for instance, is a necessary precondition for large-scale collaborative research infrastructures as well as for the cross-border comparability and sharing of personal data. In the same way that formerly national STI systems become increasingly international, so do the scientific-technological infrastructures that underlie and regulate the cross-border movements of people and knowledge, constituting an assemblage of security politics, national and international STI governance and corporate interests (the travel ban for people from a range of Muslim countries recently imposed by the current US administration and the public resistance against it is only one example).

While these assemblages are an inherent part of our everyday life, they remain yet underexplored with regard to how they constitute social and political order, affecting the ways in which we can or cannot produce and share knowledge. What is more, it will be fruitful for future work interested in international cooperation to attend to the various ways in which security resides within STI internationalization policies. More precisely, it

will be necessary to ask how security is framed and by which actors, how power is both exerted and shifting, and how security enables and hinders different kinds of agency – in short, to think about STI-internationalization as a site of security politics or what can for now be termed contingent “internationalized regimes of security innovation.”

Contributing to STS research in the co-productionist idiom that has shown how S&T is always embedded in various state apparatuses of knowing and ascertaining and, conversely, how statehood is being envisioned, enacted and operationalized through projects of S&T (e.g. Ezrahi 1990), the three moments of transformations described here have explicitly alluded to the global political dimension of these processes.

The first moment, described as the transnationalization of socio-technical imaginaries, suggests paying more attention towards the transnational political processes by which scientific-technological projects are shaped by and shaping, connecting and (dis)connecting societal imaginations around the globe. I have argued that, in an increasingly interdependent world, it will be necessary to also investigate how transnationalized sociotechnical imaginaries are shaped by and shaping international relations and to unravel the how they are actively constructed to serve different actor configurations and purposes in the arena of global politics.

The second transformation in the relationship between S&T and global politics, referred to as STI internationalization as a form of “extra-statecraft”, was seen in the ways in which current STI internationalization policies need to be understood in relation to processes of politicization and de-politicization, I have argued here that national S&T policy making is becoming politicized in novel ways, as the field is confronted with issues of power, authority, and political representation that are played out differently in different countries. At the same time, international STI cooperation can be seen as way to de-politicize processes of international relations, since STI policies are not held accountable in the same way that foreign policy is when it comes to conflict and cooperation with authoritarian regimes. Understanding STI internationalization policy as a form of extra-statecraft (Easterling 2014), would then allow to grasp how the entanglement of S&T policy-making and international relations, will be shaped in the future, in particular with regard to issues of democracy and possible forms of responsible research and innovation as applied to a global scale.

Similarly, the third moment of transformation has alluded to STI internationalization policies as security regime. The mobility of people and things, the transfer of technologies and embedded political and cultural meanings, and the circulation of knowledge and money, it was shown, are all at the core of STI internationalization projects and are the focus of security politics. However, they seem to be comparatively downplayed within current policy discourses and narratives on STI internationalization and its purposes. Therefore, work from the vantage point of STS and IR could contribute much to explore the political practices by which security issues enter into and shape the political practices of STI internationalization, how these at once encourage and enable international cooperation and exchange, and render them controllable through the deployment of specific scientific-technological infrastructures.

4. EPILOGUE

Science has lost a lot of clout and credibility, and we cannot rely on “reason” when arguing for global science. Those engaged in science and science policy-making could potentially be a key component in the shaping of responses towards populist movements, including how to deal with claims that science is contributing to the splitting of societies along dividing lines of class and privileged forms of knowledge, as encapsulated in former Education Minister (and top proponent of the Brexit) Michael Gove’s claims that “the people of this country have had enough of experts.” If this claim is accurate (and the success of the Brexit vote as well as the election of Donald Trump to the US Presidency lends credence to this argument), then science and scientists face the challenge of finding radically new approaches to ensuring public support and public engagement when traditional flows of knowledge production are being called into question. The year 2016 may indeed represent a turning point in the relation between science and international politics that provides opportunities for reconsidering the science-society relationship – one that is not only embedded within national and international political decision-making, but which plays an important, if albeit challenged, role in global and local democratic deliberation writ large.

2016 was also the year when “post-truth politics” was named the word of the year by the Oxford Dictionary, defined as “relating to or denoting circumstances in which objective facts are less influential in shaping public opinion than appeals to emotion and personal belief” (OED Online 2016). Exploring the semantic and the political meanings of such terms should call for scholarly attention from both STS and IR, as it speaks to the core of both disciplines’ interests and expertise. What is the role of scientists and experts in discourses on post-truth politics? How does scientific knowledge come to matter to democracy or vis-à-vis anti-democratic tendencies? How do post-truth politics, associated with countries such as Turkey, China, Russia, the UK and the US alike, influence today’s and future global politics and international relations? What is the role of scientific expertise in international negotiations? How does the notion of post-truth politics change the backstage and front stage interactions of science and politics (Hilgartner 2002), in democracies and also in authoritarian regimes?

My hope is that new forms of research, public interest and collaborative initiatives at the intersection between knowledge politics and international relations could be at least one set of positive outcomes to these otherwise disappointing political developments. While there certainly are disciplinary boundaries between STS and IR that need to be overcome, interdisciplinary accounts are increasingly called for and, indeed, seem to already be on the rise. We can see this, for instance, when it comes to the large academic conferences, which are effectively seismographs of the scientific communities and that show which issues need to be addressed and explored in more detail. On a personal account, participating in both IR and STS conferences while writing this thesis seemed to indicate that there is interest from both communities in these issues. This year's 4S Presidential Plenary will focus on "Interrogating 'the Threat'" by explicitly addressing issues like (in)security, (anti)militarism or (im)migration.

