

Instruments and instrument mixes for knowledge transfer and science industry relations. A pilot analysis using STIP Compass database in selected countries

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1. Introduction

The analysis of STI policies and their effects on the R&D and Innovation systems has historically moved in two analytical levels, macro and micro. Studies range from the analysis of general overarching policies to the evaluation of specific programmes. Both approaches have some structural problems and often imply complex methodologies.

On the one hand, the micro level of analysis is focused on specific programmes and it is commonly adopted in the evaluation of innovation policies; this approach often presents problems of selection bias and endogeneity (not considered or unobserved variables that cause the effects) leading to the omission of the control of interactions and undermining the generalization of conclusions. On the other hand, in the macro level of analysis causality remains opaque and it is frequently substituted by correlations.

There is a wave of self-criticism regarding the way in which the analysis, evidence, evaluations and recommendations of S&T policies have been formulated in the recent past. Some terms like “generalities”, “ambiguity” or “ignorance” have been used to account for the situation of the innovation policy studies, their limited influence and the lack of appropriate empirical investigations.

A recent review on the topic of instruments and policy mixes, Ben Martin (2016) depicts some of the key lines for a policy relevant research agenda and emphasises the need of improving the conceptual and empirical frameworks for arriving at more evidence-based and effective R&D policies, employing an appropriate mix of policy instruments.

To advance in the STI policies we need to improve the notion of “STI policy instruments”, through a stronger articulation in the context of the public policy literature on policy design, with better definitions, taxonomies and conceptual frameworks as a first step to develop good theories on the conditions under which policies affect performance and enable better effects.

More empirical work is required on the full range of STI policy instruments, not in an isolated way, but taking into account how they interact with each other in specific “sub-domains”. Additionally, more systematic comparisons of different STI policy instruments are needed, as well as of the interactions within different national contexts and among the different levels of competence, to contribute to understanding what makes a coherent and effective policy mix.

2. Policy instruments in the STI policy literature

In recent years we have seen a general increase in the attention paid to the policy instruments in Science and Innovation studies as a more specific way to address the STI policies, and to the “policy mixes” as a way to consider the interactions among

instruments. This is evident in the general literature on innovation policy (Flanagan et al., 2011; Borrás and Edquist, 2013; Lanahan and Feldman, 2015; Flanagan and Uyarra, 2016; Martin, 2016) and also in specific areas like regional innovation policies or smart specialization strategies (Magro and Wilson, 2013; Magro & Wilson 2018), and in a emerging fields, loosely connected with innovation through energy policy and eco-innovation, such as the “sustainable transitions” (Del Rio 2015, Kivimaa and Kern, 2016; Kern et al., 2017; Rogge and Reichardt, 2016; Reichardt and Rogge 2017; Rogge and Reichardt, 2018). Most of these approaches have made efforts to link with some lines of work in public policies, like those represented by the policy-design’s scholars (Howlett and Rayner, 2007, 2013; Howlett et al., 2015; Capano and Lippi 2017).

In this section we will briefly revise some of the arguments of a few recent contributions aiming to improve the conceptualization, the analytical frameworks and the empirical approaches focusing on some of the STI policy contributions and on the instruments for knowledge transfer and science-industry relations (KT&SIR) while in the next section we will bring in some “classical” topics of discussion of the literature on policy design, based on their incorporation into the so call “sustainable transitions” literature.

2.1. Previous contributions to the issue of STI policy instruments

We should acknowledge that in the last years, the increasing attention paid to the issues of the “policy mix” in R&D and innovation by the academic community was preceded by some salience of the concept, at the policy making debate at the European Community, in the first years of the last decade (Guy et al 2009; Nauwelaers et al (2009) and at the OECD (2007, 2010, 2016). Previously, the literature on “STI Policy instruments” was rather fragmentary and usually considered only single instruments for the purpose of evaluation.

We could probably say that Flanagan et al (2011) (Flanagan et al., 2011) represents the first relevant attempt to pay attention and conceptualise the innovation policy mix as a framework to account for the innovation results of countries and regions. They warned us that in the previous innovation literature the term “policy mix” was ambiguous and under-conceptualised. Their main contribution was to draw the attention to the issue of the interactions among instruments and to the potential effects for the effectiveness of policies and their intended outcomes. They also called for a more systematic consideration of the interactions of different levels of governance stressing that policy mixes should be considered in the context of governance.

In fact, their approach borrowed the idea of the dynamic nature of policy and of the emerging nature of the policy mix from the “policy design” literature. In the policy consequences side, their approach suggested that no realistic expectations about finding “unambiguously established good mixes” could be hold.

A second attempt to highlight the relevance of addressing the instruments and the policy mixes is represented by the work of Borrás and Edquist (2013) (Borrás and Edquist,

2013); they insist on the problem of the instruments' choice. Their perspective looks more "technocratic" than previous analysis and it has been criticised for having a "normative" and "idealised" conception of the instruments (Flanagan and Uyarra 2016 (Flanagan and Uyarra, 2016)); however, they recognise that "even if instruments have a purposive nature (instruments for something), it does not mean that all innovation policy instruments have been consciously chosen and designed" (Borrás and Edquist 2013). One important aspect is that they assume a terminological differentiation between "instrument mixes", as the tools selected for targeting a specific social problem and the "policy mixes" that refer to a normative concept of appropriate combination of policies to improve the effects. For empirical and comparative analysis it is probably more practical to keep the analysis at the intermediate level of "instrument mix" related to a single policy objective than to either stay at the macro level of the STI policies (or policy mixes), or at the micro evaluation of single STI instruments.

It is relevant to note that for the purpose of examining the different instruments Borrás and Edquist adopted one of the most simple categorizations of "instrument types", the one suggested by Vedung (1998) (Vedung, 1998), that defined them as a set of techniques by which governmental authorities wield their power in attempting to ensure support and effects (or prevent) social change" (B&E 2013 #1515). In this perspective, policy instruments could be classified in three main categories (*stick, carrots and sermons*) and they also defined 8 areas of policy intervention in innovation policy.

This choice is relevant because the classification in three big groups of the different instruments (regulatory, economic and financial and soft) is the most accepted one when academics in innovation policy attempt to classify the diversity of instruments to examine the policy mixes in general terms. This is also the typology of instruments adopted by OECD (2018) in the TIP analysis of STIP Compass database (DSTI/STP/TIP(2018)).

However the idea of using the different types or classes of instruments as a way of addressing the complex analysis of policy mixes is not very extended, and the literature, as reflected in a recent review of the of evaluation of STI policies (Cuningham et al. 2013), is dominated by the analysis of single policy instruments or at best, in very few cases, by examining the interaction between two different types of instruments of the same family (e.g. subsidies and R&D tax breaks). Only in very few occasions the level of analysis of the "policy mix" has referred to a country (with the exceptions of the innovation policy mixes review of the OCDE and EC-CREST).

As mentioned before, the STI policy domain, understood as "the component of the policy system, including the actors and stakeholders, organized around the substantive issue" of Science, Technology and Innovation (Burstein 1991 ((Burstein, 1991)) is composed by a significant amount of "issue areas" that could be nationally shaped. One of the themes that has become more and more relevant in the last 30 years is precisely the issue of interest here: knowledge transfer and science-industry relations. Knowledge transfer refers to different ways of valorisation of the knowledge produced in the

academic or public sector or its use by firms. We could find a significant amount of reviews of the topic addressing some distinctive dimensions (e.g. (Bozeman, 2000), (Breschi and Lissoni, 2001), (Perkmann Markus and Walsh Kathryn, 2007), (Perkmann et al., 2013),) but we will refer to one of the most recent ones as a basis, especially as regards the public policies pursuing knowledge transfer (Kochenkova et al., 2016).

2.2. Instruments for knowledge transfer and the mix of policies

Despite its popularity in innovation policy studies, the “policy mix” term is under-conceptualized, as it is presented as self-explanatory and unproblematic; moreover, despite this under-theorization, normative assertions referring to “effective”, “appropriate” or “balanced” mixes are often made (Flanagan et al. 2011). Policy change is often seen as the addition of new instruments and there is a common assumption that policy makers should use the more instruments the better. A different point of view is to think about the interactions and possible tradeoffs between instruments in the realization of the policy goal. Moreover, the complexity of the policy process precludes any static comparative analysis of instruments as if they were stable and independent units.

Science-industry knowledge transfer occurs through various formal and informal channels. Formal channels include collaborative and contract research, academic consultancy, intellectual property transactions, labour mobility and academic spin-offs. Informal channels include conferencing and networking, facility sharing and continuing education provided by universities to enterprises, among others (OECD DSTI/TIP (2015)15). KT&SIR instruments can be connected to four main underlying policy rationales: funding gaps, systemic failures, communication gaps and knowledge gaps (Kochenkova et al. 2016).

At the macro level in this policy domain, it is common to identify three broad types of public policy intervention. Firstly, legislative and institutional measures define the rules and boundaries to undertake KT between universities and industries, such as those related to IP rights, laws establishing the financial and organizational autonomy, laws for establishing TTOs, or laws to regulate university-industry collaborations; they are mainly oriented at avoiding systemic failures. Secondly, direct financial measures aim to close the funding gap or transferring knowledge from universities to industry through subsidies, commercialization grants, proof of concept or translational funds, seed funds, funding programs to establish TTOs, incubators, science parks etc. The third broad type of interventions refers to competence building measures to address communication and knowledge gaps between academic researchers, entrepreneurs and TTOs staff in relation to technology exploitation through training programs.

Overall, the research attention paid to the different KT policy instruments is imbalanced. In the policy analysis literature, some measures and instruments have received much more attention than others; in particular, in the area of regulatory measures, IP rights have received maybe a disproportioned emphasis. Likewise, different types of financial measures are very prominent in the scholarly literature. A

second imbalance pertains to the focus of analyses that emphasize policy design but largely neglect impact assessment in terms of commercialization rates, innovation, economic development, social benefits or job creation. Additionally, there are considerable deficits in research about the third broad set of public interventions related to knowledge gaps (Kochenkova et al.2016) where analyses and evidence are scant.

From the existing empirical research in KT instruments, some insights are worth taking into account. As regards regulatory instruments, research on the effects of the passing on legislation to allow universities to retain IP rights on inventions on the rate of patents has revealed problems of causality and attribution, with interaction effects between legislation and university autonomy, and the lack of a direct relationship between reforms leading to an increase in university patents and an actual rise in commercialization of research (Lissoni et al. 2013); some research has also shown that patent laws may disincentive firms to engage in early stage research where identification of rights is more difficult (Geuna & Muscio 2009) (Geuna and Muscio, 2009) and that the organizational context (PRO versus university) matters.

Other legislative measures that have been investigated in the literature are the laws to promote and regulate the creation of TTOs, with some findings supporting the idea that establishing TTOs has a strong significant impact on university decisions to retain IPR over their researchers' discoveries. However, some research on the effects of legal provisions directed at the creation of university incubators, spin offs and science parks, warn about the underestimation of necessary time scales from the funding authorities, as well as the difficulties of creating new structures in well established organizations like universities (Mustar and Wright 2010). On the indirect financial measures side, legislation enabling tax deduction schemes have generally been found to have a positive effect on the number of links between industry and academia (Crow & Bozeman 1998).

Turning to direct financial measures, in general, studies that investigate publicly funded programs aimed at helping universities to shift to commercialization and TT or collaboration with industry report positive impacts. These positive effects also holds when looking at grants targeted at individual researchers, for instance in the form of leave-of-absence grants, spin off related salary subsidies, or mobility to the private sector scholarships. Most existing studies in the area of seed funding to finance early phases of university start-ups offer mainly descriptive accounts of policy interventions but pay little attention to the governance and design of instruments. Although in general analyses of direct financial measures to foster KT support the idea that public funding has a reinforcing effect, and that access university access to private funding for knowledge commercialization is more likely is public funding is already in place, some studies also highlight the potential "crowding out" effects of public funding (Lotta 2003).

Another policy measure extensively covered in the literature is the financing of the set up of TTOs (often following the introduction of institutional ownership legislation) university incubators and science parks; here again, many descriptive accounts are

available but the scant research that goes into some kind of impact analysis is rather inconclusive across countries; for instance, concerns about concerns about the long-term financial self-reliance of technology incubators in the US contrast with the higher research productivity reported by firms located in science parks compared to firms not located in these facilities in the UK. Despite questions about actual effectiveness of science parks and incubators for academic start ups derived from principal-agent problems involved in public-private partnership, the academic literature agrees that they provide valuable professional assistance in spotting and joining established business networks. However, Siegel & Wright (2007) argue that the increasing use of TTO in the university governance of KT does not necessarily accelerate the KT process in the form of commercialization (Siegel et al., 2003).

One of the classical instruments for KT is the public funding of university-industry collaborative projects and centres that aim at bringing the incentive structures of academia and industry closer (Acosta Ballesteros and Modrego-Rico, 2001); (Santamaría et al., 2010). These are very numerous in several countries, but quantitative assessments of the impact of these programs are largely missing.

Tax deductions for R&D expenditures in private firms are also an important type of financial instrument. The extent to which these tax incentives are linked (via for instance a premium) to expenditures that involve cooperation with the public sector research varies across countries. In common with direct funding for collaborative projects, tax incentives can be justified on the basis of market failure. Advocates of this type of instrument highlight their lower implementation costs compared with direct funding of cooperative projects; critics warn about the drawback that they generally do not permit distinctions in the type of R&D supported, and the difficulty to support longer term and riskier innovation activities with this type of instrument.

Kochenkova et al (2016) identified some relevant dimensions to take into account when analyzing KT instruments and improving the policy mix. One is related to whether the impact of policy instruments vary according to the level of implementation (national/regional/local), the degree of involvement of universities or PRO (direct management or not) or the level of the target actors (organizations, individuals). Another factor that is worth considering, especially in methodological terms is that multiple government measures are implemented in parallel, making attribution of effects to single instruments very difficult. A third aspect is also methodological and refers to the impossibility to achieve a sound assessment of the outcomes of KT based only on quantitative measures (patents, revenues, spin-off firms, contracts) as there are also non market modes of interaction between industry and firms; for instance open innovation in which the university can both acquire and distribute unused intellectual property, and open source approaches in which KT extends to collaborators through standards creation and tacit knowledge sharing for which the TTOs can serve as a broker (Bozeman et al 2015: 35) (Bozeman et al., 2015).

The assessment of policy instruments and mixes must also account for differences in the institutional contexts and paths of public support for KT and divergent amount of available resources and the interaction of these with the countries' innovation policy. Policy makers need to seek complementarity since a vast number of instruments implemented in parallel at many levels could create fragmentation, duplication and hinder additionality of measures.

The analysis of KT policy instruments and policy mix should also consider the degree of institutionalization and professionalization of KT that exists in the system and whether institutionalizing KT is a policy goal itself. Institutionalized KT usually refers to four main mechanisms: patenting (and invention disclosures), licensing (royalties), spin off companies, and industry funded laboratories; most of the empirical evidence on university KT focus on these mechanisms. However, there are several other mechanisms without which the picture of KT would be incomplete; these range from recruitment of university graduates, to personal exchanges, cooperative joint research, contract research, consulting, and publications and other forms of open science. As pointed out by Geuna & Muscio (2009) the partially tacit nature of knowledge, the importance of social capital and networks, informal contacts, and the difficulties involved in pricing knowledge, complicates the design of a governance structure that creates the right incentives for balancing academics involvement in KT with the university traditional role of knowledge producer.

In this regard, it might be sensible to distinguish KT for economic gain from knowledge diffusion originating from basic research. Some authors consider that too much emphasis has been put on the side of policies and instruments encouraging commercialization, hindering the traditional open science culture of universities. It is also important to acknowledge that KT operates in both directions, something that well designed policies mixes should not overlook. The diversity of institutionalization of public research across the EU countries has resulted in wide heterogeneity in KT institutions. This diversity, together with the mixed evidence on the effects of national coordination of KTOs (*versus* regional or sectoral) makes policy recommendations for a common model for KT institutions almost impossible. In any case, one should be critical about the premise that the more institutions that are put in place to govern KT the better.

3. Instruments and mixes in public policy analysis

As we have presented, we can find in the literature several definitions of policy mix and instrument mix, but three common features can be found in those definitions: the objective of the mix, the interaction between the instruments, and the dynamic nature of the mix and its evolution.

Even if our empirical focus will be limited by the comparative strategy and the available information to the “instrument mixes for KT&SIR”, a significant contribution recently

made to the conceptualization of the policy mixes (Rogge and Reichardt, 2016) is worth revising.

