Legitimation and effects of mission-oriented innovation policies: A spillover perspective

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Recent times have seen a rising interest for mission-oriented innovation policies (MIP) as a means to mobilize innovation capacities for addressing societal challenges. Building on advancements in heterodox economics and innovation studies, this paper discusses the economic rationales for three MIP intervention types by considering the spillovers they might engender. We provide an empirical illustration by using survey data retrieved from 276 firms participating in Dutch examples of each MIP type. Our findings warn against pursuing system transformations by adhering to traditional firm-level stimuli and impact measures (*MIP drift*), as well as against avid support for context-specific solutions (*myopic MIP*).

Key words: spillovers, externalities, mission-oriented policy, innovative public procurement

JEL: O38 (Government Policy); O33 (Technological Change: Choices and Consequences; Diffusion Processes)

Highlights:

- An overview of different mission-oriented innovation policy (MIP) intervention types
- An integrated spillover framework capturing a wide variety of innovation externalities
- Theorizing and an empirical illustration of the spillovers associated with each MIP type
- Discussion of MIP-related *policy drift* as mismatches between rationales and intervention
- Discussion of MIP-related *policy myopia* involving support for context-specific solutions

1. Introduction

Rooted in science and technology policy, public expenditures on business R&D are commonly legitimized by economic reasoning regarding the existence of spillover externalities (Aghion & Jaravel, 2015). The lack of possibilities to appropriate all value created through innovation activities prevents firms from investing in R&D. Across the majority of at least OECD countries, the common response has been to internalize spillovers in the economy by providing compensation – e.g. as subsidies or tax advantages (Guellec & Van Pottelsberghe de la Potterie, 2003). This way of solving market failures should encourage firms to undertake R&D and innovation activities they would otherwise consider too risky.

As science, technology and industrial policy have been evolving into innovation policy, attention arose also for issues like the circulation and application of knowledge stemming from R&D. Currently, innovation policy is in turn moving towards approaches that even surpass improving just the level of knowledge production and diffusion (Mowery et al., 2010; Boon & Edler, 2018). Instead of hoping that policy-induced innovations will also have a positive impact in terms of mitigating complex societal problems, like climate change and health concerns (often resulting from earlier innovations), contributing to solutions for such challenges is becoming a key policy objective (Borrás & Laatsit, 2019; Foray, 2019). Scholarly work on transformative innovation policy has highlighted how this shift in policy objectives is associated with different roles and rationales regarding governmental intervention in innovation systems (Weber & Rohracher, 2012; Steward, 2012; Schot & Steinmueller, 2018; Diercks et al., 2019; Borrás & Edler, 2020). For instance, Weber & Rohracher (2012) suggest that transformative innovation policies are legitimized by overcoming transformational system failures like directionality, demand articulation, policy coordination and reflexivity failure.

Highly visible within the current thinking on transformative innovation policy is the notion of mission-oriented innovation policies (MIP), i.e. policies directed at meeting an ambitious and

measurable societal goal (Mazzucato; 2018). The strong directionalities of such policies is believed to allow for collectively focusing innovation efforts on overcoming the inertia that keeps a mission's focal problem in place (Cantner & Vannuccini, 2018). A large body of studies on innovation systems and transitions has shown that the very amassing of a wide range of innovation activities and institutional changes is crucial for socio-economic transformations to occur – and thus for missions to succeed (Weber & Rohracher, 2012). Acknowledging the systemic and cumulative nature of change, policy makers in search of grand solutions are urged to accommodate the adaptation of knowledge creation and diffusion mechanisms, entrepreneurship possibilities, market creation, financing, regulation, competition law, public debate, etcetera (Hekkert et al., 2007). Especially in the face of 'wicked' unstructured and contested problems, there is no script telling who should be doing what and which moment (Wanzenböck et al., 2020). Thus, rather than executing a well-defined roadmap, finding novel answers to complex questions requires transformative innovation policies that drive entrepreneurial experimentation and respond to institutional barriers hampering the implementation of promising solutions (Schot & Steinmueller, 2018; Hekkert et al., 2020).

The rationales for transformative innovation policies like MIP are markedly different from only internalizing spillover externalities. At the same time, as governing transformative change entails steering private (along public) interests in the direction of collective benefits, this almost inherently involves evoking policy outcomes going beyond the value that private firms can appropriate individually. Surprisingly little attention has been paid to the question what type of externalities this would be. Neoclassical economists have traditionally only considered knowledge spillover externalities in relation to rent spillovers and business stealing effects, all of them mostly concerned with just the level of R&D or productivity. Additionally, development economists like Hausmann and Rodrik (2006) draw attention to information externalities and coordination externalities as a driver for economic growth and diversification.

The imperative of eliciting such externalities has informed modern views on industrial policy (Stiglitz & Greenwald, 2014), but so far without also reaching the MIP debate (exceptions being e.g. Mazzucato, 2018; Foray, 2019). Coming from yet an entirely different tradition, innovation scholars point at the existence of system dynamics adding to the emergence and adoption viability of new technologies and solutions. Again, although rarely linked to spillovers explicitly, also governing firm involvement in processes like niche formation and regime contestation is essentially a matter of yielding collective returns on private investments.

The principal objective of this paper is to synthesize the range of spillovers that are relevant to consider for activities supported by currently unfolding MIP policies. Advances in various literature streams shed new light on known spillovers, while also pointing at some neglected ones. We present a comprehensive framework, linking the various kinds of spillovers that may be at play for three different MIP types. The framework offers a basis for reflecting on what dynamics to assess when encouraging private firms to contribute to the collective exploration of new innovation paths.

Focusing on the typically overlooked types of spillovers, we illustrate our framework with a case study on SBIR policy instruments in the Netherlands.[1] The objective of this policy scheme is to challenge and support firms in providing innovative solutions for societal issues. The three distinct instruments underlying the overall scheme consists of a 'Valorisation Grant' for academic start-ups, a catalytic form of public procurement of innovation (PPI), and a 'direct' form of PPI. Studying these instruments is suitable for our illustrative purposes, as their respective properties roughly correspond with the three different MIP types we distinguish. Our analysis of the particular spillovers targeted and observed in projects supported by the three Dutch SBIR policies is based on the response of 276 respondents in an online survey.

[1] In the original U.S.A. version, SBIR stands for 'Small business innovation research' as it focuses on SMEs. The Dutch adaptation of this policy is open to large firms as well. Hence, it is unusual to spell out the acronym.