In turn, ISA, a traditional IR conference, has established its own section for Science, Technology, Art and International Relations (STAIR), signaling that interdisciplinary engagements are entering a stage of increased institutionalization, with more and more scholars committed to engaging with the manifold entanglements and mutual shaping of science, technology and international politics. On a more pragmatic level, I am convinced that these exchanges need to grow further. As social scientists interested in questions of knowledge, power, and politics, we should not shy away from the search for answers and possible solutions to a world in which new forms of conflict, crisis, insecurities and human drama are proliferating. For there is no question that not only are new answers needed, but new questions as well.

5. REFERENCES

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ANNEX

Summaries of the Articles and Individual Contribution

Article 1

Ruth Müller & Nina Witjes: "Of Red Threads and Green Dragons: Austrian Sociotechnical Imaginaries about STI cooperation with China"

Published in: Mayer, M., Carpes, M., Knoblich, R.: *The Global Politics of Science and Technology: Perspectives, Cases and Methods* (Volume 2). Springer, Berlin/Heidelberg, pp 47–65.

ABSTRACT

In this chapter, we address intersections of Science and Technology Studies (STS) and International Relations Theories (IR) by looking at how Austrian science, technology & innovation (STI) policy makers and related stakeholders envision and enact a close relationship between China and Austria in the field of green technologies. Analytically, we draw on the concept of ‘sociotechnical imaginaries’ as proposed by Jasanoff and Kim, which attempts to grasp how visions of social order and technological development become entangled in the processes of science and technology policy and politics. China is currently arising as one of the key global players in STI. It is intensely courted by numerous countries seeking collaboration and market access. China’s most recent Five-Year-Plan has introduced a focus on environmental sustainability to complement economic growth. Based on interviews, participant observation and document analysis, we show how Austrian STI actors connect their national positioning activities to this recent focus on sustainability. We trace how they attempt to find common ground for relating to the rising and ever so dynamic People’s Republic by drawing on a nationally accepted narrative about Austrian technopolitical history and culture that casts the country as pioneer of environmental awareness and green technologies. We understand and analyze this process as part of a broader Austrian sociotechnical imaginary in the making that constitutes a situated response to an increasingly globalized STI system, while building on and reaffirming central elements of Austria’s local technopolitical culture and history.

Contribution Nina Witjes: I have contributed to this article by co-conceptualizing its outline and design, by collecting materials and analyzing interview data. I have co-written several parts of the article, in particular its introduction and the theoretical parts that concern the field of International Relations. Further, I have contributed to the methodological framework of argumentative discourse analysis.

Article 2

The Internationalization of Science, Technology & Innovation (STI): An Emerging Policy Field at the Intersection of Foreign Policy and Science Policy?

Published in: Franzmann, A., Jansen, A. & Münte, P (2014).:
“Legitimizing Science: National and Global Public, 1800–2010”
Campus: Frankfurt/New York, pp. 245–272.

ABSTRACT

In this paper, we focus on STI internationalization policy-making as an arena in which STI policy and foreign policy increasingly interact. Since 2000, national governments have increasingly invested in new infrastructures for their STI internationalization. More or less strategically, they aim at maximizing participation in EU funding schemes and developing a complementary internationalization framework. A range of European countries are in the process of creating science policy networks somewhat akin to embassy-like institutions that would be responsible for international STI relations. We ask if and how STI internationalization has led to a new policy field in the making and how STI stakeholders assess the interrelation between STI policy and international relations. The STI internationalization policies of Germany and the UK are used as case studies for exploring the different ways that EU member states actively build a global STI internationalization infrastructure. We will trace the actor configurations that emerge in this new policy field and, in building on qualitative interview work, analyze their contingent approaches towards the role of the nation state as a central category of international policy-making in the field of science and technology cooperation. Our analysis contributes to the understanding of how science, technology and the respective policies are also co-productive of nation states' foreign policy-making.

Contribution Nina Witjes: As the main author, I have contributed to this article by conceiving its idea and structure, together with Lisa Sigl. Further, I have co-written the introduction, conceptualized and written the theoretical approach regarding “Soft Power” and International Relations, conducted the field work and analysis for the case study on Germany and have co-written the conclusion.

Article 3

Nina Witjes & Philipp Olbrich: “A Fragile Transparency: Satellite Imagery Analysis, Non-State Actors and Visual Representations of Security”

Accepted for publication in: Science and Public Policy (2017)
Author’s Original Version

ABSTRACT

A broad range of non-state actors make use of commercial satellite imagery to monitor global security issues. Questioning the favourable narrative of achieving ‘global transparency’ through Earth observation, the paper unravels the underlying relations between the US government, commercial imagery providers and other non-state actors. Linking insights from Science and Technology Studies and International Relations, two related arguments are put forward: First, the commercialisation of satellite technology and imagery does not dismiss the influence of the state but is conducive of the co-production of shifting actor constellations and related to that, different ideas about transparency and power. Second, this leads to a less benign understanding of transparency which emphasizes its contingent emergence, limited scope and context dependence. This ‘fragile transparency’ exposes the shifting power relations inherent to commercial satellite imagery and its potential as a political practice to render certain things as visible and threats to international security.

Contribution Nina Witjes: I have conceived the idea and design of this article. I have contributed specifically to development of the theoretical approach of linking STS and security studies and have developed the notion of fragile transparency. For the empirical part, I have conducted and analyzed interviews (together with Philipp Olbrich) and have, as the main author, been responsible for the review process and the revised version.

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