Rogge and Richardt (2016) propose a definition of “extended policy mix concept” as the combination of three building blocks. Firstly, the elements comprise a strategy with its objectives and plans, as well as the instruments and its interactions. Secondly, the processes: the content of the strategy and of the instruments is the outcome of processes of policy design and choice and subsequently they have to be adopted and implemented. Thirdly, the characteristics of the mix: consistency of elements (strategy and instruments), coherence of processes, comprehensiveness and stability, among others, for instance, complexity. Additionally they also include the “domains”.

The policy mix concept consists of four aspects: 1) the elements (we call it the policy concept) describe the interacting policy instruments and the superordinate policy strategy; 2) the policy processes designate both policymaking and implementation. 3) The characteristics (we call them evaluation criteria) are the overarching “determinants for the performance of the policy mix” (Rogge and Reichardt, 2016, p. 1629), and include four criteria: consistency (are the elements of the policy mix aligned and work towards the same goal), coherence (is the policy mix synergic and systematic), credibility (is the policy mix believable and reliable) and comprehensiveness (is the policy mix extensive and exhaustive). Together, they are used to determine whether the policy mix will be or was successful. Reichardt and Rogge further added a fifth criteria, stability, which depicts the long-term stability of the policy mix (2016, p. 65). 4) The dimensions qualify some relevant elements of the broader policy context, such as the different governance levels or policy fields involved, as well as time and geographical factors (Rogge and Reichardt, 2016, p. 1628-29) Mavrot 2018. (Mavrot et al., 2018)

This framework can be useful to empirically analyze policy mixes in a given area and country and it is possible to combine it with the insights from related work. For instance, Howlett et al (2015) (Howlett et al., 2015) point out to three sets of issues that are relevant when analyzing instruments and policy mixes: the number of instruments, their choice and evolution, and their consistency.

The first building block in Rogge et al. (2016) framework refers to the elements. Policy instruments do not exist in a vacuum, so it is important to take step up in the policy level and take the overall policy strategy into account, including the policy objectives and plans. In the absence of clearly stated policy objectives and well developed plans, any analysis of the instruments’ mix (and moreover of its impact) is a difficult, maybe not even a feasible exercise. As the second element in the policy mix, the instruments are the concrete tools to achieve goals. There are several typologies of instruments in the literature.

Apart from belonging to a particular type, instruments can also be described along their attributes or features: costliness, political risk, level of intervention, universality, adaptability, market reliance (Peters, 2005) (Peters, 2006) , level of support, and flexibility, among others. The conventional categorization between directives” and

“incentives” “received some criticism and Bressers and O’Toole (2005) (Bressers and O’Toole, 2005) added the notion of hybrid instruments which involve elements of both and proposed some qualifications: whether the instrument makes a normative appeal to the values of the target group; whether the instrument provides or denies access to resources desired by the target group; and how much discretion in application or flexibility does the instrument provides.

In a similar way, the categorization of instruments in sticks, carrots and sermons (Vedung 1998) is interesting. Sticks refer to the regulations taken to influence actor’s behaviour through rules and directives, carrots would be the incentives involved in the policy, and sermons would imply influencing actors through communication and knowledge. Coordination would be a further relevant type of instrument.

After examining the main classification schemes put forward by scholars in the field, we have arrived at a primary designation of policy tools as either “substantive” (designed to alter the mix of goods and services provided and available in society) or “procedural” (primarily intended to alter the policy process rather than the substance, *per se*) Howlett (2000) ((Howlett, 2000).

We also adopt the classic approach to classify instruments is based on Hood’s (1986/2007) taxonomy (Hood, 1986) (Hood and Margetts, 2007), that combines the principal government resources used (NATO- Nodality (or information), Authority, Treasure and Organization) and whether the instrument is designed to affect the policy environment or to detect changes in it.

As regards procedural instruments Howlett (2000) classified them in accordance to the type of “governing resources”, with the underlying idea or objective of either “promote social networks” or “restrict social networks”.

For the purpose of this paper we use this main typology based on Hood (1986) and Howlett (2000) and adapted in Howlett and Rayner 2007 (Howlett and Rayner, 2007) (table 1).

Table 1. A Taxonomy of Eight Basic Policy Instruments Components of a Policy Mix (cells provide examples of instrument in each category)

		Principal Governing Resource Used			
		Nodality	Authority	Treasure	Organization
General Purpose of Instrument use	Substantive	<i>Advice Training Reporting Registration</i>	<i>Regulation Self-regulation Licences Census-taking</i>	<i>Grants User Charges Loans Tax credits Polling</i>	<i>Administration Public Enterprises Policing Consultants Record-Keeping</i>
	Procedural	<i>Information provision/ withdrawal</i>	<i>Treaties Advisory committees/ commissions</i>	<i>Interest group funding / creation</i>	<i>Conferences Commissions of Inquiry Government Reorganizations</i>

Source: Adapted from Hood (1986: 124-125) and Howlett (2000) (Hood, 1986); (Hood and Margetts, 2007); (Howlett, 2000). Taken from Howlett & Rayner (2007)

The second building block, the processes, relates to how mixes originate and evolve, and whether they are the outcome of intentional design decisions or rather the product of haphazard processes of policy layering, or the result of a path of policy trajectory and past decisions. An important consideration relates to historical trajectories and the extent to which a particular instrument mix is the outcome of intentional choice. In the absence of an intentional design, the most common feature of the mix would be layering, a policy design found in cases when it is difficult to remove previous instruments. One way to overcome path dependencies is replacement, where design occurs more or less from scratch once previous instruments are removed. Nevertheless, policy tools portfolios that have evolved and consolidated over time may be difficult to replace.

Apart from those two designs (layering and replacement), some authors point to two other emerging ones: policy packaging and policy patching. While the first consists in the creation of new mixes, in the second only selected aspects of the existing mixes are altered, and may be a more realistic design.

Policy instrument choice

Maybe the most important question to address in a qualitative analysis of country profiles regarding the processes involved in policy mixes relates to the drivers of instrument selection: why are some instruments chosen instead of others? There are many approaches to instrument choice, but these may be grouped into two main categories. Whereas rational models emphasize the optimal adjustment between means and goals and assume that decision makers can adopt an instrumental approach, other various approaches see the selection of instruments as a more complex process in which the goals-means link is less clear, a process that is contextually constrained.

For instance, incrementalism assumes that decision makers are bearers of interests and that due to fragmentation of those interests, choice is made through successive limited comparisons which usually lead to small changes with respect to the status quo; “muddling through” goes beyond and argues that decision makers are mostly interested in doing what they can without destabilizing the existing situation and therefore instrument settings; finally, in the garbage can model pre-existing solutions to policy problems configure the problems themselves. The empirical reality of instrument choice includes elements of the different approaches.

Capano and Lipi (2017) highlight two analytical dimensions, instrumentality and legitimacy, as the fundamental reasons why policy makers choose some instruments over others, emphasizing that instruments are also chosen based on the congruence with politically accepted values and the need to build consensus among different actors. Although legitimacy is important in any policy area, the risk exists that some instruments are adopted regardless of the context and of their effectiveness only because

they fit with the governance mode and meets the expectations of the insiders or of the broader policy community. Sometimes the source of such legitimacy is external and originates either from a different policy sector or from a different context (the private sector, international organizations or think tanks) and instruments are “imported” or adopted, invested with positive meaning as “best practice”.

Instrumentality is the second main driver of instrument choice and derives from the available resources of various types: capability and technical knowledge, financial arrangements, use of regulations, use of authority, etc. Therefore, instrumentality is not only about effectiveness but also about feasibility. Instruments may be generic or specialized depending on their degree of substitutability. A generic instrument is targeted to integration and to cover several different policy problems, an example could be policy evaluation which comprises a wide range of alternatives. A specific instrument, by contrast, can only be used for a specific purpose and in a specific way.

Capano and Lippi (2017) (Capano and Lippi, 2017) argue that specialized instruments are more demanding in terms of actors’ expectations and less flexible for the policy maker, while generic instruments are less demanding in terms of political cost and allow for more flexibility as regards interpretation and reshaping by decision makers.

Whichever the pattern of instrument choice, it is important to bear in mind that newly chosen instruments must operate in settings where an array of them already function (Bressers and O’Toole 2005) (Bressers and O’Toole, 2005).

Another part of the policy process, implementation, has a fundamental role in the effectiveness and efficiency of a policy instrument. Although insufficient resources (staff and funding) are often cited as the main difficulty for implementation, political resistance at sublevels of governance might also lead to implementation deficits. Howlett (2011) developed an inspiring ideal type categorization that provides us with two dimensions relating the nature of the policy target (complexity) and the severity of state constraints in resources and legitimacy (capacity) to predict the “national policy styles”, as a series of hypotheses about how different situations connect the nature of the policy objective with the state constraints and produce styles. Of course, implementation styles could change over time, and could move in specific directions.

Bressers and O’Toole (2005) point to a number dynamics of implementation in which a combination of instruments may operate of which three are worth highlighting: firstly, increased intensity of policy intervention by which more than one instrument is targeted simultaneously to the same group; secondly, integration of multiple instruments into one interactive process between government and different target actors; thirdly, implementation of instruments at different levels of governance (which may reinforce or weaken each other). These authors claim the need to build a process-based approach to aid in the choice or policy instrument; such approach should assess the key relevant actors, consider the already existing instruments and the relative efficacy of possible additional ones.

The third building block in the framework refers to the characteristics of the policy mix; among them, consistency and complexity are especially relevant. Consistency has to do with the adjustment or fitting of different instruments into a mix or portfolio. However, according to Rogge et al. (2016) we need to distinguish at least between three levels of consistency: consistency of the policy strategy, consistency of the instrument mix (complementarity, supplementarity and conflict among the instruments), and consistency of the instrument mix with the policy strategy.

Table 2. Definitions of the policy mix characteristics

Characteristic	Definition
Consistency	<i>“captures how well the elements of the policy mix are aligned with each other, thereby contributing to the achievement of policy objectives. It may range from the absence of contradictions [weak consistency] to the existence of synergies [strong consistency] within and between the elements of the policy mix.” (p. 1626)</i>
Credibility	<i>“the extent to which the policy mix is believable and reliable [...], both overall and regarding its elements and processes.” (p. 1627)</i>
Comprehensiveness	<i>“captures how extensive and exhaustive [the elements of the policy mix are] and the degree to which its processes are based on extensive decision-making” (p. 1627)</i>
Coherence	<i>“referring to synergistic and systematic policy making and implementation processes contributing—either directly or indirectly—towards the achievement of policy objectives.” (p. 1626)</i>

Source: Rogge and Reichardt (2016).

For a policy strategy to be consistent the plans have to be consistent with the objectives and the objectives must be aligned among themselves; otherwise conflicting objectives are a source of tension between instruments in the mix. At the second level the instruments within a mix have to be consistent in their interaction, reinforcing and not undermining each other. Instrument in a mix should be, at the very least, not contradictory, and at best, capable of creating synergies. Finally, at the third level, the policy mix has to be consistent with policy strategy; examples of inconsistencies occur when very ambitious policy targets are not accompanied by the adequate instruments to operationalize the strategy.

Consistency is different from coherence, the elements of the policy mix can be consistent, for example when every instrument oriented to the same objective, but lack coherence, for instance if an important target group is forgotten, or the instruments are not coordinated (Mavrot et al. 2018) (Mavrot et al., 2018). Consistency is very much related to complexity, and it might be the case that both characteristics have a negative relation. The recent literature has highlighted the need to incorporate the level of complexity in any analysis of policy instruments.

In addition to consistency and complexity, comprehensiveness may also be relevant for describing the nature of policy mixes; this characteristic captures the extension or scope of its elements and it depends on how much the policy mix addresses a variety of market, system and institutional failures.

Extending Rogge and Reinhart's model, Mavrot et al (2018) put a stronger focus on the actor and institutional context in which policy instruments come into play instead of analyzing the policy field. However, putting a very strong emphasis on context (or settings in their terminology) restrain their possibility of the analysis to very concrete case study and undermines the applicability of the approach to comparative analysis.

It is important to highlight that one of the challenges of analysing any type of policy design of a policy mix concerns the delimitation of its boundaries; such boundary setting will partly determine the complexity and consistency of the studied policy mix. It is likely that the wider the boundaries are set, the greater the scope and complexity of the policy mix and the more the challenges for consistency. Empirically, delimiting the boundaries of a policy mix depends on the research or policy question to be addressed.

4. Policy instruments' mix coherence as an analytical comparative feature: basis for an empirical approach.

From a complementary perspective we could consider coherence as an emergent property of instrument mixes and policy mixes; it means that various instruments (or policies) go together because they share the same goal or a related set of goals. Although we have to acknowledge that "greater coherence in policy does not necessarily imply better policy" in terms of appropriateness for the problem (May et al. 2006), however, policy coherence is a positive attribute that most analysts would consider an important basis for policy acceptance and implementation. Some authors even consider that coherence and consistency are essential for policy optimality (Howlett and Reyner 2007).

The very concept to policy instruments' mix implies that there is more than one instrument; quantity, however, is different from variety or diversity; diversity has a complex relationship with coherence: on the one hand, if there is too much diversity of types of instruments the mix may lack coherence; on the other hand, a diverse mix of policy instruments can still cohere if policies contain integrative and coordination properties.

The consistency of policy goals is in itself a potentially powerful integrative force, but goals are often too vague or too numerous to be useful in this regard. A second integrative force is the targeting of policies to specific groups. Policy targeting affects the policy image or, in other terminology, the social construction of the target group; the more specific the targets of the instruments, the more attention these groups get and pay. More diffused instruments fail to achieve this commonality of goals. Some scholars suggest that targeting can be used as a proxy of for the political influence of the target group (Schneider and Ingram, 1993). Third, the steering role of bureaucratic or policy executive structures may function as a coordination mechanism.

The empirical analysis of an instrument mix requires the identification of the key instruments and their design features. The most common approach for the identification

and characterization of the instruments is the analysis of databases. Databases are descriptive repositories from which it is usually possible to derive the main characteristics of instruments and instruments' mixes. Although data bases of policy instruments are unlikely to contain much information about the strategy or the policy processes, a more qualitative interview-based approach can be a complement.

Despite acknowledging the value of previous exercises based on a quantitative approach to instruments mix intensity in this paper we will focus on the diversity and coherence of the policy instrument mix. Inspired by the work of May et al. (2006) (May et al., 2006) about policy coherence and policy domains we propose to test some associations. Coherence and consistency are latent concepts that are very difficult to measure, however, some propositions can be advanced and some indirect measures could be developed reducing the problems resulting from the potential subjective bias of substantive documentary analysis.

- ***The concentration hypothesis.*** On the one hand, a policy mix composed of diverse and diffused instruments is likely to be relatively incoherent as compared a policy mix composed of focused instruments of the same type, using the typology proposed in table 1.
- ***The targeting hypothesis.*** A policy instrument mix with many competing groups or interests and little targeting is likely to be less coherent that one with supportive groups and higher targeting. Policy mixes with a high diversity of instruments or interests are not necessarily incoherent if they have greater targeting.
- ***The institutional-bureaucratic hypothesis.*** Instrument mixes for which there is a dominant executive agency will be more coherent than policy mixes designed and implemented by several executive agencies. The basis of this hypothesis is that agencies can act as an institutional basis for instruments' consistency and coherence.

Some tentative indicators

Firstly, we will empirically approach **instrument concentration** as the degree to which one or more instruments appear as dominant in the policy mix. For instance, for each country the proportion of particular types of instruments can be analyzed. Additionally, we will look at how instruments are integrated in policy initiatives. Secondly, policy **targeting**, understood as the degree to which one of more category of target groups or entities dominate a given policy instruments' mix can be approached by looking at the number, variety and frequency of appearance of particular target/beneficiaries/potential applicants in the instruments. Previously, we will have to identify the main categories of those target groups (individuals, firms, universities, research organizations, etc). Finally, **institutional fragmentation**, considered as the degree to which one or more agencies are dominant influences in instrument choice and implementation can be operationalised first by the simple indicator of whether of the presence or absence of a lead national

agency managing the policy mix; however, in cases of multiple agencies it will also be important to take into account their relative weight in the policy area.

5. Data sources and previous approaches

In this paper for the empirical analysis, we use the operational definitions set up in the European Commission/OECD Science, Technology and Innovation Policy (STIP) Compass Database (<https://stip.oecd.org/stip.html>). The EC/OECD STIP database collects country responses to a biannual STI policy survey. Responses are provided by government official to the OECD Committee for Scientific and Technological Policy (CSTP) and to the European Research and Innovation Committee (ERAC).