The remainder of this paper is as follows. Section 2 first provides a brief overview of different policy intervention types suitable for mission-oriented innovation policy. Based on our pragmatic distinction, we then introduce the aforementioned spillover framework and theorize which particular kinds of spillovers are deemed most relevant for innovation activities supported by each of the MIP types. Section 3 presents the empirical illustration, in which we investigate the spillover profiles of Dutch SBIR policy instruments corresponding with different mission-oriented approaches. Section 4 concludes.

2. Mission-oriented innovation policies and spillover types they help engender

2.1 From policy for knowledge to policy for solutions

With the ever increasing interest for societal challenges reflecting a normative turn in innovation policies (Uyarra et al, 2019), mission-oriented innovation policies are rapidly drawing attention (Robinson & Mazzucato, 2019; Janssen et al., 2021). As the name suggests, these policies are primarily marked by the objectives they set – i.e. the missions they are pursuing. Mission-oriented innovation policies (MIP) entail policy strategies aiming to provide novel solutions for specific goals with public relevance beyond or even instead of boosting economic growth (Mazzucato, 2018). This typically concerns major societal challenges like climate change, poverty, or inequality, requiring solutions combining societal and technological change. Although there are exceptions, MIP are mostly focused on problems in which the developments on a wide range of factors are deemed crucial (e.g. technology, regulation, behaviour). As this requires cumbersome alignment processes and continued commitment, such problems are often also referred to as 'grand' societal challenges. Essential for these challenges (and addressing them through policy) their systemic nature, i.e. the problems are kept in place due to a variety of techno-economic as well as institutional factors. Policy strategies for coping with such 'wicked' problems have been studied extensively in the transition literature that unfolded over the past two decades.

A second key feature of MIP is that they rely on (or at least involve) mobilizing innovation as a means to provide solutions. In practice, scholars and policy makers differ in their appreciation of how important (technological) novelty really is and how novelty-based solutions can best be elicited. While some argue for starting out with spurring the development of better technologies, others point at the relevance of first disentangling the nature of a wicked problem (Wanzenböck et al., 2020). In any case, there seems to be consensus on the importance of directionality as a distinctive feature of mission-oriented innovation policies (Boon & Edler, 2018). Such policies should overcome inertia by steering entrepreneurial experimentation towards cumulative development pathways (Cantner & Vannuccini, 2018; Schot & Steinmueller, 2018). Occasionally, MIP is therefore regarded as a special variety of preferential innovation or 'specialization' policy (Foray et al., 2012; Foray, 2019).

Almost without exception, contributions on the emergence of MIP outline how such policies mark a change with respect to other types of science, technology or innovation (STI) policy (e.g. Robinson & Mazzucato, 2019; Foray, 2019). This typically also involves a discussion of legitimate grounds for policy intervention, like solving market failures, fixing system failures or overcoming transformational failures (Mazzucato, 2016; Weber & Rohracher, 2012). While it is common to contrast system and transition thinking against a market perspective, scholars have repeatedly stressed that the creation of markets is in fact of utmost importance for the widespread diffusion of viable solutions (Mazucato, 2018). This is not to say that creating markets is sufficient; for the adoption of new solutions to take off it might be essential to also address socio-technical factors like institutional and behavioural changes. The question remains how top-down guidance for innovation investments, e.g. by prioritizing a mission goal, can best be complemented with giving room to bottom-up experimentation, sectoral support, and broad stakeholder involvement (Janssen et al., 2011). Ensuring convergence between such dynamics

is likely to require a balanced policy mix, containing support policies for both the development as well as the diffusion of solutions with a transformative potential (Reinhardt & Rogge, 2016).

Furthermore, emphasis has been placed on the importance of *transformative activities* (Rodrik, 2004; Foray, 2019) and *transformative innovation policies* (Weber & Rohracher, 2012; Janssen, 2019; Schot & Steinmueller, 2018). Originating from transition literature as well as modern industrial policy literature (Rodrik, 2004; Stiglitz & Greenwald, 2014), transformative innovation policies cover the range of interventions aimed to eliminate barriers hampering entrepreneurial exploration of new economic opportunities. These interventions have been characterized as systemic, preferential, experimental, cumulative, and adaptive (Janssen, 2019; Foray, 2019). Since offering transformation possibilities is regarded as essential for accommodating disruptive change, many of these characteristics are reflected in current thinking on mission-oriented innovation policies (Mazzucato, 2018; Hekkert et al., 2020). This is manifested in the distinction between accelerator missions and transformer missions (JIIP, 2018). While early examples of mission-based R&D-programs typically aimed for accelerating (technological) innovation within existing systems, modern-day transformer missions on wicked societal challenges are believed to require changes in the socio-economic systems themselves (Wittmann et al., 2020). Indeed, this confronts policy makers and scholars with an array of questions on how to design, monitor and evaluate policies for missions with such a transformative scope (Larrue, 2021).

Three mission-oriented innovation policy approaches

Clearly, the succinct description of MIP characteristics already touches upon a broad range of views on why, how and even by whom innovation policy is formulated and executed. A close look at the emerging literature quickly reveals different conceptions on issues like the importance of novelty, the link with specialization and industrial policy, or the different ways a mission can be framed. For instance, Wanzenböck et al. (2020) draw attention to the degrees

of contestation, complexity and uncertainty characterizing a societal problem as well as its solution. Allegedly, different positions in the 'problem-solution space' they define demand different policy strategies.

For the purpose of discussing the spillover dynamics legitimizing mission-oriented innovation policy, more specificity on their instrumentation and policy design features is needed. In this study, we therefore take a pragmatic approach and distinguish between policy interventions associated with four consecutive stages on the continuum between generic technology push and specific market (or rather: society) pull. Critical in this respect is the main objective a policy instrument aspires to, which can vary between simply boosting knowledge development and innovative economic activity in general, spurring innovative activities with wider societal impact, eliciting coordinated solution development for societal problems, and facilitating search for implementable solutions not necessarily depending on innovation.