Exhibit 1. STIP Compass official presentation

The main data source for STIP Compass is countries' responses to the EC-OECD STI Policy survey, which is run every two years. The most recent edition was administered at the end of 2017. The survey is addressed to national government officials working on STI policies in a range of public administrations, including ministries and agencies. The survey is wide in scope, covering policy issues around public research, business innovation and entrepreneurship, knowledge transfer, innovation skills, innovation for societal challenges and governance of the STI system. For the most part, countries are asked to list and characterise the policy initiatives they are implementing to address a particular challenge, such as the innovation deficit typically found in SMEs or knowledge transfer gaps between universities and firms. All policy initiatives are characterised using a standard template. This template uses taxonomies of policy instruments and target groups that allow comparison of policy initiatives within and between countries. (<https://stip.oecd.org/stip.html>)

The basic definitions and the structure of the questionnaire condition the information collected and shape the opportunities for the direct use of the data. The STIP Compass questionnaire is organized in sections referring to “all relevant areas of STI policy”, and it is expected that all initiatives spread across in different Ministries and national agencies will be reported, at least at the national level. The sections' structure of the questionnaire conditions the way in which the data could be constructed (see Annex 1).

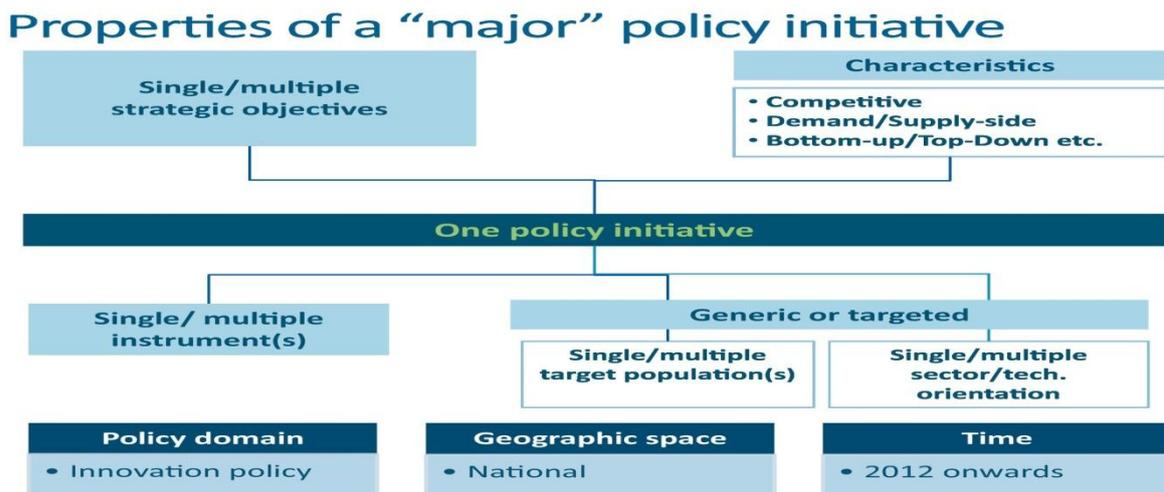
The unit of observation/reporting is the “major national policy initiative”. Policy initiatives are defined as a public action that i) aims to achieve one or several public policy goals; ii) is expected to modify or frame the behaviors of actors and stakeholders; and, iii) is implemented with a minimum time horizon or on a continuous basis (i.e. not as a one-off “event”).

Accordingly, all policy initiatives are accounted on the same scale (one unit, unweighted). In its current form, and with the quality of information collected, the STIP database falls short of allowing the assessment of the size of the initiatives or instruments, for example taking into account the resources or budget allocated to the initiatives or the qualitative assessment of relevance.

The strategy was justified as a response to a trade-off between capturing the completeness of a policy mix and preserving the simplicity –and feasibility- of the data collection. However the problem is not deciding what a “major” or most important initiative is [as suggested by Kergroach 2018 (Kergroach, 2018)]; the main problem of the approach is the matching between the “initiative” and the “instrument” approaches, and how the respondent understands the issues at stake.

As reported by Kergroach et al (2017), it is assumed that a policy initiative has several properties (Figure 1). In their words, a policy initiative serves a single (or multiple) *policy goal(s)*. In addition, a policy initiative: a) aims to achieve a single (or multiple) *strategic objective(s)*, b) makes use of a single (or multiple) *policy instrument(s)*, and c) is generic or targeted if it addresses a single (or multiple) *target population(s)* and/or a single (or multiple) sector(s) and/or technology(ies). It is also said that a policy initiative takes place in a particular *policy domain*, in a particular *geographic space* and at a particular *time*.

Figure 1. Properties of a policy initiative



Source: Kergroach (2010)

Kergroach et al (2017) (Kergroach et al., 2017) represents the first attempt to exploit the available information at the STIP database. The objective of their work is defined as “benchmarking of the country STI policies” and they focus on the domain of technology transfer for comparisons.

The paper is a nice example of the potential uses of the data collection, but as many other attempts to exploit information from the “big data perspectives” it has some weaknesses that should be tackled in further efforts. The main deficit is related with problems of terminological ambiguity (e.g. policy domain), lack of rigorous conceptual definition of the key concepts (policy mix), problems of operationalization (the data collection is based on “policy initiatives” and not on “policy instruments” and it is split in “dedicated” and “other initiatives”, as a result of the problems of structure in the

questionnaire) and measurement of the attributes (the idea of “density”, as the proportion of the total number of initiatives, as an expression of the different composition of the mix).

The main effort in this previous work was to map the “composition” and the share of different “policies” in various countries, but they used an “*ad hoc*” classification of “types of instruments” (5 classes) for this mapping.

Additionally, attempting to provide some explanation or correlation, they highlight some relevant country dimensions to understand the differences in the “maps of instruments”: the country structural features, the way policies are embedded in the national STI policy and the country development stage.

A second approach to analyze the STIP policy initiatives has been taken recently by the OECD in its document “Mapping the policy mix for knowledge transfer-descriptive results from the 2017 EC/OECD International Survey on STI Policy (STIP)”. We could consider this mainly as a quantifying approach to the KT instruments since the focus was on identifying policy initiatives. Some attention was also paid to identifying the target groups and, when possible, approximating the allocated budgets. The exercise also made some categorizations of the instruments by type and facets. The mapping was complemented with some country cases from which some patterns could be identified, for instance the relevance of financial direct instruments: project grants for public research and grants for business R&D and innovation. Our aim is to go a step beyond the quantitative approach.

A last problem, related to the construction of the questionnaire, comes from the fact that it is not very likely that countries will report about other policies not directly related (or nationally understood as related) with KT&SIR, or about instruments that were in place in the past and have been removed from the mix.

6. Country selection

A regular debate in policy analysis refers to the possibility of considering the instruments as “technical tools” that could be compared across countries (or settings), or even more directly “transferred”. In fact, there is a general agreement that policy mixes are country, context and time specific; therefore, we cannot approach the understanding of policy mixes without providing some country “context”; this is why we have selected countries that are different in various dimensions and in their attributes.

We could take two potential approaches:

The first one is the “pure comparative approach”, using the countries as units of reference to assess the similarities and differences in policies, programmes or instruments regarding science and industry relationships. Comparing is a step beyond mapping.

The second one is to analyze the way in which countries' policies change over time (in comparison with the other countries). With the proper analytical framework, understanding why and how policies change in a country could also be of relevance to help in determining the conditions for success. This approach, however, is very demanding in terms of country specific longitudinal information.

Even if the explanation of policy change is not the focus of the current work, it is important to take in account some of the basic models or theories that could contribute to the "explanation" of policy variation (and policy change); those models provide interesting insights to select the country cases. In that way we will take into account different theoretical perspectives to explain why governments set up, modify and, indeed, terminate public policy. What are the central explanatory factors that are relevant in order to explain policy variation (and policy change)?

Various general approaches have been identified in the literature. However, for the purpose of this study we will consider two main ones:

1. Structure-based models that emphasize the possible policy consequences of enduring macrostructures in societies; in our context, socioeconomic development levels or the investment in R&D that countries present are important. These models draw attention to the most basic socio-economic problems present in society, which provide decision-makers with the incentive to create or modify public policies. These approaches are concerned with the socio-economic structures rather than with the nature or the structure of the problems. It is, in fact, a "functional" understanding of the public policy that is capable of explaining a good deal of variation of public policy across countries.

2. Institutional-based models primarily outline how formal and informal institutional arrangements may influence public policy. There are various ways of understanding institutions, but a summary of how institutions affect public policy outputs was provided by March & Olsen (2008) who argue that institutions empower and constraint actors. There are at least three different types of institutionalism, but the common underlying idea is that institutions shape actors preferences and affect their behavior; they also define new logics of action (different from the rational one) like the logic of appropriateness (legitimacy); institutions also recall the fact that "history matters" and highlight the role of path dependences, lock-ins in policies and sequences in the construction of policy mixes.

In this context we have selected two types of country attributes that appear relevant from different theoretical perspectives: a) structural features of the country (or the STI system) and b) institutional characteristics of the country. In this way, we acknowledge that policy-making is path dependent and other elements of the policy processes, such as political bargaining, instrument lock-ins and resistance across government levels are also influential.

To select the countries included in the exercise we have used two main criteria resulting from the general model to account for variation in the policy outcomes of the countries:

a) Structure-based (or socio-economic) models and b) Institutions-based (or policy capabilities) models. To account for the difference in how socio-economic conditions could influence the choices we have used the level of “socio-economic development” (or the R&D expenditure level per inhabitant or GDP per capita). To account for the differences in how institutions could shape policies we have adopted a classic typology of the countries; Castles (1998) analyzed the variations in public policies by combining political-institutional variables and socioeconomic indicators, with four families of countries that differ in respect to policy making: Anglo-Saxon, Continental, Scandinavian and Southern European.

	Level of Socio-economic development indicator		
	High	Med	Low
Type of Country according policy making (Castles 1998)			
Anglo-Saxon	Canada		
Continental	Austria, Netherlands, France,		Hungary
Scandinavian	Norway		
Southern			Spain Portugal;

There is a second dimension that refers to the attempts to explain or at least to establish some correlation between some of the country’s attributes and the policy mixes. For example, Kergroach et al 2017 has taken a traditional approach and selected some structural features of national STI systems that could be considered key factors determining policy design and how policies are implemented. They consider various structural aspects that are hypothesized to have a significant impact on the policy mixes for KT&SIR. They also assume that those “structural factors” could have effects on the design and efficiency of policies for KT&SIR.

7. Characterizing policy coherence: policy initiatives, target groups and managing agencies on the STIP compass

As mentioned, the STIP compass is a repository of information on national STI Policy initiatives. A recent OECD document [DSTI/STP(2018)8] presents the situation of the development and acknowledges some general concerns on the quality of the data, such as problems of definition, verification, completeness of data and missing information on budget and other aspects. Given those problems, that we cannot tackle in this pilot exercise, and since information gathering in the STIP compass is organised in themes, we will use theme number 4 “public private partnership and knowledge transfer”.

For the purpose of this work, we will use information that comes from the STIP Compass, in particular, an extraction of data made by OECD staff in February 2018.

The STIP questionnaire has eight sections directly related with our subject (under the label “Public-Private Knowledge transfers and linkages”), five of which are related to specific aspects of public policy intervention; that is the information that we are going to use to test the different indicators we propose. Therefore, the reliability of the analysis in this document is highly dependent on the data characteristics and the current classification embedded in the description of the policy initiatives and the general design of the STIP questionnaire. There are other more inclusive options, such as doing a search of topics related with KT and SIR in other sections of the questionnaire, but for a pilot exercise like this one, that option would probably include additional bias. We would like to make clear that the main objective of the paper is not to assess the KT&SIR in a few countries, but to use the data from a limited number of countries to test the hypotheses underlying the process for constructing the indicators.

While the main aim of this section is to develop and test a set of indicators related to various analytical dimensions of the “KT instruments’ coherence”, to valorise the whole STIP Compass it would be necessary to go beyond simple inventories and to produce proper taxonomies, a more developed type of classification established with clear and explicit criteria and provided with analytical meaning. Those efforts to advance STIP Compass are necessary and deserve specific attention, but they are not the focus of this exercise.

As already mentioned, the entry point of the information in the STIP survey are the so called “policy initiatives”. Policy Initiatives are defined as a public action that: i) aims to achieve one or several public policy goals in the policy area of science, technology and innovation, ii) is expected to modify or frame the behaviours of actors and stakeholders, being national, domestic or foreign, who are part of or influential on, the national innovation system, and iii) is implemented with a minimum time horizon or on a continuous basis (i.e. not as a one-off “event”). The definition is therefore deliberately wide: a policy initiative can be a financial policy measure (e.g. a grant, a tax incentive, etc.), a programme (e.g. environmental technology programme led by an environment agency, a cross-border research programme, etc.), a law or regulation (an evaluation/impact assessment requirement applying to the STI area, etc.), an informal framework (e.g. an indicative rule or guideline on stakeholder consultation on research priorities or on minorities’ inclusion) or an ‘institutional event’ (e.g. creation during the last two years of a research agency, a high level STI council, etc.).

Among the fields used by the respondents to characterise a “policy initiative” there is one dedicated to the “policy instruments” that the initiative uses in its implementation. The survey incorporates a list of policy instruments (Inventory) for respondents to choose from. The respondent could add as many policy instruments from the inventory as desired. Other features are also collected at the level of the Policy Initiatives (Pin.)

such as the Target Groups or the Managing Agencies involved, and the respondent could select one or several in both cases¹.

The current format of the data collection forces that the dominant unit of analysis to be considered is the Policy Initiative (Pin.), because this is the one that allows to construct multidimensional (at least two dimensions) indicators. Unfortunately the analysis of the policy instruments (Pol.Ins) could only be done in a single dimension.

We believe that counting the number of initiatives and the instruments are necessary steps to better understand the policy mixes and the instrument mix, but we need to provide meaning to the number of initiatives that a country describes (discounting the disincentive for the respondents to report several). Reporting initiatives could be understood as the policy actions to address some identified problems; having a initiative in one area could mean that the issue is in the political or policy agenda, but it does not tell us how important the issue is in the government agenda.

7.1. Initiatives, multi-instrument initiatives and Instrument concentration

We start using the Policy Initiatives (Pins) data. For the eight countries that we have analysed, we combine and link the initiatives and instruments. Two main dimensions are worth highlighting. Firstly, we need to consider the total number of initiatives: in principle, the larger the number of initiatives, the greater the risk of losing coherence; secondly, the relation between initiatives and instruments, which, assuming there are no errors in the filling of information in the database, will give us an indication of the tendency to integrate different instruments in a single initiative. This leads us to the issue of single versus multiple instruments' initiatives and which option is likely to be more coherent. This is not an easy analytical decision since, on the one hand, single instrument initiatives may be seen as more direct and simple, whereas, on the other hand, integrating several instruments by design into one initiative may result in a more coherent instrument mix, provided instrument layering is avoided and instruments consistency is increased.

In Figure 2 we develop an ideal type approach in which we can observe the interaction of both dimensions and the hypothetical resulting patterns in terms of degrees of coherence. The different quadrants are numbered from 1 to 4 so that 1 would be the lowest degree of coherence and 4 the highest. Quadrant 1 depicts a situation in which there are several KT&SIR initiatives corresponding to only one instrument. This, according to our framework, would lead to policy fragmentation. In quadrant 2 we have cases in which the number of initiatives is also numerous but these are mostly multi-instruments, which would make the mix or portfolio difficult to coordinate. These two combinations are likely to be suboptimal in terms of integration and coherence. The lower quadrants depict better combinations. Our contention is that coherence is likely to

¹ Since filling out the questionnaire is costly, we should consider the possibility that the different respondents had different propensity to properly describe the use of different instruments related to the policy initiative.

be enhanced in policy mixes characterized by few initiatives each of which combines more than one instrument. The more simple combination in quadrant 3, in which initiatives are limited in number and mostly single instrument, could also be coherent but maybe scarce or lack intensity.

Figure 2. Patterns of relative integration/coherence of the KT initiative mix

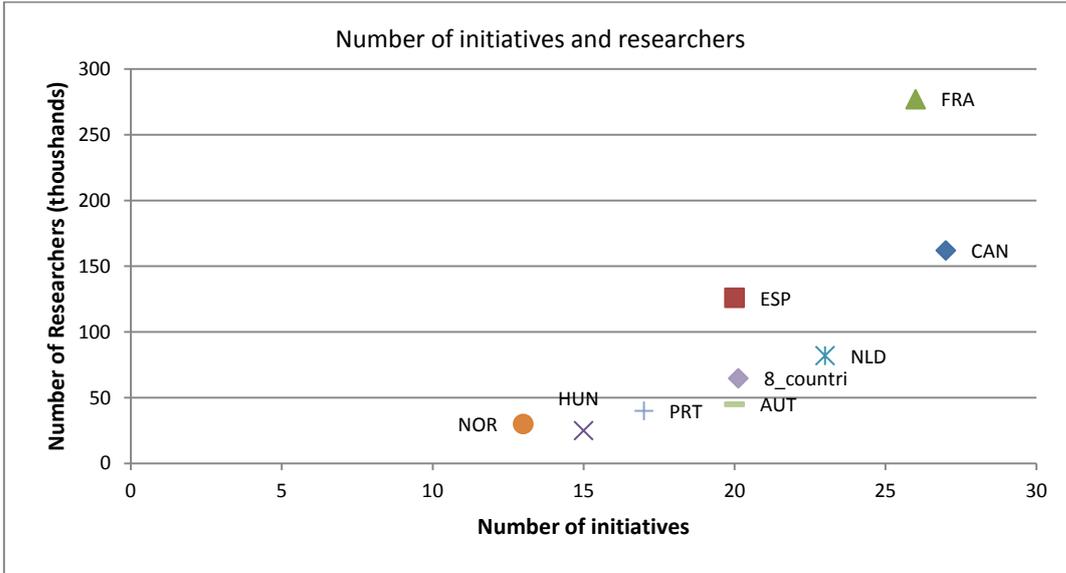
Several initiatives	Several single instrument initiatives 1 <i>Fragmentation</i>	Several multi-instrument initiatives 2 <i>Non coordination</i>
	Few single instruments initiatives 3 <i>Scarcity/Dispersion</i>	Few multi-instrument initiatives 4 <i>Rationalization</i>
Few initiatives	Single-instrument	Multiple-instrument

Having fewer initiatives and being a large part of them multi-instrument could be taken as an indicator of a high level of policy coherence and instrument consistency.

However, to provide to our analysis with some meaning it is necessary to consider some additional factors that could shape the number of initiatives, and the relationship between Pins and Pol.Ins. The first factor is the plausible existence of a relationship between “the number of initiatives” and the size of the country, and with the political capability of the actors in the policy domain. We expect that if powerful actors exist in the country they will promote many initiatives to advance their interest. The second relates to the relationship between instruments and initiatives, because packing various instruments in a Pin could be taken as an indicator of higher “technical capabilities” in the Government of that country.

What factors are associated to the total number of initiatives reported by a country, if data collection has no critical incidents? Figure 3 shows the positive relation between the size of the country, measured in number of researchers FTE, and the total number of reported initiatives. It appears that some linear relationship exists, so we can tentatively conclude that the larger the size of the country the more initiatives we could expect.

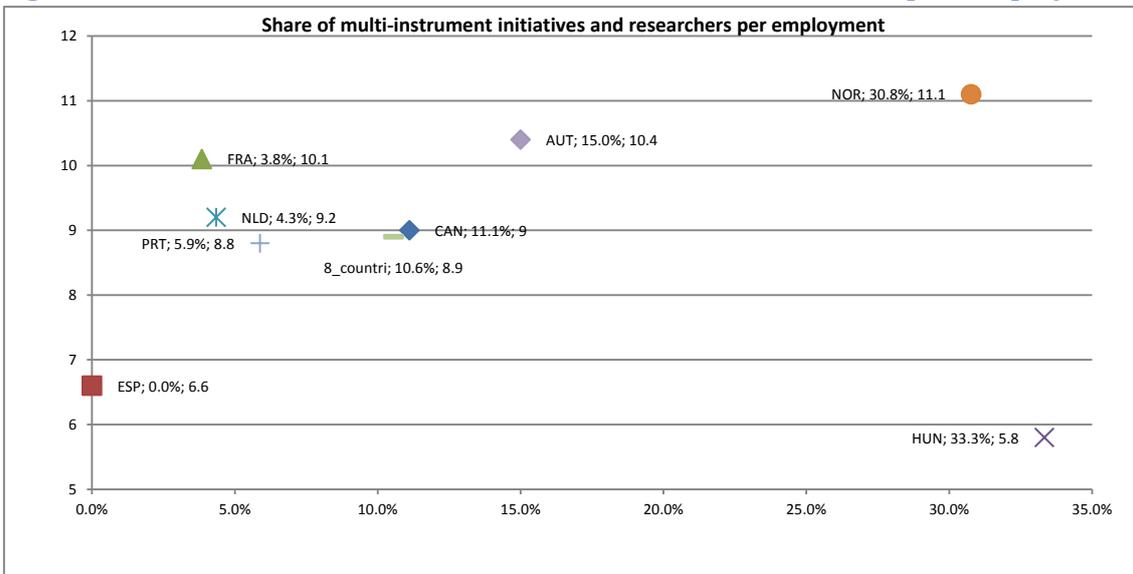
Figure 3. Number of policy initiatives for KT&SIR by country



One could also have the expectation that the R&D system's strength of a country (measured by GERD/GDP or number of Researchers per active Population) could be related with some of the variables that reflect the sophistication of the policies and the increasing coherence of the instruments mixes for knowledge transfer and science–industry relationships.

The Figure 4 shows a trend of increasing multi-instrument initiatives, as the countries increase the value of the number of researchers per thousand employments, but there are some outliers, like Hungary.

Figure 4. Share of multi-instrument initiatives and researcher per employment

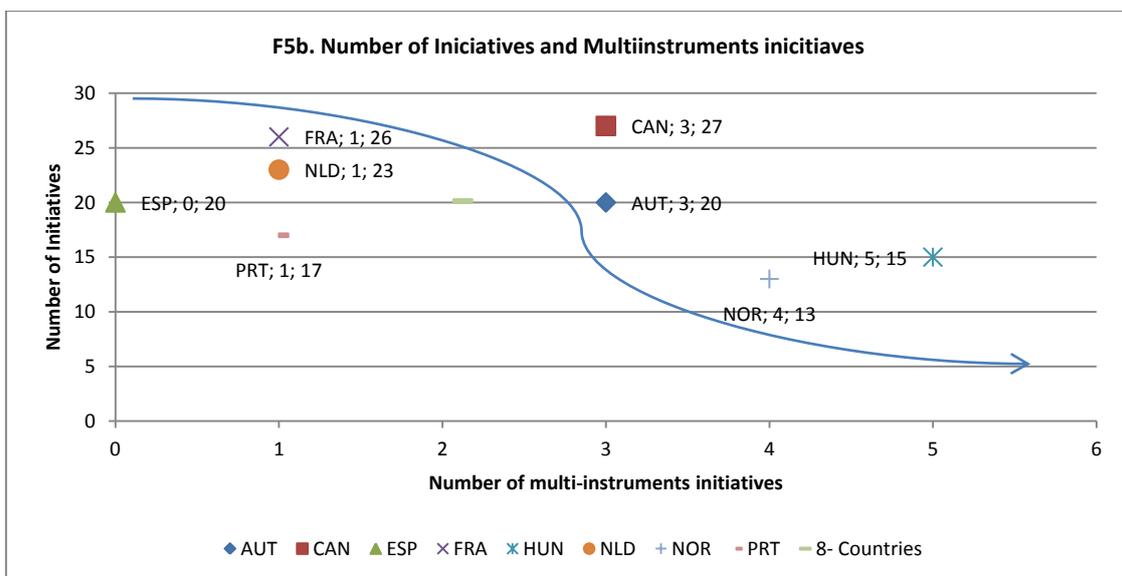
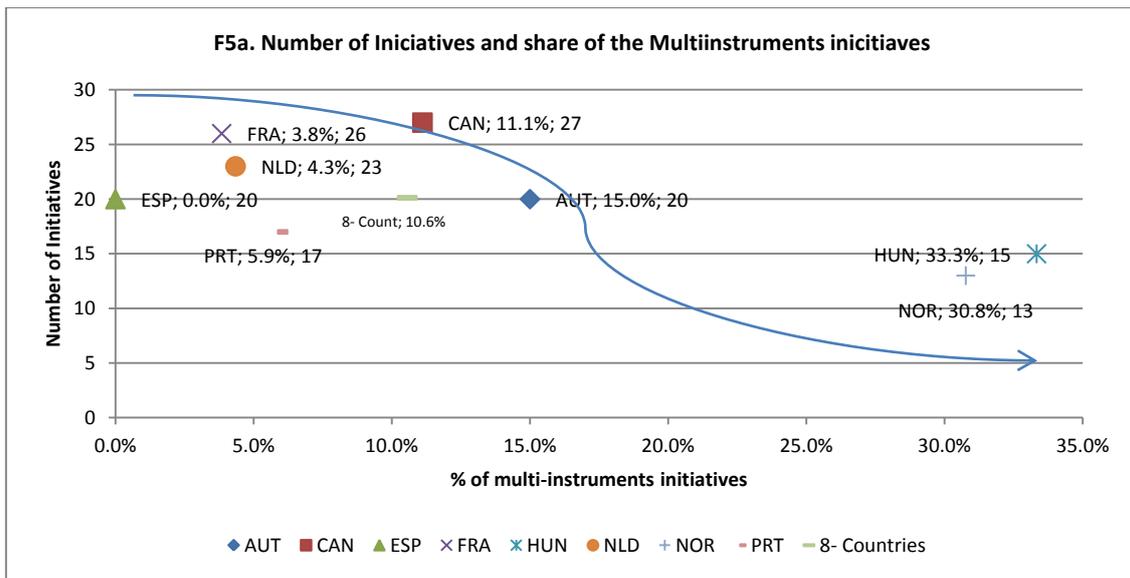


In Figure 5 we can see how countries are placed in the bi-dimensional space according to their information in the database. Firstly, we just present the absolute numbers of initiatives (Pins) and multi-instrument initiatives. Secondly, we represent the multi-instrument initiatives as a share of the total. In both Figures the idea is simple: the more

and the higher the share of multi-instruments initiatives the more consistent instrument mix for KT&SIR.

We can see how for instance Spain is a rather singular case in which every initiative corresponds to a single instrument. Portugal, France and the Netherlands show rather fragmented initiatives mostly with initiatives that are single instrument ones. Conversely, Hungary and Norway appear to have more integrated and rationalized initiatives, where the number of initiatives is not very large and with a larger share of multi-instrument initiatives. Austria and Canada are placed in intermediate spaces.

Figure 5. Total number of initiatives and number of multi-instrument initiatives and share of the total.



7.2. Policy targeting

A second dimension that the theory relates with policy coherence and instruments' consistency is the level of policy targeting. Public policy theory says that the more focused on a target group an instrument is, the better, and that it is important to avoid “catch all” instruments that are likely to increase the lack of coherence. Additionally, focused instruments tend to get more attention from the targeted group. Therefore, having many initiatives addressing several target groups at the same time could be an indicator of lack of coherence in the initiatives, and an indicator of potential conflicts among the different interests of the target groups. From another perspective, if public administrations have limited resources and technical capabilities, policy makers usually search for instruments that are flexible in terms of their management, with limited policy targeting.

As in any of the indicators to be constructed, the policy targeting of any initiative is conditional on the inventory of target groups to be used and the taxonomies constructed to classify the TG. We have constructed an index that measures the average level of concentration or focus of the initiatives on a target group. In Table 1 we present the distribution of the number of initiatives by country, according to the number of target groups they are addressing. It also includes a “Focus Index” as a synthetic measure, for each country, of the average number of TG per initiative in each country.

Table 3. Distribution of the initiatives according the number of Target groups and TG focusing index

	Num TG	Country								8 Countries
		AUT	CAN	ESP	FRA	HUN	NLD	NOR	PRT	
Number of Initiatives according the number of Target Groups included.	1	10	7	4	9	3	6	4	4	47
	2	2	5	7	5	0	3	3	1	26
	3	1	7	3	9	5	3	3	1	32
	4	2	4	3	1	2	2	2	1	17
	5	3	1	1	0	1	4	1	0	11
	6	1	2	1	0	1	1	0	3	9
	7	0	0	0	0	2	0	0	2	4
	8	0	0	0	0	1	1	0	1	3
	9	0	1	0	1	0	1	0	0	3
	10	1	0	0	0	0	2	0	0	3
	11	0	0	0	0	0	0	0	1	1
	12	0	0	1	0	0	0	0	0	1
	13	0	0	0	0	0	0	0	1	1
	14	0	0	0	0	0	0	0	1	1
	16	0	0	0	0	0	0	0	1	1
	17	0	0	0	1	0	0	0	0	1
Total TG		56	80	62	76	59	92	32	107	564
Total Ininitaves		20	27	20	26	15	23	13	17	161
TG Focusing Index		2.8	3.0	3.1	2.9	3.9	4.0	2.5	6.3	3.5

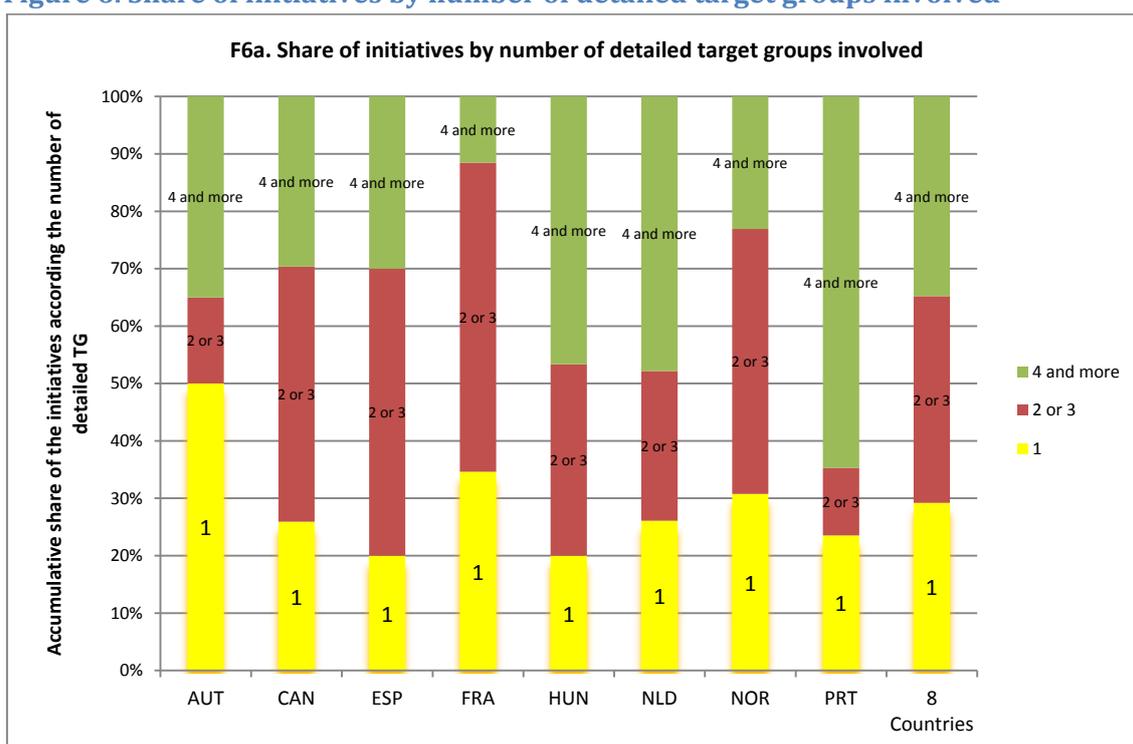
The higher the values of the focus index the lowest the focus of the knowledge transfer and SIR initiatives on a single group. Value 1 would indicate the total concentration or focus on a target group (one target group per initiative); in this case, the higher the value (above 1) the less focused and more disperse the initiative mix. On the one hand, we can observe how Norway and Austria have the lowest values, whereas Portugal, the Netherlands and Hungary have the highest (more dispersion) above the 8 countries average. Canada, France and Spain, with values around 3, occupy intermediate

positions. The average number of target groups per initiative varies from 2.5 to 6.3. However, we should remember that the focus index is an average value and it could be conditioned by some extreme values in the distribution of a few instruments; for instance, Portugal has various instruments with more than ten target groups.

Another way of analyzing the focusing of the initiatives is to estimate the cumulative share, or concentration, of the total number initiatives that are highly focused, for instance, in one target group, 2 or 3 target groups or 4 and more TG. Countries having higher shares of initiatives in the first category would have potentially more coherence than countries with a higher share in initiatives with 4 or more TGs.

Figure 6 complements the information provided in table 3. Green and red bars show the share of initiatives targeted to 4 or more groups and 2 or 3 groups respectively. Portugal, Hungary and the Netherlands show greater shares of initiatives targeted to 4 and more groups in comparison with the rest. Yellow bars represent the share of initiatives targeted to only one group. Austrian initiatives would be the most focused, with 50% of the KT initiatives in this category.