The suggested push-pull spectrum of interventions, depicted in Figure 1, is closely associated with Mazzucato's (2018) hierarchy of missions and their underlying mission projects, as well as with Janssen et al.'s (2021) interpretation of missions as interlinkages between innovation systems and socio-economic systems concerned with a societal problem. In our view, MIP policy as understood in most contemporary writings (having a transformative nature due to its directional and systemic character) particularly covers interventions in the mission-oriented experimentation policy layer in the middle of Figure 1. This layer entails the alignment of various innovation projects - embracing technological, organizational and business model innovation - and institutional changes required for developing an innovation path with impact on a particular mission's goals. Below that layer we find mission-oriented R&D policy merely favouring innovation in designated priority areas, while above it there is the solution search policy approach for identifying which solution directions are promising in the first place.

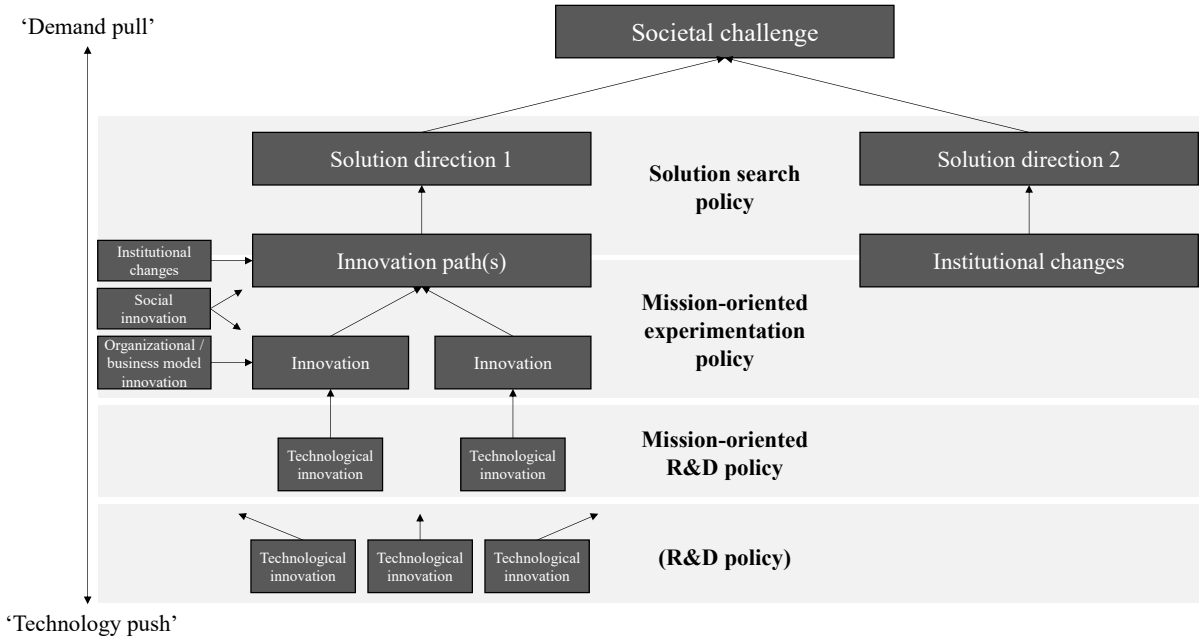

Figure 1: Hierarchy and the focus levels of different intervention types with relevance for mission-oriented innovation policy.

The four intervention approaches shown in Figure 1, three of them being MIP types, can be characterized as follows:

- Motivated by economic growth theories, traditional R&D policy aims to enhance the amount of R&D conducted in an economy. R&D policies are successful whenever they result in the creation of knowledge that, once applied, yields productivity improvements. Rooted in science and technology policy, R&D policies often implicitly or explicitly favour innovation based on technological inventions (Martin, 2016).
- Mission-oriented R&D policy differs from generic R&D policy as it takes a more proactive stance when it comes to the directionality of knowledge development (Foray et al., 2012). Typically this involves a prioritization of topics related to grand societal challenges or Sustainable Development Goals, without fundamentally changing the mechanics of R&D policies. Exemplary here is the European Commission's new R&D framework 'Horizon Europe' (European Commission, 2018).
- Mission-oriented experimentation policy acknowledges the interaction and accumulation of complementary innovation efforts required for effectively addressing

societal challenges. More than about eliciting genuine novelty, this MIP approach is about interlinking, testing and diffusing promising solutions by shaping favourable system conditions. A well-documented way of achieving this is by creating markets via PPI; the public procurement of innovations that may form a response to pressing societal problems (Edquist, & Zabala-Iturriagagoitia, 2012; Wesseling & Edquist, 2018). As the focus lies on demonstrating the use of new solutions in practice, policies of this type may want to give room to social innovation rather than only technological and non-technological (but organizational and business model) firm-based innovation. After all, users like citizens and professionals may play a key role in understanding and solving problems, as well as in overcoming institutional resistance (Wittmann et al., 2020).

- Solution search policy, finally, does not necessarily start out with the presumption that firm-based innovation is required for solving a societal challenge. Instead, of primary importance for this MIP approach is to support the search for promising solution directions, which might also consist of behavioural changes stemming from social innovation or purely institutional changes at the socio-economic system level. Supporting the search for solutions with a transformative potential is largely a matter of organizing debate and public discourse, or of awarding prizes and setting up contests allowing for original perspectives on solving particular societal needs. The latter can also have the form of an 'open' or functional version of PPI, characterized by a low degree of specification on how the solution to a given problem should look (Uyarra et al., 2014; Edquist, & Zabala-Iturriagagoitia, 2020).

The intervention-based distinction of MIP types offers a basis for reflecting on the type of change processes that should be supported, and observed to take place, in order to legitimize policy intervention. In the next section we address this by extending the spillover perspective underlying traditional R&D policy interventions to the various MIP approaches.

2.2 Spillover types associated with various (mission-oriented) innovation policy approaches

Spillovers are often regarded as the unintended spread of results stemming from R&D investments (e.g. Coenen et al., 2015). A key element of the definition adopted here, following the standard economic view on externalities, is that spillovers concern the value R&D-investors create without being able to appropriate it (which is precisely what legitimizes policy intervention). One might thus speak of spillovers as the collection of all imaginable innovation externalities (Breschi & Lissoni, 2001). In other words, while innovation might also give rise to e.g. environmental or network externalities, we focus our discussion of spillovers only on the unappropriated production of value relevant for developing and implementing innovations.