Figure 6. Share of initiatives by number of detailed target groups involved



One interesting aspect of this analysis relates to the fact that integrating multi-target initiatives in a policy design in an efficient manner probably requires a significant level of technical capabilities in the STI policy domain of the countries, something that could be measured.

The classification of TG defined by the OCDE includes an inventory of TGs, and an aggregation of the whole inventory in 7 different main categories. In the next figure 3b we will present four of the main categories of TG addressed in the initiatives. For each

country, we present the share of initiatives that address the main TG of reference. The picture shows differences among the countries in the type of targeting and a higher propensity towards different types of TGs in some countries.

Figure 7. Types of main target groups and relative presence in initiatives (%)

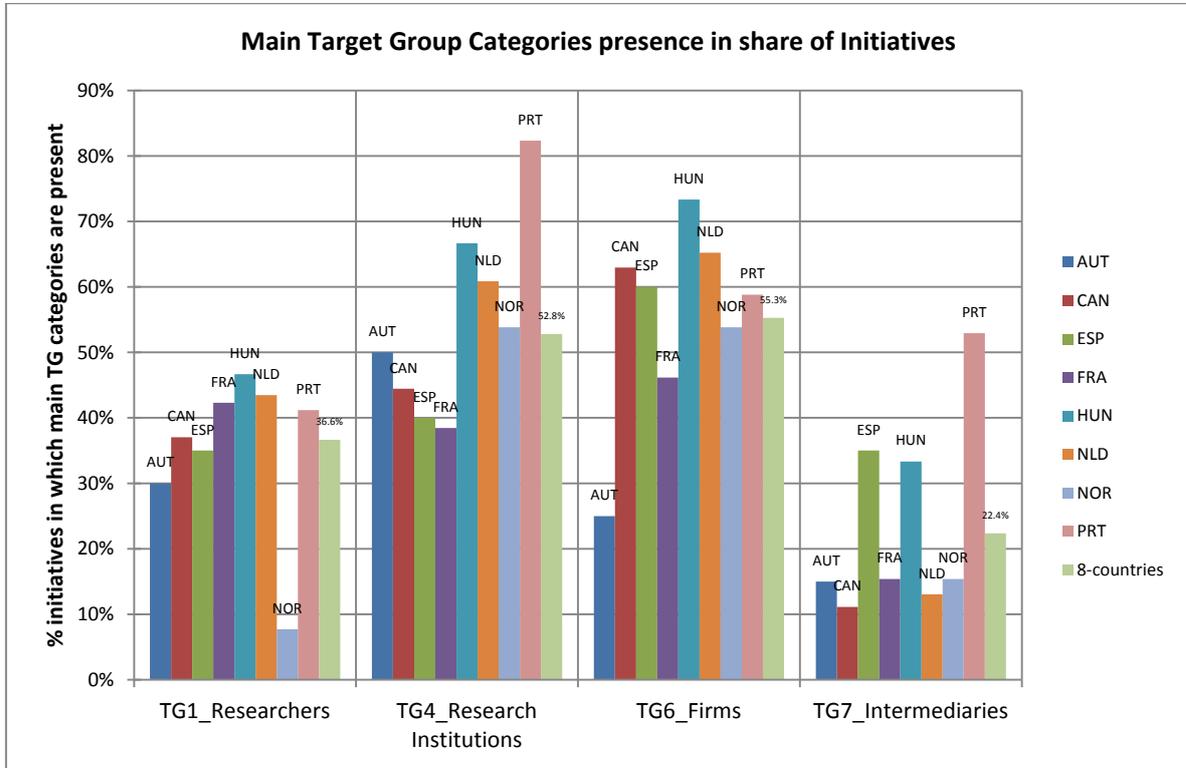


Figure 7 shows that in general research institutions and firms are the dominant target groups of knowledge transfer initiatives, but differences across countries are also visible. For instance, KT initiatives in Norway have very little focus on researchers in comparison with the rest of the countries. Compared with the rest, Austrian instruments focus less on firms. Portugal is the country with a larger share of initiatives focusing on research institutions as well as on intermediaries followed by Spain and Hungary; Hungarian KT initiatives have a stronger focus on firms and researchers. As regularity look like if countries have lower levels of expenditure the focus is more with the public sector, where the capabilities exist. Probably the different focus on researchers/individual versus organizations depends on the nature of the authority structure in the national R&D and innovation systems.

7.3. Institutional fragmentation

We now turn to the analysis of the Government entities involved in the management of the initiatives. The expectation is that as more agencies are involved in the management of policy initiatives the risk for policy coherence increases, because such multiplicity could increase the difficulties for inter-agency policy coordination. As more agencies are involved, the higher the risk for the coherence and consistency of policies.

In the STIP data there is an additional problem in the identification of the lines of authority among agencies and entities; there is not a clear establishment at national level of the inventory of the managing agencies (including changes in names) and the levels of dependence; therefore it could be the case that a country going into a very fine grain detail in the identification of the managing agencies has included “non autonomous or independent” units of bigger agencies under the same political authority, as managing agencies increase the value of the indicator.

There is an additional complication because one policy initiative may be managed by various different agencies, as included in the STIP compass; however, our analysis will not address whether or not one initiative has multiple managing agencies.

This indicator of institutional fragmentation refers to the number of different agencies managing the overall number of knowledge transfer initiatives. Analyzing the degree of fragmentation could refer to two different dimensions. The first is the number of different agencies managing the initiatives in each country; the more agencies per country, the more fragmentation and potentially the less coherent and consistent the instrument mix could be. Secondly, we measure also the concentration of the initiatives in few agencies, with the expectation that the more concentrated the less fragmented; the second hypothesis has a conditional effect: a country could have many managing agencies, but if one or a few of them concentrate a significant share of the total initiatives this could reduce the institutional fragmentation. We assume that in-house coordination in one managing agency is easier than coordination between different agencies.

Like the total number of initiatives, the total number of managing agencies is probably related to the size of the country; additionally the expansion of the number of initiatives will be related with the enlargement of the number of managing agencies, all in the context of an increased bureaucratic complexity.

Linking the number of executive agencies in charge of the KT initiatives with the number of initiatives, we could also think about some combinations regarding institutional fragmentation. We could have situations in which several agencies each of which manages a reduced number of initiatives; this, according to our framework would lead to fragmentation, and possibly, lack of coordination; a second institutional scenario would be one with several agencies each of which manages also several initiatives, increasing complexity and maybe leading to saturation and also lack of coordination. According to our hypotheses, coherence is enhanced when there is a dominant executive agency that manages most of the initiatives and acts as a basis for policy consistency. In this case, the dominant agency could manage a large or a small number of initiatives. The resulting combinations are summarized in Figure 5 and developed as ideal type. Numbers in the quadrants would indicate an increasing degree of coherence, so that 1 would be the lowest and 4 the highest.

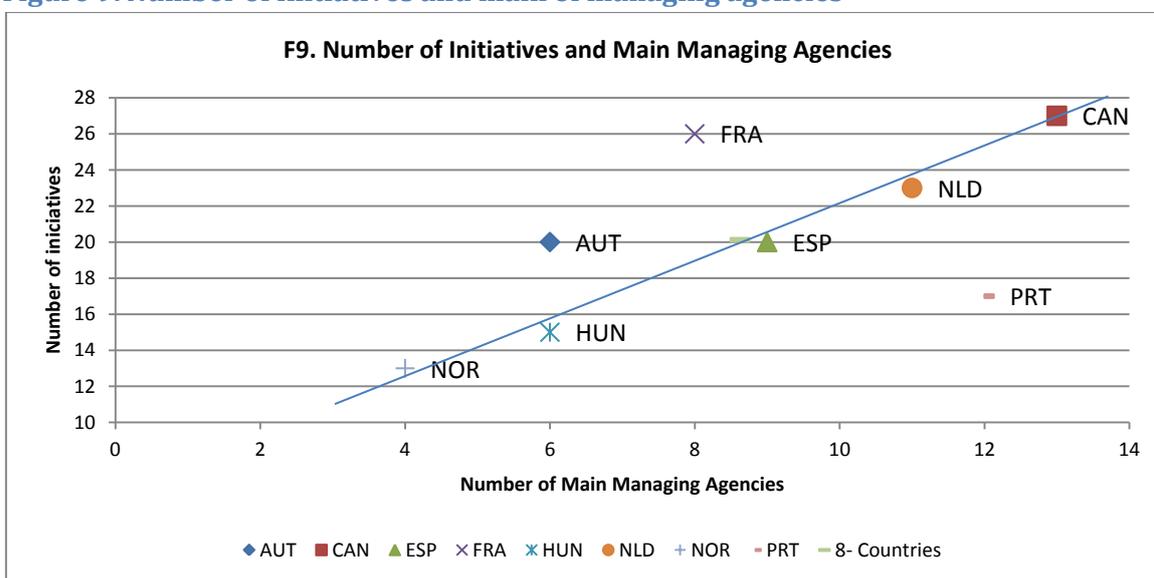
Figure 8. Institutional integration patterns

Several initiatives	A dominant agency/s managing	Several agencies managing several
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	several initiatives Concentration 4	initiatives Complexity/Saturation 2
Few initiatives	A dominant agency/s managing a limited number of initiatives Simplification 3	Several agencies managing a reduced number of initiatives Fragmentation 1
	Very few agencies	Several agencies

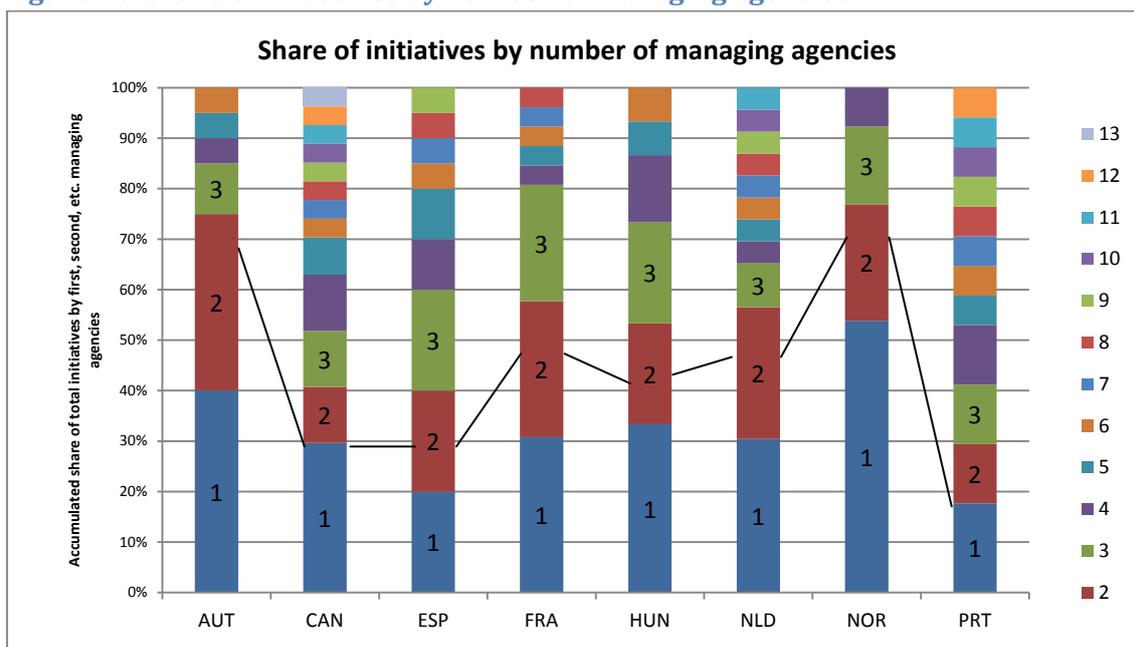
Figure 9 shows the relationship between the number of managing agencies in a country and the number of Initiatives. It appears that some underlying co-variation exists; having more initiatives means that the country also has more agencies managing them. We have no evidence on the direction of causality. The trend line indicates that some countries have fewer agencies than expected, considering the number initiatives, and some other more, for instance Portugal.

Figure 9. Number of initiatives and main of managing agencies



In Figure 10 we complement the analysis with share of the concentration of initiatives in one or two agencies. Cases of executive concentration would be Norway and Austria. In Norway for instance, one agency manages more than 50% of the initiatives, the figure is 40% in Austria, a country that has many more agencies. Cases of higher fragmentation are Portugal, the Netherlands, Spain and Canada. The Portuguese and Canadian cases are maybe the most fragmented in terms of managing institutions.

Figure 10. Share of initiatives by number of managing agencies

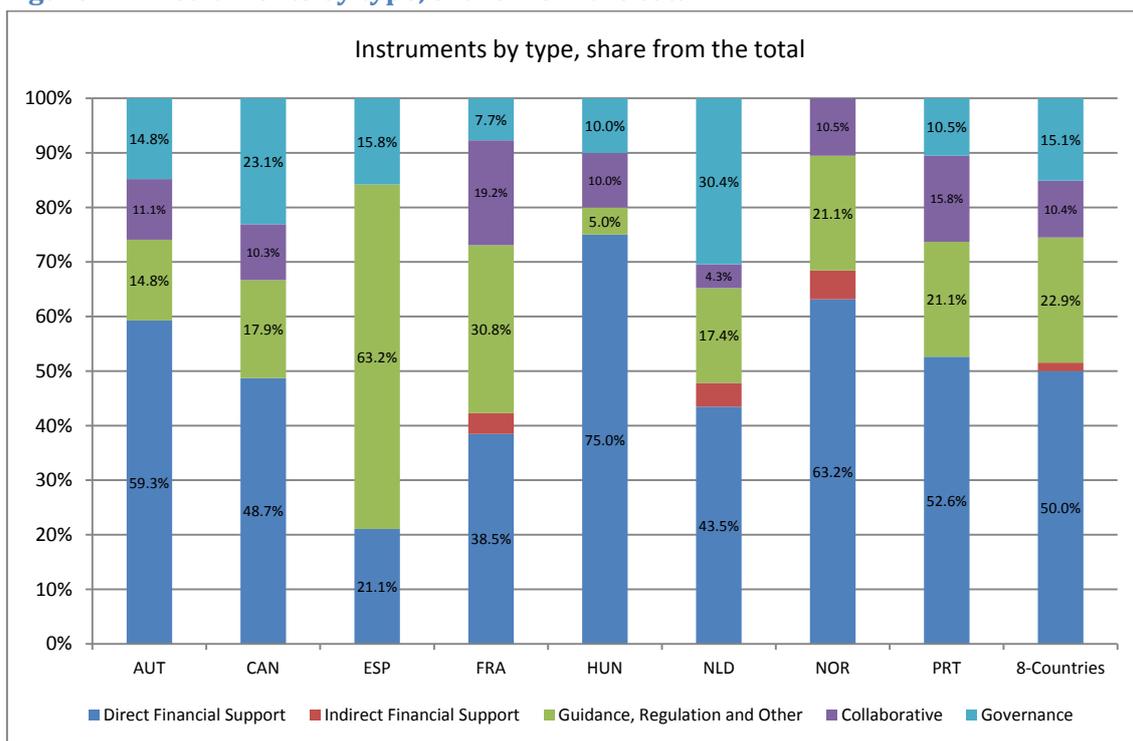


7.4. Instruments

Turning to the profile of the countries regarding the mix of policy initiatives, we have produced a data set that individualizes the different policy instruments reported in the policy initiatives. However, as we have already mentioned there is the risk that respondents from the country have identified policy initiative with instrument or, due to the filling out burden, they have not reported all the instruments included in the initiatives. The total number of instruments reported makes this plausible. A second relevant problem is the classification of the instruments included in the databases does not respond to the standard ways of addressing policy instruments in the literature, i.e. differentiating them according to the type of government resource used by government (e.g. NATO based typologies); additionally the classification used does not include instruments aimed at changing processes or “the way of doing things”, therefore the collection of the information might produce a bias towards the financial ones.

In figure 11 we can observe the relative share of the different types of initiatives in each country. We use the categorization of policy instruments (Pol.Ins) that classifies the detailed instruments of the inventory. There are 5 main types of instruments according to the OECD.

Figure 11. Instruments by type, share from the total



Direct financial support is the dominant type of initiative in the majority of the selected countries with the exception of Spain where guidance and regulatory initiatives are more prominent (63.2%). The dominance of direct financial support is particularly visible in the cases of Hungary, Norway and Austria. France has the more balanced distribution. The Netherlands, and, to a lesser extent Canada, have greater shares of governance initiatives, compared with the rest of countries.

8. Country profiles: qualitative insights from indicators and interviews

AUT-Austria

KT has been a strategic major strategic policy issue in Austria for a long time and it is considered one of the pillars of the past and current National RTI strategy and reflected in its specific goals, as well as embedded in the sub-strategies. A recent statement by the Council of Ministers highlights increasing excellence in basic research, long term planning and stability for public R&D funding.

The set of KT programmes is quite diversified and its design has traditionally followed a bottom up approach in which the needs of the different stakeholders has played a relevant role; despite the leading role of the Ministries and the thematic focus of a few initiatives, the conception of the instruments takes place at the level of the relevant Ministry but in interaction with the actors, both industry and academic side. The current KT policy mix is the result of a sequential incremental type of policy choice rather than an overall design. Looking at the instrument concentration index, there are 20 KT initiatives reported for Austria in the database (a figure in the middle of the range of 13

to 27 for the overall group of countries) but only 15% of them multi-instrument. This will place Austria in between quadrants 1 and 2 of the taxonomy with potential issues regarding policy fragmentation.

In relation to policy targeting, Austrian KT initiative mix is quite focused, with half of initiatives targeted to only one group, and its value in the targeting index is 2.8, with a strong focus on research institutions, but a low focus on firms in comparison with the rest of the selected countries, something that may be due to the identification of the target group as the recipient of the funds since in many KT cooperative instruments the beneficiary is the research group and not the firms, which does not necessarily mean that firms are not addressed. Researchers are seen as the most active group in applying to the instruments, but some instruments require that the projects are linked to a specific industrial need. Austrian KT initiatives mix is dominated by direct financial instruments (almost 60%). CDG is the programme with the longest tradition in Public-Private partnership and well considered by all partners, but COMET is also relevant. An interesting feature of the set of KT programmes in Austria is that programmes with low entry barriers are regarded as an opportunity for applicants to gain experience in S&T cooperation and motivation for the scale up of competences and further participation in more demanding programmes.

There are three main Ministries involved in the policy area of KT, and each of them has a different focus, for instance the Ministry of Digital and Economic Affairs has traditionally had a strong focus on the funding of industry-science cooperation; the design takes place at the level of the ministries and the management is done by the funding agencies. All initiatives need as an *ex ante* coordination with the Ministry of Finance. According to our executive concentration index, KT policy management is quite concentrated with a few executive agencies: 75% of initiatives are managed by the two main agencies. Additionally, a RTI Task Force has been set up in 2016 with the objective of coordinating or the RTI strategy at the administrative level. In the view of policy makers, although some overlap seems unavoidable, programmes should not be overloaded with additional targets as there is also a value in instruments being specialized. Overall, the initiative mix is potentially coherent, but with room of improvement in rationalizing initiatives increasing the number of multi-instrument ones.

CAN-Canada

KT programmes in Canada are well defined but the objectives of KT and SIR are cross sectional with other issues and KT is a side goal of other government policies. KT is part of a larger strategy. On the one hand, in 2017 the Government launched the Innovation and Skills Plan and one of its goals is promoting R&D collaboration, and this includes a target of doubling the percentage of companies engaged in collaboration with academic institutions by 2025. On the other hand, one of the objectives of the Intellectual Property Strategy is the establishment of an IP marketplace and the standardization of the way post-secondary academic institutions manage their IP. In the view of policy makers, one of the key challenges is to ease the way enterprises may

approach universities and colleges and be able to identify the intellectual property that is available in academic institutions for transfer to the private sector for commercialization. Another challenge comes from the lack of systematic data on how KT is occurring beyond IP and licensing records. Also the difficulties for SMEs to access opportunities for collaboration and negotiate with universities are seen as a challenge too; and the building of entrepreneurial capacities in academic researchers.

Canada has the highest number of KT initiatives among the selected countries (27) and a limited share of multi-instrument ones (11%) so it risks fragmentation and lack of coordination. As regards targeting, the majority of Canadian initiatives (55%) have two or three groups. The main target group of KT initiatives in Canada is the firms, addressed in more than 60% of initiatives, followed by research institutions, addressed in 45%. According to the qualitative information gathered, programmes tend to be oriented either to academic institutions (i.e. the calls of the National Research Council of Canada) or to firms (for instance the Industrial Research Assistance programme or the Strategic Innovation Fund).

Canada has a wide diversity of types of instruments. There is recognition that there are a number of different players in the KT process, and therefore the need to target the different players, and there is also the idea that the different instruments address different points in the continuum of KT and should be specific. As in other countries, direct financial instruments are predominant (47,8%) but governance ones also have a significant share of 23%. There are also a number of initiatives providing advice for both the academic and the private sector.

The Innovative Superclusters Initiative, launched in 2017, supports large-scale industry-led consortia, and is considered by policy makers as representing a novel approach, and has received a lot of attention both in Canada and internationally. The Canadian Technology Access Centres (TAC) is worth mentioning as a programme targeting the innovative capacities of SMEs through the transfer of talent, expertise and technology from technical universities and colleges. This programme has been evaluated and is considered to be a quite successful initiative; some of the features related to its effectiveness are that the projects being driven by industry challenges, the territorial distribution of the centres are across Canada and the specialization of the dominant sectors within the region, and the involvement of the college students and faculty members in the research which has improved the industry relevance of the educational offer, and the industry readiness of the graduates.

At the level of Federal Government of Canada most KT policy design takes place in the Ministry of Innovation, Science and Economic Development; most of the Federal Granting Agencies fall within that Ministry, and the Research Council is in that Ministry's portfolio too, as well as the Research and Development Agency. In the implementation side, Canada could be seen as a case of saturation, with 13 different agencies managing 27 initiatives; the first agency manages 30% and the rest is distributed among the other 12. However, the fact that several agencies fall under the

umbrella of a single Ministry that could act as a coordination mechanism. KT policy has evolved sequentially and historically, and it has been mostly responsive or reactionary to dynamics already taking place within the university sector, and more recently in the technical universities and colleges. Universities started quite early to develop their own TTOs for managing the patent portfolio imitating their US colleagues, even without a similar legal framework. The federal political structure of the country and the need for co-ordination should be taken into account since it has specific funding and funding cycle implications for project grants. Although from the perspective of policy makers there are no conflicts between the objectives of the different programmes, the Canadian KT initiative mix is likely to gain coherence with an increase in multi-instrument initiatives and a reduction of managing agencies.

ESP-Spain

While Knowledge Transfer instruments are quite specific, the overall KT strategy is not well defined within the STI policy, and, despite being included in the general innovation policy which has gained momentum in the last decade, it is not seen by the stakeholders as highly prioritized. The very concept of KT is rather diffuse. As regards the objectives of the policies, much emphasis has been historically put on intermediary organizations (University TTOs) since the early nineties, following the diagnosis that there were communication and diffusion problems between the scientific and the private sectors. However, the issue of the low private investment in R&D has concentrated most of the policy attention and many instruments have focused on promoting such investment, including the increase in the number of R&D employment in private firms and the set up of tax breaks. More recently, the issue of mobility across sectors, including the movement of public researchers to firms, has gained policy relevance, together with the proposal of increasing incentives of public sector researchers to orient their production towards the market through a change in the merit evaluation mechanisms. The challenges identified refer to the low motivation of public sector researchers to engage in KT, to improving the functioning of TTOs at universities, and to engage SMEs in KT activities.

Spain reports 20 KT initiatives and the same number of corresponding instruments; therefore all of its reported initiatives are single-instrument, which positions this case in a clear situation of policy fragmentation. Additionally, instruments are not very focused, with only 20% of them targeted to a single group, and 50% to two or three; its value in the policy targeting index is 3.1. The most prominent target group is the firms' one, addressed in 60% of the initiatives, research institutions in 40% and researchers and intermediaries addressed both in 35%. The general view of the stakeholders is that it is mainly the large firms those which benefit the most from policy initiatives and programmes aiming at collaborative research and that accreditation burden involved in qualifying for R&D tax deductions seriously harms the possibility of SMEs to benefit from them. In the general legal framework of tax R&D deductions there is not at present any premium for expenditures linked to cooperation with the public research system,

but some sector specific (pharmaceutical industry) scheme includes this kind of additional bonus.

Policy makers acknowledge that this is an area in which financial instruments are most effective; however, according to our indicators, Spain is by far the case in which guidance and regulatory instruments are more prominent (63%). The low share of direct financial instruments (21%) is striking comparatively. The economic and fiscal crisis and their effects on many areas of public policy in Spain are undoubtedly related to this finding; some important instruments involving large amounts of resources for collaborative public-private R&D and with a focused on few target groups, like the CENIT projects, were removed from the instrument mix and have not been replaced with a similar one at least in scope; the CIEN programme, much smaller as regards resources, and targeted to financing large private R&D projects through firms consortia, is worth mentioning; however, the requirement of contracting with research institutes in this programme is rather low (15% of the budget). Moreover, fiscal consolidation through increasing *ex ante* controls in the operation of public moneys is signalled as a very important obstacle in the views of the stakeholders.

KT policy design is embedded in the general planning of the Spanish Strategy of R&D&I which is the responsibility of the Ministry of Science, Universities and Innovation. KT policy implementation is more or less split between the Industrial and Technological Development agency (with a major role) and the Research Funding Agency. The perception exists that traditional “clients” of these agencies are different and that the movement of instruments or programs across agencies is very difficult. Our indicators show that as regards executive concentration, with nine different agencies managing 20 initiatives, some issues regarding lack of coordination and possible saturation are likely to emerge; the first three agencies identified in the database are allocated proportionately 60% of the initiatives (20% each) but there other six agencies also in place.

A decentralized political structure and the overlapping competences between the central and regional administration, make the picture even more complex. Overall, this is a rather problematic initiative mix in terms of coherence, it is highly fragmented in single instruments initiatives, there are several agencies managing those instruments, policy targeting has room for improvement and the predominance of regulatory measures is somehow problematic, in a policy area where financial resources are key incentives. This is a real concern since the abundance of regulatory initiatives occurs in parallel with the common perception that the general regulatory framework for R&D is ill-suited for enabling KT. The need for policy stability and predictability, together with the need to evaluate the programmes, are also prominent in the view of the stakeholders and in the discourse of policy makers.

FRA- France

The KT policy area has no clear boundaries as it is entangled with the general research and innovation policy and strategy, but the instruments are specific and well defined and there is a dedicated line in the budget. France reports one of the highest number of initiatives (26) and one of the lowest shares of multi-instrument ones (3.8%); this clearly situates the French KT initiative mix in the fragmentation case, with several single-instrument initiatives. Although the policy is defined at the national level the implementation is decentralized at the level of the research organizations and institutions, something that also contributes to the lack of definition of the policy domain. In fact, the main challenge in the view of the policy makers is to simplify the policy landscape and the articulation of the European, national and regional levels.

KT priorities in France are defined in very general terms but with a focus on increasing the knowledge produced in the public sector that can be used in private firms, and to increase the number of high tech companies in the economy. The policy targeting index is 2.9 with most initiatives (53%) targeted to 2 or 3 groups. The focus of initiatives is rather distributed across target groups, with firms addressed in almost half of the initiatives and researchers also as a prominent group (targeted in more than 45% of the initiatives) in comparison with other selected countries; conversely, the focus of French KT initiatives on research institutions is lower in comparative terms. While, as in other countries, the larger companies have always pressured and advocated for keeping the R&D tax deduction schemes, it is more difficult to identify a common voice or view among the public sector institutions partly due to the fact there is a wide diversity of them in France. From the policy side the balance is slowly changing from a traditional techno push approach to a more market pull one.

French KT initiatives are diverse in terms of types of instruments without a dominant particular type of instrument; although the share of financial instruments is the largest (38.5%) it is followed closely by regulatory ones (30,8%) with a special recent emphasis in facilitating the mobility of public sector researchers to the private sector and the creation of their own companies. R&D tax deductions are highlighted in the policy discourse and they have a premium for expenditures related to cooperation with public research organisations. In the last ten years, within the framework of the “Investment for the Future” programme, the government has set up two important initiatives: the SATTs, that are transfer acceleration companies created since 2011 to co-ordinate the TTOs of universities /PRIs within their regions, with the main mission of managing the IP entrusted to them by their members, universities and PRO; and the Institutes for technological research (IRTs), which are thematic organisations that develop road maps on specific subjects and support public-private cooperation in those specific fields.

The current mix of KT initiatives and instruments has evolved sequentially and incrementally; policy makers acknowledge that there has been a degree of policy layering especially due to the fact that some research organizations have been very

active in the field of KT for a long time, have developed their own structures that run in parallel with others at different institutional levels. There has been a lot of change in the last two decades but not always in a systematic way; initiatives and instruments have been developed over the years sometimes with competing objectives, and one of the current policy objectives is to streamline and simplify them for the researchers and also to simplify the landscape for private companies willing to work with public sector researchers but are unclear on how the mechanisms. From the perspective of governance and public finances, the need to avoid duplications or contradictions is also seen as important. According to the qualitative information gathered, the main shift in STI policy came with the set up in 2010 of the “Investment for the future” Programme, not only because of the significant resources associated to it, but also because it entailed a change in the way of doing things, with more budget allocated to initiatives instrumented through competitive calls and concentrating funding in areas and places that could make a difference. The Programme is evaluated every 4 years.

In France, KT policy design is shared between three main bodies, the Ministry of HE, Research and Innovation, the Ministry of Economy and Finance, and the General Secretariat for Investment, dependent on the Prime Minister and in charge of supervising the “Investment for the Future” Programme and working with the two ministries to design the general KT strategy. In relation to executive concentration, our data shows that 80% of the initiatives are managed by 3 agencies, so that each of them manages around ten initiatives, but there is also a myriad of other agencies at the regional and local level in charge of just one instrument. This is in line with the French policy view that an effective policy mix has to be efficient at the local level and tailored to the needs of all the actors at that level; the idea is that some instruments may work in a context or sector and not in others. However, according to our indicators, the current French KT initiative mix is likely to reveal some problems of coherence, due to instrument and institutional fragmentation and some risk of executive saturation at the national level.

HUN- Hungary

The National Research, development and Innovation Office (NRDIO) has been the main department in charge of all the policy and instruments (including planning and evaluation) until the recent political change on June 2018. KT is a well defined issue in the general STI policy. There are 3 pillars and one pillar is the KT that will also be very important in the new strategy under preparation. During the process in which the different KT instruments were developed there was also a learning process, with incremental changes in the design. European recommendations are important especially in the sense of showing directions

The main challenge of KT instruments is that the research system in Hungary has a dual nature. The research institutes are focused in basic research, sometimes they have shorter projects with companies but it is not the norm, and on the other side there are the companies, focusing on the market oriented research and have different motivations

than the universities to cooperate. One of the main financial instruments, the Higher Education and Industry Cooperation Centres, tries to overcome some of the administrative obstacles at the institutional level. It is a financial instrument, universities have to make consortia for three to five years projects, and cooperation with one or more company has to be in place before the project. They involve quite large grants in financial terms (10 million).

According to our indicators Hungarian KT initiatives are dominated by direct financial instruments (3 out of 4). The main type of KT instruments in Hungary are financial and include: funding for collaborative research, general research tax deduction, start ups and spin offs, innovation vouchers and TTOs at universities, but they don't have performance funding or researchers' mobility schemes. Policy makers realize that the success of financial instruments needs other developments that are more complex to develop. Financial instruments are easier to implement and are related to the role EU Funds play. Looking at the instrument concentration index, The KT initiative mix in Hungary seems quite integrated and rationalized, with a limited number of initiatives (15), a third of which are multi-instrument.

The KT policy has been traditionally designed and implemented in the National research, development and innovation office, so there was a high degree of executive concentration in design. The approach to instrument choice and planning has been incremental and sequential and has built on previous experiences and already existing administrative and policy capacity. The big universities and large companies are the focus of the Higher Education and Industry Cooperation Centres; the big universities were active in the preparatory phases of the policy.

The target groups vary according to the instrument but instruments mostly address universities, research institutes and companies, rather than individual researchers. The actors who are more active in applying to the instruments also vary with the specific programme. Our data show that Hungarian initiatives are not very focused; the country reports a considerable share of initiatives targeted to 4 groups and more, and its value in the targeting index is rather high (3.9), with a strong focus on firms and research institutions (both addressed in around 70% of the initiatives) and researchers (above the share of initiatives than in the rest of the selected countries), but as revealed in the interview, they are not the main target group of any instrument.