Stemming from a market perspective, the notion of spillovers might seem fundamentally at odds with the systemic and transformative perspectives underlying the various MIP types. However, ignoring market dynamics altogether is like throwing the proverbial baby out with the bathwater – precisely the formation of new markets is an essential (yet far from the sole) condition necessary for socio-economic transformations to succeed (Mazzucato & Penna, 2016). The creation of markets is a process susceptible to market as well as non-market value creation and value exchanges, some of which will fall into the externality-based definition of spillovers. That is, in as far as MIP policies involve private entrepreneurs contributing to the emergence and strengthening of promising innovation pathways, interventions will aim to elicit benefits extending beyond the value that can be appropriated by individual firms undertaking R&D investments. Characteristic for the industry-targeted aspect of MIP policies is that they encourage firms to experiment and thereby initiate, participate and accelerate transformations also yielding returns for competitors as well as the society demanding a mission-based solution. Clearly, such external returns to firms' private innovation efforts fit the notion of spillovers.[2]

[2] One might maintain that inter-organizational learning is a more useful concept in the context of collective complementary innovation efforts. Our stance here is that learning is in fact one the *mechanisms* that might cause other parties to respond to results stemming from MIP-induced firm behaviour. Spillovers occur whenever these

Just like literature on innovation policy, research on spillovers has been evolving within different bodies of literature (notably: heterodox economics and innovation studies). Advancements therein provide a basis for reconsidering the way particular types of spillovers are of relevance for the various policy approaches discussed earlier. Moreover, they point at some spillover types so far largely neglected. Below we address which spillovers may be expected from firm-level innovation activities supported by MIP policy types. Insights on this matter are retrieved from reviewing in what forms spillovers are implicitly or explicitly referred to in research on each of the policy approaches as distinguished in section 2.1. Generally, we find that individual studies are either concerned with investigating just a single specific type of spillover, contrasting two specific types, or with discussing spillovers without even specifying which exact types of innovation externalities are taken into consideration. Instead of presenting another narrow or overly broad view on the phenomenon of spillovers, we aim to unpack the concept into its constituent types of innovation externalities.

Spillovers with relevance for generic R&D policy

As many R&D policies are motivated by an externality rationale, an extensive body of literature is dedicated to assessing investment and productivity improvements encountered beyond policy beneficiaries (Griliches, 1992; Aghion & Jaravel, 2005; Hall et al., 2009). Of key importance here are the *knowledge or 'technology' spillovers*, which allow others to learn about new technologies and their workings. Due to knowledge often having a public good nature, R&D firms are limited in preventing knowledge from leaking away. For codified knowledge some legal protection might be enforced, notably via intellectual property policy, while the spread of tacit knowledge (e.g. via skills and labour mobility) is harder to control. Not being able to appropriate all value created captured in R&D-based knowledge can lead firms to refrain from

responses seize value that was created but not fully appropriated by the firm originally involved in the MIP policy instrument. Given the scope of this paper, we are particularly interested in the form these spillover responses might take. Note that third parties might also respond without learning taking place.

conducting the R&D in the first place, hence the need for policy (Arrow, 1962). Particularly challenging for implementing and evaluating the wider effect of such policies is the variety of mechanisms affecting the total societal returns. Third parties may increase their R&D expenditures and performance either because of the spillovers they enjoy, or because of the 'product rivalry effect' urging them to keep up with R&D firms (Bloom et al., 2013). Disentangling these mechanisms requires insight in which firms would be competing, and which firms are using the same technologies – the two of them not necessarily overlapping (Lucking et al., 2018).

R&D policy ideally helps to resolve the tension between a R&D firm's private interest (appropriating all value it creates) and the public interest of enhancing the stock of available knowledge. However, innovation externalities can also cover possibly unaccounted advantages for the R&D firm itself. Collaboration, investment and trade activities allow firms and economies to access external stocks of knowledge. To effectively make use of that knowledge, a sufficient level of absorptive capacity is required (Cohen & Levinthal, 1989). Firms may develop absorptive capacity and an advantageous network position by engaging in R&D themselves. Thus, engaging in R&D might not just yield novel knowledge (potentially spilling over), but also allows the R&D firm to incorporate value embodied in the spillovers generated by others. Bye et al. (2011) refer to absorption spillovers as positive internal knowledge externalities warranting R&D policy as well as export promotion.

Moving from the R&D process to commercializing products or services it brings forward, another type of spillover entering the picture is the *rent spillover*. Rent spillovers occur when firms can not appropriate all R&D-based value in market transactions, for instance due to market competition prohibiting them to process quality improvements fully into market prices. Alternative explanations include the existence of coordination failures and information asymmetries between R&D firms and clients (or investors). Since R&D is inherently uncertain,

it is only natural that third parties - an even the R&D firm itself - cannot properly assess the market value of R&D results. This holds especially in case of what innovation scholars call 'exaptation': the phenomenon when an innovation turns out to be useful in an entirely different context then the one envisaged by the developer (Bonifati, 2010). For policy makers and evaluators this implies it may be hard to determine the scope of policy-supported innovation activities' spillovers from the outset. Being somewhat like the opposite of rent spillovers, *business stealing* takes place when firms appropriate more value than they created. Market power can be one of the circumstances allowing R&D firms to do so, which makes this also belong to the policy domain of competition law. Contrary to knowledge spillovers, rent spillovers and business stealing typically form side-effects of innovation rather than legitimization for policy intervention.

Spillovers with relevance for mission-oriented R&D policy

Targeting R&D support to a specific range of challenge-based topics is only a relatively small step away from generic R&D policy. From a knowledge spillover perspective, the difference that matters is the extent spillovers are taken into account when defining the desired direction of innovation. A typical aspect to consider in mission-oriented strategies is the degree of novelty the supported R&D activities render. Highly novel knowledge is commonly believed to have a higher application potential, which makes it more eligible for policy support than context-specific knowledge. Moreover, how far knowledge can spill over is subjected to several proximities, one of them being cognitive proximity (Boschma, 2005). Building also on the notion of (technological) relatedness, contemporary contributions on targeted rather than neutral innovation policies occasionally stress the importance of spurring R&D activities resulting in knowledge spillovers which can truly be absorbed by other parties in the economy (e.g. Foray et al., 2012). Indeed, even when still focusing on knowledge spillovers and absorption, the act of defining a mission direction already offers a possibility for taking an

'intelligent' approach to maximizing policy impact. This fits with the policy rationale of not just eliciting as many spillovers in a priority area as possible, but precisely the ones most likely to bring a mission forward.

In as far as mission-oriented R&D policy is also concerned with the diffusion of knowledge throughout the innovation system, a categorically different type of spillover needs to be taken into account as well. Besides knowledge and skills in the technological sense, third parties can also learn about the existence of unfulfilled demand. So-called *information externalities* consist of the unappropriated spread of valuable market intelligence. Especially in the literature on development economics and industrial policy we find claims that there might be substantial social returns from spurring entrepreneurial experimentation, i.e. encouraging firms to explore new possibilities for commercializing the capabilities and knowledge they can mobilize (Hausmann & Rodrik, 2006). Competitors might not only learn about how to do deliver a certain product or service, but also that it is feasible to do so in the first place. This type of spillover, informing actors on the demand and potential for a certain type of (innovative) offering, comes into play when mission-oriented R&D policies aim to steer the innovation system as such more towards spawning promising solutions. Innovation systems will be more inclined to do so when the lessons of experiments (successful or not) reach parties who might crowd-in or decide to explore alternative paths. To prevent misalignment and duplication, there is a policy rationale for ensuring that valuable market intelligence is not entirely confined to the firms undertaking policy supported experimentation.

Spillovers with relevance for mission-oriented experimentation

Looking at research on what we called mission-oriented experimentation, yet another set of spillovers can be added to the spectrum discussed so far. Fundamental for this MIP approach is the imperative of spurring transformative activities resulting in the convergence of private and public efforts required for exploring and exploiting promising innovation paths. Following

heterodox economists again, the policy challenge regarding firm involvement pertains to evoking *coordination externalities.* The unappropriated value involved here consists of impulses policy supported firms or projects give to the emergence and strengthening of solutions as well as the markets in which they can flourish. Besides knowledge spillovers and information externalities already covered earlier, this is also a matter of putting in place proper infrastructures and institutions. While policy supported R&D firms likely benefit from this themselves, it is also of value for potential second-movers. As these third parties will not (fully) reimburse the activities paving the way for them to enter, they are enjoying value not appropriated by the policy supported R&D firms. The resulting coordination externalities are similar to network externalities, be it that the synergies in this case concern the *supply* side rather than demand side. In that sense they are more like a club good, with the exception that they do not necessarily have to result from deliberate sharing agreements. In fact, the rationale for mission-oriented experimentation precisely consists of overcoming the lack of coordination and alignment that prevents from complementary factors to accumulate. Developing agendas and providing specific public goods and infrastructures might be powerful ways to set directional change in motion (Foray, 2019), provided that they attract follow-up efforts from firms and clients enjoying the associated externalities. Because this might lead to further strengthening of the innovation path, coordination externalities may also be referred to as 'adoption externalities' (cf. Baptista, 2000).

As noted, the research community engaged with transitions has been influential in defining the type of transformative innovation policy underlying this MIP approach. Although the concept of spillover externalities is largely absent in their idiom, many of their statements point in the direction of evoking the abovementioned coordination or adoption externalities. Policies involving firms or other actors in building niches and pressuring regimes are to a large extent doing precisely what we just described in economic terms (nurturing the alignment of

complementary public and private factors). From a spillover perspective it is important that such policies do not just target innovative actors and projects fitting a niche, but especially the ones breaking grounds for followers. As noted when referring to social innovation in section 2.1, this would also require openness to users and professionals with intimate knowledge of the problem at hand (and the context in which solutions would need to be integrated). Because such actors can play a key role in the development as well as the adoption and diffusion of innovative solutions, they can be both be at the creating as well as the receiving end of spillovers.

Spillovers with relevance for solution search policy

The last MIP approach to consider is solution search policy, which doesn't just drive innovation towards a missions but is fundamentally concerned with solving a problem. By not necessarily belonging to the sphere of economic and innovation policies, this approach is much less associated with firm-based experimentation and corresponding externalities. Especially when focused on achieving alignment between problem interpretations and appropriate solution directions, the issue of yielding social returns by spurring private investments is hardly relevant. This only starts to be of importance when policies become instrumental in selecting and accelerating innovation paths that lend themselves for mission-oriented R&D and experimentation. In case firms take part in exploring novel opportunities to solve societal needs (e.g. via contests), this should be aimed purely on eliciting knowledge spillovers directly feeding into the solution, or on information and coordination externalities facilitating its adoption. How the contributing firms perform business-wise is irrelevant: a genuine solution-oriented approach dictates that in principle it is fine when competitors (even foreign ones) absorb these spillovers for taking the desired solution forward.

2.3 An integrated spillover framework

Based on our review of the fragmented literature on spillovers, Figure 2 synthesizes the findings in an integrated spillover framework.

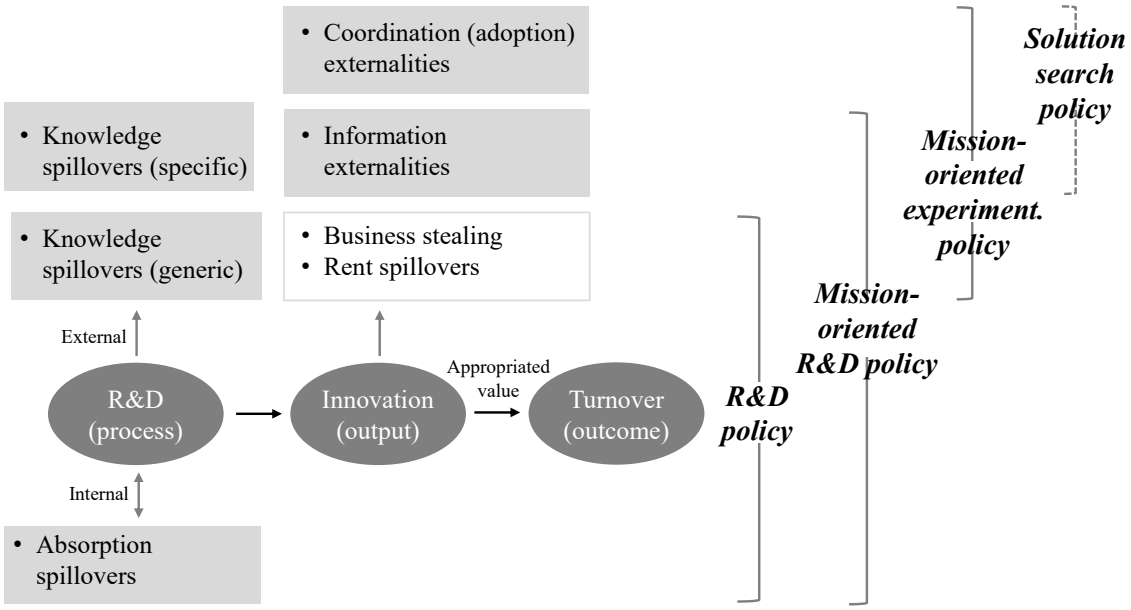

Figure 2: Integrated framework of spillover types and the policy approach for which they matter most.