As regards institutional coordination among agencies involved in the implementation of the instruments, there has been quite a lot of concentration; there are some smaller instruments managed by other agencies, but there is only one other important apart from the office, the Ministry for the national economy, responsible for the structural funds. There are not R&D institutions at the regional level. However, our executive concentration indicator shows that KT policy management is more or less distributed across agencies, with a third of initiatives managed by an agency but another third managed by four different agencies, which may lead to issues of fragmentation.

Interviewed policy makers think that there have been possible interactions between the instruments directed to start-ups and spin-offs and also with the innovation vouchers. On the downside, there may be some negative interaction between the regulations affecting the administrative capacity and flexibility of universities, as well as intellectual property rights or some issues related to open access and reluctance of firms. The long term time frame of financial instruments is seen as an important feature of its effectiveness, because it makes the cooperation sustainable. The new instrument on cooperative centres funds consortia from 3 to 5 years.

Overall, the KT initiative mix is potentially coherent, but with ample room of improvement in policy targeting and some room for executive concentration, since there seems to be different agencies managing a limited number of initiatives given the size of the country. The recent creation of the Ministry of Innovation and Technology could affect executive concentration. Hungary is an interesting case in the sense that main KT initiatives are instrumented through the funding of centres.

NLD- The Netherlands²

In general, STI policy in the Netherlands is better understood in the context of the so-called “Top sectors approach” introduced in 2011 and the latest in a long line of policy initiatives aimed at research co-ordination through public private partnerships (PPPs). One of the key objectives of the top sector approach is to leverage business sector R&D, and a greater collaboration between universities, PRI and industry, and to increase the responsiveness of public research agendas to the needs of industry. The Dutch KT policy illustrates the dynamic nature of the policy over time moving from the predominant view in the 1990s that policy should be generic leaving it to industry to decide in which areas to invest to a more thematically-oriented approach from the 2000s onwards. Looking at the instrument concentration index, the KT initiative mix in the Netherlands seems very fragmented, with only one of its 23 initiatives counted as multi-instrument. Initiatives are not very focused either, with a value of the policy targeting index of 4.0; only 25% of the initiatives addressing only one group and almost 50% targeting four groups or more. Firms and research institutions are addressed in the majority of the initiatives.

If we look at type of initiatives, the KT mix in the Netherlands is the most diversified in comparison with the rest of selected countries, with an important share of governance measures (30.4% of all initiatives, and the largest proportion in comparison with other countries). Within financial instruments, tax deductions are also important. It is relevant to note that, according to the 2014 OECD Innovation review, The Netherlands (and also Canada and France) places more emphasis on tax incentives than on direct funding instruments than most OECD countries. Interestingly, Dutch R&D tax incentives are more generous to SMEs than to larger firms.

² We made the contacts with Dutch policy makers but no interview could be arranged eventually (see Annex 3).

In the Netherlands, there has been a growing separation between making and executing policy (OECD review: 179). The main actors in the design of STI policies are the Ministry of Economic Affairs and the Ministry of Education, Culture and Sciences. The main actors in managing and implementing policies are the Research Funding Agency (NOW) and the Technology Foundation. According to our indicators, in the specific domain of KT there is a considerable degree of executive fragmentation with 11 different agencies managing the instruments; although the first two agencies manage more almost 55% of them, there are 9 more agencies in place. Overall, to move towards coherence, the initiative mix should be rationalized, increasing the number of multi-instrument initiatives and concentrating its management in a smaller number of agencies. At present, a considerable amount of agenda setting research system co-ordination takes place in the context of the top sectors too; although this approach relies on the co-ordination of the different communities, it largely leaves out the research and technology areas outside it.

The Dutch tradition of consensus-oriented policy making has advantages but it also means that it can be difficult and can take long to decide on necessary changes. The Netherlands also have a tradition of STI policy evaluation, especially at the instrument level; this is indeed a positive feature, however, the OECD review of Innovation warned already in 2014 that frequent instrument level evaluations and a responsive government may have contributed to some instability which is also a necessary feature for the long term effectiveness of KT policy.

NOR-Norway

KT has been more salient in the R&D Norwegian policy agenda since the beginning of the 2000s, where there was a shift in innovation policy. Big KT instruments were put in place in the mid 2000s and increasing KT has been both a primary objective and a side goal of more general policies. Although it has been a 15 years period with a lot of activity, KT as a policy area is not very well defined in relation to the boundaries with related issues and division of labour between ministries. Very often, KT policies are entangled in the objectives of other policies.

The institute sector is serving most of KT needs of the system but increasing the participation of the institute sector and overcoming the systemic division across higher education institutions and the institute sector remain as important challenges. KT instruments have tried to increase the incentives for these two types of institutions to complement each other but they are actually competing rather than collaborating, and this is changing the traditional division of labour between the two actors. Collaboration between ministries is a challenge as well (Ministry of Education and Ministry of Trade and Industry). Incremental innovation is happening in the private sector but not very well connected with science. There has been a shift from KT as commercialization to a greater emphasis on collaboration.

The most important types of instruments that have been introduced are financial (FORNY Programme) (something that our indicators also show), including tax deductions with the aim to increase R&D in industry. However, introducing incentives to researchers' mobility or incentives to collaborate in the big research grants that go to the institutes is something that has not prioritized yet; there have been cases of anticipated unintended consequences of instruments: for instance, rewards to the universities for contract research were introduced in the context of the performance based funding, but policy makers realized that this could interfere with the traditional division of labour with the research institutes.

Overall, KT instruments have been thought of in a sequential, incremental way, rather than as part of an overall strategy, and the traditional instruments and the corresponding administrative capacities have been influential. Over time, there have been new elements added to the policy mix but not radical change. One thing that has been a concern is that sector neutral instruments tend to support business as usual. Among the innovative instruments, the excellence schemes are worth mentioning.

As regards the executive management of the KT instruments, Norway is a clear case of simplified concentration of the initiatives in a single or few agencies (something also confirmed by the data), with a dominant role of the Research Council of Norway, which is in charge of both the design and the implementation of the policy, and Innovation Norway that administrates programmes which support the early phases of commercialization; taken together, these two agencies manage almost 80% of the KT initiatives. In fact, the main advocacy actor of KT policy in Norway has been the Council itself rather than the stakeholders or the targeted groups. The Council has been active in screening and imitating best practices in other countries and incorporating them to the policy mix. Both agencies have been active in proposing the introduction of new instruments.

The KT instrument mix in Norway is quite diverse but not very diverse, with a preference for financial instruments (which are more dominant than regulation) and with a main orientation to research institutions and firms, and less to individual researchers, but there are exceptions, like the mobility programmes, or the initiative to incentivize PhD education while the candidate is employed in a company or a public organization. According to our instrument concentration index, the Norwegian knowledge transfer initiatives' mix is quite rationalized with a few but important initiatives, most of them multi-instrument.

The public sector actors have been the more active in participating (applying) to the instruments, especially the health sector. Research institutes are also very active but that seeking for collaboration is part of their nature. Relative participation has to be analyzed in relation to who is addressed; most instruments are targeted to firms because there is a recognition that their participation should increase, whereas the participation of the institute sector is more or less taken for granted.

Regarding the experts' appraisal of the relative effectiveness of the KT instruments, not many evaluations have been conducted; the Clusters Program has been mentioned as noteworthy due to its long term horizon (8 years) which is valued as a feature for effectiveness because it enables a different dynamic, making the consolidation of the collaboration possible. Also, the tax deduction scheme has been growing and successful in terms of mobilizing R&D efforts in SMEs, that could get an additional deduction if the R&D expenses related with R&D cooperation, complemented with direct collaborative grants; in that sense, both instruments have complemented each other; the tax deduction scheme has been a point of entry for firms to realize that if they collaborate there can be gains. In the downside part, the expectations of the regulations on the commercialization of research in the higher education institutions have not been realized. There seems to be an underlying conflict between the incentives that researchers at universities face in the context of the performance based funding of higher education institutions, and the research outputs that are valued on the one hand, and the goals of the initiatives trying to foster commercialization of research and other forms of KT, on the other hand.

In relation to the policy targeting index, Norway has a fairly good figure (2.5), with roughly a third of initiatives targeted to one group and the rest to 2 or more, but the success rate in the FORNY programme is very low, around 10%, although this varies a lot across programme. In this regard, it is worth noting that from 2019 the Research Council will have the capacity to shuffle around applications between programmes to improve matching of applicants and instruments. This is likely to fine tune the targeting of instruments towards the proper groups. This could increase the steering capacity of the Council but administrative and peer review capacities will also have to be strengthened to cope with this innovation.

PRT -Portugal

The KT policy area in Portugal is intertwined in other parts of the STI policy. KT is a dimension in other programmes which main target may be different, such the funding of R&D Units. The main challenge is related to increasing the research activities in private firms. Policy design has been incremental and sequential and built on previous initiatives, more simple, such as the funding of collaborative projects or the exchange of staff.

Portugal reports 17 KT initiatives, of which only one is multi-instrument, placing the case in a fragmented situation regarding instrument concentration. According to the policy targeting index, Portuguese initiatives show the highest value of dispersion (6.3) or in other terms, lack of precise focus. Accordingly, 65% of its initiatives are targeted simultaneously to four groups or more. Policy makers see two different possible explanations for this; the first is related to the Portuguese institutional ecosystem and the reality that research is not only performed at universities, there are many research performing actors in the public sector and the private sector is also characterized by diversity in terms of size; the second has to do with the political governmental discourse

oriented to promoting research having impact in very diverse fields, including social innovation, participation etc. In general, in the view of some policy makers, KT programmes are not very competitive in terms of success rates; instruments are quite coordinated with the stakeholders and for instance in the case of the CoLabs and Interface Centers, funding tends to keep the support of already existing ones, trying to send a message of stability of support to the actors.

With the usual predominance of the direct financial instruments (52.6%) the Portuguese KT policy mix show some but not much diversity. The predominance of the financial instruments is seen by policy makers as related to the influence of structural funds in the Portuguese STI policy, and also to the fact that financial instruments are seen as a more direct incentive for firms; for instance, the innovation voucher initiative supports the acquisition by firms of specialized services from universities and PRIs. The main programme, INTERFACE, coordinated by the Ministry of Economy has four different main initiatives (CoLabs, the interface centers including the technology centers, the Clusters, and the Suppliers club).

The design of KT policy is distributed between the Ministry of Economy and the Ministry of Science and HE and three main agencies, as well as several other less important ones. Regarding the managing agencies, Portugal is a clear case of low executive concentration, with several agencies (12) managing a not very large number initiative portfolio; this implies a risk of lack of co-ordination among agencies and therefore a deficit of coherence. It seems clear that a combination of instrument and institutional fragmentation, with low policy targeting is likely to lead to an initiative mix lacking coherence. Although some policy makers see a value in the specialization of agencies in a few programmes, they also acknowledge the problems of excessive complexity, for instance regarding the governance of European funds.

There is not a tradition of evaluation of the effectiveness or impact of KT &SIR initiatives or other types of policy instruments at this level, but there are more general reviews of political and systemic approaches, like the OECD ones.

9. Some provisional conclusions

The countries we have analysed in this paper report quite a lot of policy action in the area of KT. The initiatives are quite specific, however, whether or not they have a clear and consistent KT&SIR strategy is a different issue. In countries that do have such a declared strategy, the boundaries with other policy domains are more defined; in the rest of the countries the boundaries are rather wide, the KT policy is embedded in broader domains, and KT is a side goal of other policies; this inclusion partly contributes to the complexity of the policy mix. In general and for most of the selected countries it has been difficult to identify clear policy objectives or targets beyond the general increase of KT. Policy discourses commonly assimilates strategy with initiatives but without a

clear link of objectives to plans. This is generally the case regardless the number of initiatives. In comparison with objectives, policy makers identify the challenges in the area of KT&SIR more easily, but this identification is often shaped by the perception of the practices of other countries and international recommendations (sometimes without a clear evidence based analysis).

According to the NATO typology on instruments based on Hood (1986) and Howlett (2000) the principal governing resource in the majority of the countries analysed is “Treasure”, given the predominance of the financial instruments. There are some cases in which “Organisation” is also prominent, especially those countries which make ample use of PPPs in the design of the policies instrumented through the funding of cooperative research centres and consortia. According to our data, this is clearly an area governed by the use of incentives more than directives; this does not imply that regulations are not important, but they are so in the sense that legal frameworks sometimes operate as a constraint or disincentives for researchers and firms to engage in KT (i.e. the regulation of IPR). The removal of those barriers appears as an increasingly acknowledged policy objective. Finally, resources linked to Nodality have not come up as very prominent in the indicators, but this is partly due to the way data has been collected. However, Nodality does not come up as very salient in the interviews either, with the exception of one or two countries in which technology transfer offices have been an important policy instrument.

As regards the distinction between generic and specific instruments, although the majority of instruments in the KT domain in the countries analysed are specific, the most important ones, grants and taxes, are generic; nevertheless, some countries have introduced a “co-operation premium” in the tax breaks making the instrument more specific. Tentatively, we can say that the predominant type of KT instruments across countries are characterized by a low level of intervention, a low degree of universality, a high degree of competitiveness (also there are cases of coordinated instruments too) and a low level of political risk; KT instruments are mainly state-led, but increasingly involve market elements with the requirement for consortia or PPPs. More and more, KT instruments are characterized by making a normative appeal to the values of the target groups, namely public research organizations and private firms, in terms of accountability of public resources and social impact and responsibility of both public and private institutions.

Turning to the processes, we cannot say that in any of the countries analysed the origin of the KT policy initiatives respond to an intentional master plan design, but they are rather a sequence of responses to a perceived problem, generally related to the need to improve innovation performance, or to raise low levels of firms R&D investment. All policy mixes have evolved sequentially, and the choice of instruments have taken place in an incremental path dependent way. We have not found in the interviews insights supporting the existence of a rational model of optimal adjustment between means and goals in the context of a purely instrumental approach. On the contrary, coordination among actors and of policy makers with stakeholders appears centrally in the policy

discourse and in some of the instrumentation of the policies, a fact that highlights the greater importance of legitimacy over instrumentality in policy choice in this area. The drawback of this predominant incremental policy process is that we have found at least as many cases of policy layering, some cases of policy replacement, and very few cases of innovation.

Using Bressers and O'Toole (2005) terminology, we could say that the most common dynamic of instrument implementation across countries has been "increased intensity" of policy implementation, in the sense that it is very common that more than one instrument is targeted to the same group, usually firms; the integration of multiple instruments into one interactive process between government and different target groups is less common, but the "Top Sectors Approach" in the Netherlands would be an illustrative case of such dynamic. More generally, this dynamic is relevant in cases where PPPs are a policy pillar of the policy mix.

We have approached the analysis of coherence through a pilot methodology for the building of three different indicators: instrument concentration, policy targeting and institutional fragmentation. Even acknowledging the potential limitations of the quantitative analysis, our indicators' analysis has shown that in purely quantitative terms, the countries report a significant number of KT initiatives; this, however, is related to the size of the system or other structural variables; multi-instrument initiatives also tend to increase with the size of the system measured by R&D employment. Nevertheless, there is some variation in the degree of instrument concentration that is not explained by such relationship. Of the eight countries analysed the majority of them show rather fragmented initiatives; in some cases, this is related to a diverse and fragmented institutional R&D ecosystem. With the exception of Norway and Hungary, we have observed high degrees of institutional fragmentation in the area of KT policy. We have not gone into the analysis of the centralized versus decentralized structure of governments and this is indeed an important factor, but there are in general too many agencies involved in the management of KT initiatives, a reality that is not explained by the size of the system.

In principle, KT policy has quite clear target groups: research institutions, firms, researchers, and intermediaries. We have approached the issue of policy targeting by analysing how much focused initiatives are, by looking that the number of groups simultaneously addressed with the hypothesis that the fewer the groups the more the focus. One could argue that in a policy domain that is about connections, the optimal number of target groups would be two instead of one, and this might be the reason why initiatives targeted to only one group are a minority across countries (with the exception of Austria.) However, we have identified some confusion between target group and recipient group (of the grant, the subsidy, the tax break, etc). In principle, the number of target groups is likely to be greater than the number of recipients although this might not be the case for some instruments. Whatever the case, we have also found some variation in the policy targeting across countries. All selected countries address private firms in their KT initiatives, but a key difference relates to whether they have specific

instruments targeted to SMEs. In the absence of such specific instruments, the risk exists that traditional generic instruments like tax deductions are likely to be used mainly by large companies.

A rather common example of conflict between instruments relates to the contradiction between the objective of increasing knowledge transfer from the academic to the firms sector, and the incentives involved in general merit assessment that scientists face. A shared view from the perspective of policy makers and stakeholders is that the effectiveness of KT&SIR instruments is strongly related to their stability and the degree to which they allow for long term funding expectations from the actors involved.