R&D policy as we traditionally know it is usually concerned with eliciting knowledge spillovers and absorption processes associated with conducting R&D. Besides assessing how policy beneficiaries enhance their performance over time - by appropriating the results of the supported activities - , a major question is what influence is exerted on the R&D activities and business performance of third parties subjected to knowledge spillovers (as well as rent spillovers and business stealing). The scope extends if we move to mission-oriented R&D policies. Besides deliberately targeting particularly promising knowledge spillovers arising from firm-level innovation, policies fitting this MIP approach may also consider the information externalities that emerge when experimenting with the actual implementation and commercialization of innovations. Information externalities provide valuable demand signals that may favour an innovation systems' capacity to explore innovation paths fitting a mission.

As we enter the domain of mission-oriented experimentation, the business performance of policy beneficiaries is increasingly less of a concern. Instead, policies fitting this approach are expected to strengthen the exploration and exploitation of solution paths by encouraging activities that lead firms to bring about coordination/adoption externalities (in addition to information externalities and knowledge spillovers). More than convincing firms to undertake

R&D that is risky due to technological uncertainties, mission-oriented experimentation policies should spur innovation that is risky due to the required range of complementary factors. Supporting activities that contribute to factor alignment might help to lead the way for further strengthening of the niches around promising innovation paths. To what extend such coordination externalities matter for solution search policy largely depends on whether such policy is already catalysing the development of selected solution paths, or whether it is still aiming to disentangle complex contested problems and solutions.

3. Spillovers in Dutch SBIR schemes

From a theoretical perspective, the spillovers evoked by a MIP approach and its policy measure(s) are ideally in line with the rationale for why that policy was implemented. Due to some spillovers being largely neglected in existing bodies of literature, however, little is known about how they are manifested in actual policy implementations. In this section we provide an illustration by examining the case of Dutch SBIR schemes.

3.1 The case of the Dutch SBIR schemes

SBIR is probably best known as the United States Government's Small Business Innovation Research awards-based program for encouraging small businesses to take part in R&D activities. Inspired by this example, various countries have implemented a version of their own (Siegel et al., 2003). For the Dutch SBIR the overall goal is to challenge and support firms in providing innovative solutions for societal problems. The scheme consists of three policy measures, each of them taking a different place in the earlier introduced innovation push-pull spectrum of MIP interventions. Two of the measures rely on public procurement of innovation (PPI). Just like PPI policies have been linked to mission-oriented innovation policy before (Edquist & Zabala-Iturriagagoitia, 2012, 2020; Uyarra et al., 2020), also the Dutch national government has now positioned its SBIR scheme as a policy means for solving major societal challenges (VVD/CDA/D66/CU, 2017).

The ‘Valorisation Grant’ is executed by the National Science Foundation NWO and provides grants for the further development of academic inventions with commercial potential as well as societal relevance. As it not guided by criteria focused on particular priority areas, this way of pushing societally desirable innovations falls somewhere between regular R&D policy and challenge-oriented R&D policy.

Apart from the Valorisation Grant for academic spinoffs, there is also a SBIR line directly targeted at existing business. This line is executed by the Netherlands Enterprise Agency (RVO.nl) and is highly similar to the UK SBRI policy measure based on of public procurement of innovation (PPI). Taking government challenges as a starting point, firms are invited to participate in open competitions. Per challenge, up to about 15 firms can receive a subsidy for assessing the feasibility of an innovation meeting the challenge’s criteria. In a second round, about 6 firms may obtain an additional subsidy for conducting an experiment in practice. Although this SBIR line is formally one singly policy measure, a distinction can be made between two types of challenges.

Following the PPI literature (e.g. Wesseling & Edquist, 2018), ‘catalytic’ challenges are the ones governments use when supporting innovative projects that (when successfully implemented at a sufficiently large scale) reduce the need for public services. Exemplary is the call by the Ministry of Economic Affairs and Climate Policy, asking for innovative ways for transporting and using synthesis gas (fuel gas mixtures). It is unlikely for the Ministry itself to purchase resulting solutions, but possibly the adoption of these solutions by others lowers the necessity to intervene more drastically on the energy market. Eliciting challenge-led exploration and supporting diffusion arguably is going more towards mission-oriented innovation programs than the Valorisation Grant approach of only providing R&D grants for desirable spin-offs.

There are also ‘direct’ challenges in this SBIR line. In these cases governments issue calls for innovations that improve the quality of the public services they themselves provide.

Characteristic is that these challenges are less focused on supporting the wide-spread commercialization of a desirable innovation, and more on developing innovations the challenging government might purchase (hence the label 'direct'). An example here would be a call for solutions that reduce nuisance of construction works by the Department of Infrastructure. Due to this focus on societal rather than economic relevance, direct challenges are to be regarded as positioned even closer towards the solution search MIP approach.

3.2 Mapping spillovers

As the literature on MIP emerged partially from contributions on demand-side innovation policies, much has been written about the potential of PPI to spur the development of societally desirable innovations and innovation paths (e.g. Edquist & Zabala-Iturriagagoitia, 2012; Mazzucato, 2016; Robinson & Mazzucato, 2019; Uyarra et al., 2020). It has also been established that PPI may induce spillovers to user firms (Rocha, 2017). However, which spillovers this would be remains again largely neglected, just like the question to what extent their nature and size match with the grounds on which the PPI intervention was legitimized.

To give an impression of the firm-level spillover effects of the PPI SBIR lines as well as the Valorisation Grant, we draw upon survey results acquired as part of the policy's evaluation over the period 2012-2016 (Dialogic, 2017). Out of a population of 1495 policy beneficiaries with known contact information, 276 (18.5%) provided useable answers in an online survey. This concerns 170 users of the Valorisation Grant, 65 firms involved in catalytic SBIR, and 41 firms involved in direct SBIR. The survey questions covered the nature and output of the respondents' innovation project with SBIR support. Questions on the wider spread and impact of the output are based on the development and face-to-face pre-testing of new survey items. As this section is limited to illustrating spillover profiles of distinct policy measures, only response to the three most relevant survey questions are shown here. Together, the questions provide insight in the novelty, crowding-in and niche building effects of innovation projects with SBIR support.

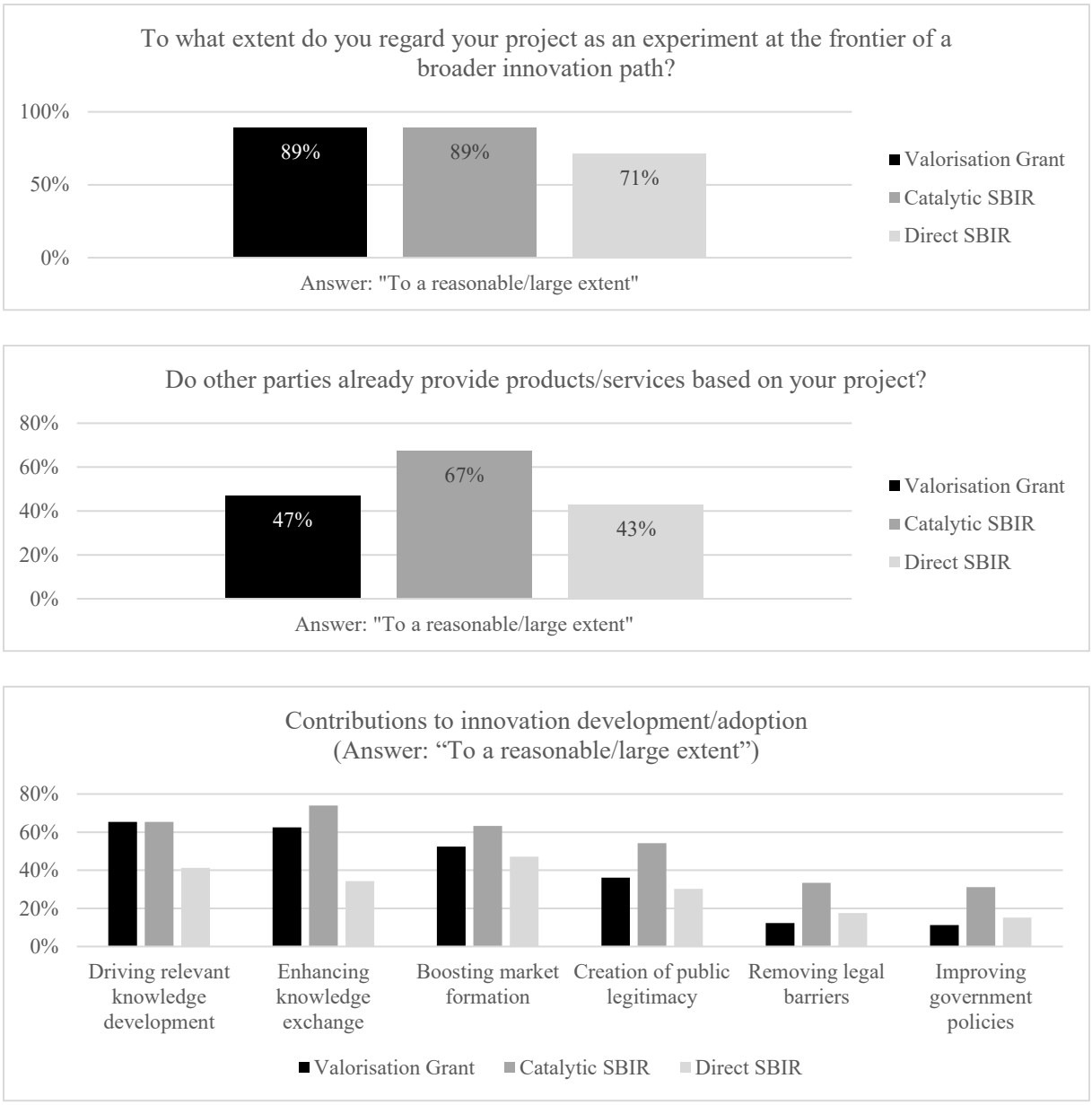

Figure 3: Response to survey questions on the wider impact of innovation projects with SBIR-support (n=276).

According to the upper graph in Figure 3, respondents involved in valorisation and catalytic SBIR are equally inclined to rate their innovations as 'frontier experiments' yielding novel knowledge. The 89% of respondents stating this qualification is to a reasonable or even large extent applicable, is significantly higher than the 71% amongst respondents engaged in direct SBIR challenges. In light of possible common method bias it is important to note that the distinction between catalytic and direct SBIR was not known to the survey respondents.

Moving to the second graph, it turns out that the direct SBIR group reports about just as often as valorisation grant users that their innovation-based products and services are already being offered by other parties as well. This percentage of 43%-47% is significantly lower than the 67% amongst respondents participating in catalytic challenges. Moreover, the middle group also draws attention in the question on contributions paving the way for such follow-up activities by others, possibly due to information externalities. Consistent with the first graph, there is no difference yet (with valorisation grant users) when it comes to driving knowledge development. On the other items in this question, however, catalytic SBIR respondents increasingly stand out. At least in their own view, these respondents contribute more often to adaptations and pressures like creating legitimacy or removing legal barriers. Assuming the respondents cannot privately appropriate all the possibilities these impulses provide (as also suggested by the second graph), the findings suggest catalytic SBIR challenges are in this case yielding the highest range of coordination externalities.

3.3 (In)consistencies between rationales and spillover effects within each MIP approach

Roughly corresponding with the three MIP approaches, the survey responses on the SBIR policies' wider innovation and adoption impact shed some light on tensions coming into play when implementing mission-oriented innovation policies.

First, policies on the solution-oriented side seem to face a trade-off when specifying the scope of the solution they like to see fulfilled. Although a strong demand-side focus may open possibilities for innovations to truly take off, there is a risk that a narrowly formulated challenge in fact elicits solutions with only a minor potential for being implemented at a larger scale. This caveat of responding to incidental problems by developing 'local' solutions is widely known to innovation strategy scholars (Danneels, 2003; Henderson, 2006). Yet, overseeing the literature on mission-oriented policies so far, few authors have warned for stepping into the pitfall of specifying *myopic MIP policies*. Our tentative case illustration suggests it is worthwhile to make

a careful ex ante assessment of the extent a new policy's scope evokes advantages for non-beneficiaries - via spillovers -, rather than only spurring the development of context-specific solutions (mostly advantaging the policy beneficiaries themselves).