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References

- Acosta Ballesteros, J., Modrego-Rico, A., 2001. Public financing of cooperative R&D projects in Spain: the Concerted Projects under the National R&D Plan. *Res. Policy* 30, 625–641. [https://doi.org/10.1016/S0048-7333\(00\)00096-2](https://doi.org/10.1016/S0048-7333(00)00096-2)
- Borrás, S., Edquist, C., 2013. The choice of innovation policy instruments. *Technol. Forecast. Soc. Change* 80, 1513–1522. <https://doi.org/10.1016/j.techfore.2013.03.002>
- Bozeman, B., 2000. Technology transfer and public policy: a review of research and theory. *Res. Policy* 29, 627–655. [https://doi.org/10.1016/S0048-7333\(99\)00093-1](https://doi.org/10.1016/S0048-7333(99)00093-1)
- Bozeman, B., Rimes, H., Youtie, J., 2015. The evolving state-of-the-art in technology transfer research: Revisiting the contingent effectiveness model. *Res. Policy* 44, 34–49. <https://doi.org/10.1016/j.respol.2014.06.008>
- Breschi, S., Lissoni, F., 2001. Knowledge Spillovers and Local Innovation Systems: A Critical Survey. *Ind. Corp. Change* 10, 975–1005. <https://doi.org/10.1093/icc/10.4.975>
- Bressers, H.T.A., O'Toole, L.J., 2005. Instrument selection and implementation in a networked context, in: Howlett, M.P., Hill, M.M., Eliadis, P. (Eds.), *Designing Government: From Instruments to Governance*. McGill-Queen's University Press, Montreal, QC; London, pp. 132–153.
- Burstein, P., 1991. Policy Domains: Organization, Culture, and Policy Outcomes. *Annu. Rev. Sociol.* 17, 327–350. <https://doi.org/10.1146/annurev.so.17.080191.001551>
- Capano, G., Lippi, A., 2017. How policy instruments are chosen: patterns of decision makers' choices. *Policy Sci.* 50, 269–293. <https://doi.org/10.1007/s11077-016-9267-8>
- Flanagan, K., Uyarra, E., 2016. Four dangers in innovation policy studies – and how to avoid them. *Ind. Innov.* 23, 177–188. <https://doi.org/10.1080/13662716.2016.1146126>
- Flanagan, K., Uyarra, E., Laranja, M., 2011. Reconceptualising the 'policy mix' for innovation. *Res. Policy* 40, 702–713. <https://doi.org/10.1016/j.respol.2011.02.005>
- Geuna, A., Muscio, A., 2009. The Governance of University Knowledge Transfer: A Critical Review of the Literature. *Minerva* 47, 93–114. <https://doi.org/10.1007/s11024-009-9118-2>
- Hood, C., 1986. *Tools of Government: Christopher Hood*. 9780934540520: Amazon.com: Books.
- Hood, C., Margetts, H.Z., 2007. *The Tools of Government in the Digital Age: Second Edition (Public Policy and Politics)*: Christopher C. Hood, Helen Z. Margetts: 9780230001442: Amazon.com: Books.
- Howlett, M., 2000. Managing the “hollow state”: procedural policy instruments and modern governance. *Can. Public Adm.* 43, 412–431. <https://doi.org/10.1111/j.1754-7121.2000.tb01152.x>
- Howlett, M., How, Y.P., del Rio, P., 2015. The parameters of policy portfolios: verticality and horizontality in design spaces and their consequences for policy mix formulation. *Environ. Plan. C Gov. Policy* 33, 1233–1245. <https://doi.org/10.1177/0263774X15610059>
- Howlett, M., Kim, J., Weaver, P., 2006. Assessing Instrument Mixes through Program- and Agency-Level Data: Methodological Issues in Contemporary Implementation Research. *Rev. Policy Res.* 23, 129–151. <https://doi.org/10.1111/j.1541-1338.2006.00189.x>
- Howlett, M., Rayner, J., 2007. Design Principles for Policy Mixes: Cohesion and Coherence in 'New Governance Arrangements.' *Policy Soc.* 26, 1–18. [https://doi.org/10.1016/S1449-4035\(07\)70118-2](https://doi.org/10.1016/S1449-4035(07)70118-2)
- Kergroach, S., 2018. National innovation policies for technology upgrading through GVCs: A cross-country comparison. *Technol. Forecast. Soc. Change.* <https://doi.org/10.1016/j.techfore.2018.04.033>
- Kergroach, S., Meissner, D., Vonortas, N.S., 2017. Technology transfer and commercialisation by universities and PRIs: benchmarking OECD country policy approaches. *Econ. Innov. New Technol.* 0, 1–21. <https://doi.org/10.1080/10438599.2017.1376167>
- Kochenkova, A., Grimaldi, R., Munari, F., 2016. Public policy measures in support of knowledge transfer activities: a review of academic literature. *J. Technol. Transf.* 41, 407–429. <https://doi.org/10.1007/s10961-015-9416-9>
- Mavrot, C., Hadorn, S., Sager, F., 2018. Mapping the mix: Linking instruments, settings and target groups in the study of policy mixes. *Res. Policy.* <https://doi.org/10.1016/j.respol.2018.06.012>
- May, P.J., Sapotichne, J., Workman, S., 2006. Policy Coherence and Policy Domains. *Policy Stud. J.* 34, 381–403. <https://doi.org/10.1111/j.1541-0072.2006.00178.x>
- Perkmann, M., Tartari, V., McKelvey, M., Autio, E., Broström, A., D'Este, P., Fini, R., Geuna, A., Grimaldi, R., Hughes, A., Krabel, S., Kitson, M., Llerena, P., Lissoni, F., Salter, A., Sobrero, M., 2013. Academic engagement and commercialisation: A review of the literature on university–industry relations. *Res. Policy* 42, 423–442. <https://doi.org/10.1016/j.respol.2012.09.007>

- Perkmann Markus, Walsh Kathryn, 2007. University–industry relationships and open innovation: Towards a research agenda. *Int. J. Manag. Rev.* 9, 259–280. <https://doi.org/10.1111/j.1468-2370.2007.00225.x>
- Peters, B.G., 2006. Concepts and theories of horizontal policy management, in: *Handbook of Public Policy*. pp. 115–138. <https://doi.org/10.4135/9781848608054.n7>
- Rogge, K.S., Reichardt, K., 2016. Policy mixes for sustainability transitions: An extended concept and framework for analysis. *Res. Policy* 45, 1620–1635. <https://doi.org/10.1016/j.respol.2016.04.004>
- Santamaría, L., Barge-Gil, A., Modrego, A., 2010. Public selection and financing of R&D cooperative projects: Credit versus subsidy funding. *Res. Policy, Special Section on Innovation and Sustainability Transitions* 39, 549–563. <https://doi.org/10.1016/j.respol.2010.01.011>
- Siegel, D.S., Waldman, D., Link, A., 2003. Assessing the impact of organizational practices on the relative productivity of university technology transfer offices: an exploratory study. *Res. Policy* 32, 27–48. [https://doi.org/10.1016/S0048-7333\(01\)00196-2](https://doi.org/10.1016/S0048-7333(01)00196-2)
- Vedung, E., 1998. Policy instruments: Typologies and Theories, in: Bemelmans-Videc, M.-L., Rist, R.C., Vedung, E. (Eds.), *Carrots, Sticks & Sermons: Policy Instruments and Their Evaluation, Comparative Policy Analysis Series*. Transaction Publishers, New Brunswick, NJ, U.S.A, pp. 21–58.

Additionally for country analysis other OECD and EC sources has been used, such us:

OECD/EC *STIP Compass. International Database on STI Policies* <https://stip.oecd.org/stip.html>

OECD *Reviews on Innovation Policy*, France, Hungary, The Netherlands, Norway, etc. and the information collected at the *Innovation Policy Platform (IPP)*. <https://www.innovationpolicyplatform.org/>

European Commission. *Research and Innovation Observatory – Horizon 2020 Policy Support Facility*. <https://rio.jrc.ec.europa.eu/>

Annex 1: Questionnaire of STIP Compass information of KT&SIR”

For the purpose of this paper, we have selected mainly the information collected at the STIP in the dedicated section to “public-private knowledge transfer and linkages” (section D on the 2016 questionnaire), because this section is quite structured and focused. Therefore we have limited the scope of the analysis to the policy initiatives that are the most closely related to the topic, as reflected in the respondents' input.

In what follows, we briefly explain the structure of the data collection in the questionnaire.

As an introduction, the section has two general questions on policy debates and strategies or plans to address the “policy issue” (PPKT&L)

4.1. Briefly, what are the main policy debates around knowledge transfer and linkages?

Your answer should provide a synthetic open text of 2 to 3 paragraphs describing the current main debates around the knowledge transfer system and relevant policy that took place during the two last years. A policy debate may include various positions or options regarding knowledge transfer and linkages in different national settings such as Parliament, government bodies and events, in the press, among scientific actors, etc. They may or may not have been followed up by concrete actions.

Of particular interest are the different positions of the various stakeholders and the different options considered during the debates. Initiatives resulting from these debates should be reported in the different questions on policy initiatives, as relevant.

4.2. What strategies or plans exist, if any, to **strategically direct national policy on knowledge transfer and linkages?**

Dedicated national plan or strategy for knowledge transfer and co-production between different actors of the research and innovation system (science-industry, business-to-business, intermediary organisations, etc.).

Additionally, the section has five more specific “questions” about more specific types of “policy initiatives”, that appear relevant for the analysis for KT&SIR. Those refer to “collaboration”, “geographical clusters” and “thematic clusters”, “commercialization”, “mobility”, and “IPRs”. These 5 classes of instruments, according their “main goal” is the information that we have mainly used.

4.3. What are the main policy initiatives for **promoting research collaboration between the public and private sectors?**

Dedicated (or significant part of) scheme, programme, incentive or instrument to support collaborative research between the public and private sectors (e.g. dedicated research programme for supporting collaborative projects; PPPs or regulation promoting PPPs; joint labs and other research-industry research organisations); Mixed public private governance in research programmes and bodies; open innovation schemes.

4.4. What policy initiatives exist to promote **geographical and/or thematic innovative clusters?**

All initiatives to support thematic and/or place-based clusters: Provision and implementation of networking infrastructures (e.g. new research centres, demonstrators, science parks, technology incubators, "innovation" hubs, technology platforms, etc.); Financial support to clusters activities, projects and cluster organisations; Incentives to strengthen liaisons between national and/or international clusters; Regional policies to strengthen STI actors' capacities and clustering; Incentives or support to networking activities between national clusters.

4.5. What policy initiatives exist to encourage **commercialisation of public research results?**

Dedicated (or significant part of) scheme, programme, incentive or instrument to support transfer of academic inventions via the sale, transfer or licensing of intellectual property, often on an exclusive basis, to existing firms or new ventures (e.g. academic spin-offs). Major policy initiatives may include a reform of universities and IPRs for publicly funded

research results, the establishment or consolidation of technology transfer offices and licensing offices at universities and PRIs, a revision of performance criteria of institutions and R&D personnel, training and mentoring for academic staff, creation of spin offs, incubators and accelerators, the provision of new demonstrator or proof-of-concept funding, etc.

4.6. What policy initiatives exist to encourage **mobility of human resources** between the public and private sectors?

Policy initiatives to foster industry-science mobility of academics and researchers (reform of the rules governing public sector employment, the implementation of secondment schemes, policy initiatives to improve pension portability, various incentives for researchers and/or companies, subsidised 'internship', etc.).

4.7. What policy initiatives exist to ensure **intellectual property rights** in public research are conducive to promoting innovation?

Reform of IPRs legislation, and/or revision or strengthening of IPRs enforcement practices in public research (Bayh-Dole act type of reform, professor privilege, etc.); Dedicated financial and non-financial scheme, programme, incentive or instrument to support IPR in public research (subsidies, training, information campaign, etc.); Dedicated body to support IPR in public research.

Finally, in section D there is space to provide additional relevant information on policy initiatives in PPKT&L, posed in the following way:

4.8. What other developments and initiatives not already covered in previous questions have had an influence on or have been put in place in relation to knowledge transfers and linkages?

All other initiatives not yet reported in previous questions or developments having led to relevant initiatives. This can include for instance other institutional changes (including informal institutional changes) or changes in framework conditions shaping national STI policy in the area of knowledge transfers and linkages.

In other sections of the questionnaire, for example section F (responsible innovation) there is one question in which explanation includes some significant instruments (not mentioned in section D) that appear to be relevant for KT&SIR, as presented here.

6.4. What policy initiatives exist, if any, to specifically **address sustainable development challenges** through research and innovation?

Dedicated research and innovation policy initiatives to address sustainable development challenges in the area of climate change, environment, water, energy, transport, circular economy, smart cities, migration, etc. Institutional/operational level changes and structures (e.g. Clean Energy Agreement, Green Growth Committee, Energy Research Centre, regulatory changes, IP fast track system, Sustainable Transport Strategy, Water Research Council etc.); **Programme/initiative level support (e.g. Green Public Procurement, Basic and Applied Science Funds, "Green" R&D schemes, Technology Vouchers, Government grants to fund a network or consortia, special loans, tax reliefs for innovators, performance targets, awareness raising and training, standards etc.).** Joint research programming initiatives addressing sustainable development challenges between OECD Member Countries and/or with third countries.

Despite the fact that the previous questionnaire the formulation was slightly different, Kergroach adopted a “broadly defined policy mix for TT and commercialisation including both ‘dedicated’ and ‘related’ policy initiatives (groups 1 + 2).

We have only used the “policy initiatives and instruments that the countries have included among the ones identified in the specific questions. The other 3 questions in section D have been used to “contextualize” the instruments mixes in the countries.

Annex 2: Interview outline

Block 1 Background of the interview. General KT policy and strategy

- How and for how long have you been involved in the policy issue of knowledge transfer?
- Is Knowledge transfer a well-defined issue and with clear boundaries in the STI policy domain?
- Please define in your own words the main challenge/s associated to KT in your country.
- Please, define in your own words what are the priority goals of your Government in this area. Is it part of a larger strategy?

Block 2 Policy process and instrument choice

- KT instruments are traditionally classified into regulations, financial, communication and direct provision types. What are the main KT policy instruments used by your government? Is there any in particular that is more prominent
- Where in government is the KT policy designed?
- In your opinion, would you say that the current mix of KT instruments were thought of together (in an overall design) or sequentially at different points in time?
- Have the administrative capacities already in place/or the traditional instruments in the area been very influential on the number or type of KT instruments chosen? Has there been any radical innovation?
- Were there particular groups/actors/stakeholders advocating for specific instruments? If yes, which ones?

Block 3: instrument concentration and mix

- Would you say there is mainly one dominant type of KT instruments or is there wide diversity? What type of instruments, if any, is favored by your government in this area?
- Would you say the KT instruments in your country are targeted mainly to the public sector, the firms, or the individual researchers?
- In a related issue: which actors in your opinion are more active in implementing/using/applying to the instruments?
- At the level of the central government, is there a main agency in charge of designing and implementing instruments or more than one? Which one/s? What roles does/do they have?

Block 4: Effectiveness of KT instrument mix

- In your view, which KT instruments have been more effective and why do you think this has been the case?
- KT Instruments do not exist in isolation. Could you comment on some examples of interaction between different instruments, whether synergies or conflicts (between goals, target groups etc.)?

Annex 3: List of interviewed people

AUT. Martin Winkler and Ulrike Unterer, Federal Ministry of Digital and Economic Affairs, and Brigitte Ecker, WPZ Research

CAN. David Clarke, Ryan Hampel, Mathew Cheriyan and Taylor Matchett, Innovation Canada.

ESP. Teresa Riesgo, Directorate of Research, Technological development and Innovation, Ministry of Science, Innovation and Universities

FRA. Olivier Mallet, Ministry of Higher Education, Research and Innovation

HUN. Krisztina Sóvágó and Márton Pete, National Research, Development and Innovation Office (NKFIK) and Andras Hlacs, Ministry of Foreigns Affairs and Trade.

NLD. We have contacted, with the following people: Caroline Tempel-van den Bout, Robin van IJperen, and Eline Casteleijn, from the Ministerie van Onderwijs, Cultuur en Wetenschap (MINOCW) and S.J.C. (Sander) Kes, drs. J.W. (Joost) Dieleman, ir. Ministry of Economic Affairs (MINEZ). No interview could be arranged.

NOR. Siri Borlaug and Espen Solberg, Nordic Institute for Studies in Innovation, Research and Education (NIFU)

PRT. Tiago Santos Pereira, Foundation for Science and Technology (FCT).