A second remark concerns the variation in the reported impact of policy-supported innovation projects. Apparently, the SBIR policy approaches differ in their ability to drive innovation dynamics extending beyond the activities of directly participating firms. As far as stated in policy documents and the publicly available evaluation of 2017, there are no clear indications that specific measures have been taken in order to prioritize policy support or accelerate the diffusion of spillovers. Much of the attention has been devoted to examining whether SBIR firms themselves increase their business performance in terms of turnover and profits. In that respect it is striking how the Dutch government is increasingly presenting SBIR as a major element of its ambition to move towards a mission-oriented innovation strategy. This becomes evident both from the coalition agreement (VVD/CDA/D66/CU, 2017), as well as letters to parliament from July 2018 and April 2019 (EZK, 2018; 2019). While there are indications of some SBIR lines indeed offering possibilities on this account - albeit with significant differences amongst them -, one would perhaps expect a more explicit plan on how to leverage the instrument for setting transformations in motion. Such apparent reframing of existing policy goals without altering its mechanisms is in many ways reminiscent of *policy drift* as encountered also in the context of sustainability policies (Howlett & Rayner, 2007; Kivimaa & Kern, 2016). Given the relatively sudden renewal of interest for mission-oriented policies, it is possible that also other governments might overstep by updating their ambitions without adjusting the policy instruments they have in place. Resulting inconsistencies in the overall policy arrangements are likely to limit policy effectiveness. In general terms this is far from an unknown phenomenon, yet how this plays out for missions remains still to be studied in more depth. Studying intended and realized spillovers may prove to be useful first step in this regard.

4. Discussion and conclusions

Contributions

Earlier research on preferential interventions like mission-oriented and transformative innovation policy has pointed at the imperative of maximizing spillovers (Rodrik, 2004; Janssen, 2019; Foray, 2019), without clearly specifying which kinds of spillovers this would concern. We have taken up this challenge by elaborating what spillovers types can be associated with innovation activities supported by particular MIP types. Adhering to basic distinction in what changes missions should engender brings to the fore various policy tensions overlooked so far.

A first contribution of this study is the overview of intervention types suitable for MIP. In our view there is no such thing as MIP theory; the current literature on this account is merely a theory-informed characterization of a topic rapidly gaining interest amongst policy makers. As the hype unfolds, more and more concepts and actual instruments are being labeled as being characteristic for 'the MIP framework' (Cantner & Vannuccini, 2018). To structure the debate, we suggested a distinction between three intervention types evolving out of ordinary R&D policy. With each MIP type having its own objective and rationale, also governance, implementation and monitoring issues are likely to be markedly different. Follow-up research on such variation in actual MIP policies is urgently needed.

Second, we have sought an answer to the question what variety of spillovers is relevant to consider when facing different approaches to spurring (mission-oriented) innovation. Our review of distinct literatures acknowledges spillover categories normally hardly captured in a single study. Spillovers often remain regarded as belonging to the sphere of market logic, despite the common claim that creating markets is key for solving grand challenges by (also) mobilizing industry efforts. Taking the definition of spillovers as innovation-induced benefits

not entirely appropriated by the originator, it can be argued that also pressures on socio-economic systems are essentially manifestations of innovation externalities.

Building on the first two contributions, we presented an integrated spillover framework as a basis for prioritizing what effects different types of MIP policy should achieve. The consistent account of spillovers and resulting framework also serve to bridge various literatures relevant for understanding, shaping and evaluating mission-oriented innovation policies. This might help overcome the limitations of adhering to individual perspectives only, as neoclassical economists and transition-minded innovation scholars are likely to focus on particular outcomes rather than the full range of changes MIP policies should bring about.

Finally, the empirical illustration based on Dutch SBIR schemes suggests it is not evident that MIP policies are coherent in their rationales and interventions. Being an adaptation of the original (U.S.A.) SBIR program targeted at enhancing the innovation capabilities of SMEs, the initial Dutch SBIR was dedicated to pushing solutions. Currently it is increasingly regarded as a key policy instrument for completing missions. Meanwhile, as the objectives and rationales have been shifting, the design of the underlying interventions and associated monitoring has remained largely unaffected. Valorisation is organized as generic push, despite the ambition to especially facilitate the development of innovations contributing to societal welfare. Also the direct SBIR is unlikely to deliver on this account, given the finding that a solution search MIP approach might steer R&D and experimentation towards myopic innovation rather than scalable solutions. This barrier in demand-side innovation policies differs from the more widely known problem of having technical instead of outcome-based specifications (Uyarra et al., 2014), and begs for more attention to the scope of prioritized outcomes. Furthermore, despite focusing on different kinds of changes, catalytic and direct SBIR have been implemented in an identical way. These findings, although stemming from an anecdotal case, point at the risk of policy drift in the context of mission-oriented policies (Howlett & Rayner, 2007; Kivimaa and Kern, 2016).

This is line with several other studies that warn against missions potentially being a strategic hype that is not accompanied by new substantive policy implementation and governance actions, but rather a way for policy makers to engage in window-dressing (Mowery et al., 2012; Brown, 2020; Larrue, 2021; Janssen et al., 2021). We echo the importance of aligning measurement instruments with actual policy goals (Arundel et al., 2019), specifically with respect to the spillovers that are envisaged per policy instrument.

Limitations and further research

Featuring in a mostly conceptual paper, the empirical analysis presented here merely serves as an illustration of the tensions that might surface when differentiating in more detail between varieties of MIP instruments as well as different spillover types. Our case study on Dutch SBIR schemes, which in no way pretends to be a sound quantitative test, suggests it might indeed be fruitful to extend innovation surveys with questions on the broader impact of innovation activities. The sketched spillover profiles were based on readily available and imperfect survey data. Follow-up research is required for developing more rigorous methodologies to gauge characteristics like the scope, speed and intensity of various types of spillovers, in particular when it comes to information and coordination externalities. A clear limitation of the survey-based approach, although not uncommon in spillover studies (Feldman & Kelly, 2006), remains that the innovating actors themselves might have the best look-out, but still a very limited view of the changes they help set in motion.

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