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**THE POLICY MIX FOR SCIENCE-INDUSTRY KNOWLEDGE TRANSFER: TOWARDS A
MAPPING OF POLICY INSTRUMENTS AND THEIR INTERACTIONS**

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The document provides a first discussion of the issues to be discussed by the 2017-18 TIP project on assessing the policy mix for knowledge transfer between industry and science and in particular the work to be conducted on policy instruments.

Participant countries are invited to provide feedback to this document in order to develop a refined version of the analytical framework to map the policy mix for knowledge transfer. Countries are invited to volunteer to provide detailed information on the policies they have in place to develop a pilot questionnaire. This would allow obtaining in the future a detailed mapping of those policies, as has been done on the governance of public research.

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THE POLICY MIX FOR SCIENCE-INDUSTRY KNOWLEDGE TRANSFER: TOWARDS A MAPPING OF POLICY INSTRUMENTS AND THEIR INTERACTIONS

Executive summary

1. The most important channels for knowledge transfer depend on the characteristics of universities, public research institutions (PRIs) and firms and on the scientific disciplines and industrial sectors. Adopting tailored approaches is important for public policy to support knowledge transfer.
2. Policy instruments to promote science-industry knowledge transfer include grants for collaborative research, tax incentives for firms that purchase services from universities, financial support to university start-ups and spin-offs, mobility schemes for researchers and open access to publicly-funded research, networking events where representatives from firms, universities and PRIs are brought together to get to know each other and joint road-mapping exercises that involve actors involved in science-industry linkages.
3. Policy instruments that aim to promote knowledge transfer can be classified by their type into financial, regulatory and soft instruments, by their target group (universities, PRIs, firms or both) and by other criteria (including whether they aim to support supply or demand, whether they are generic or industry-specific and whether they are short- or long-term). Many policy instruments have been used for long to address various barriers affecting industry-science linkages.
4. Digitalisation and globalisation have affected knowledge collaborations in science and the ways industry operates, requiring potentially new policy approaches. Private-driven digital platforms, networks and online communities have emerged. Programmes to leverage and take advantage of new developments have been implemented.
5. Often a mix of policies is in place to promote knowledge transfer and this policy mix may create synergies but also challenge intended effects of individual instruments. For example, grants for collaborative research can work better if combined with the provision of guidelines for management of intellectual property (IP) resulting from such collaborations. However, the coexistence of too many different instruments may weaken the impact of single instruments with split funding among a large number of instruments as well as challenge co-ordination as actors find themselves with diverse funding options. More subtle impacts of combined policy instruments may arise.
6. The governance of research policy is critical for a cohesive policy mix. Research and innovation councils and science, technology and innovation (STI) strategies play an important roles as co-ordination mechanisms in most OECD countries. Outreach to industry is also important, with public university boards in 22 countries include private sector representatives.
7. Little systematic evidence across the OECD exists regarding the policy instruments and mix adopted for knowledge transfer. Such an account would require a framework to systematically gathering evidence on different policy instruments and their importance.
8. The TIP project will develop an analytical framework and a questionnaire that could be used to collect information for a more systematic mapping of knowledge transfer policies across OECD countries. Initial pilot studies would be conducted with volunteer countries and offer perspectives on the knowledge transfer policies adopted. This initial description of instruments will be synthesised in a policy analysis

paper; the analysis will connect instruments to outcomes where such evidence is available and develop initial perspectives on the impact of specific economic and institutional context of countries on the effects of specific instruments on effective knowledge transfer.

1. Introduction

9. Public research performed by universities and PRIs is an important input for scientific progress and business innovation. A major rationale for public investment in research is that knowledge is a public good that once created can be shared and used by many but its returns cannot be easily appropriated by any one inventor. This means that the social returns of R&D investments exceed the private returns, so that without public support there may be less investment in new knowledge than would be desirable

10. With large public investment in research and mounting budgetary pressures, governments of OECD countries have placed increasing emphasis on improving the efficiency of these investments, specifically building upon stronger science-industry linkages. As identified in past TIP projects, the role of governments is not limited to public investment in research, but extends further to addressing systemic inefficiencies that hamper science-industry knowledge transfer (OECD, 2003; OECD, 2013). The notion of *knowledge transfer* should also refer to relationships between universities and firms that are not unidirectional and linear but rather interactive and collaborative, as it is not only universities that are relevant to firms but also firms are a critical source of knowledge for universities (Carvalho de Mello et al., 2016; Roux et al., 2007).

11. Knowledge transfer is not an end in itself but an intermediate objective that contributes to better attaining the broader goals of science, innovation and, more generally, economic policies to promote more inclusive growth (OECD, 2016a). These goals include, first, the diffusion of public research results to stimulate private sector innovation. Indeed, innovation in firms increasingly relies on the science base generated at universities, which explains some of the rise of university-industry collaboration (see also [DSTI/STP/TIP\(2016\)10](#)). Second, by transforming scientific breakthroughs into new products and services, knowledge transfer may contribute to addressing more efficiently grand societal challenges (e.g. climate change, public health, energy, food and water supply, etc.) as outlined in the 2016 STI Outlook (OECD, 2016a).

12. The aim of this document is to contribute to the 2017-18 TIP activity on assessing the impacts of the policy mix for knowledge transfer between industry and science, and in particular the proposed work on the policy mix. The document gives an overview of the different types of policy instruments to promote knowledge transfer, discusses the interactions between policy instruments, and provides some examples of policy approaches used by different OECD countries.

13. The TIP project will develop a framework and an associated questionnaire that will allow collecting more systemic information on policies to promote science-industry knowledge transfer across OECD countries, as was done for indicators of governance of public research developed in the context of the impact assessment module [[DSTI/STP/TIP\(2017\)9](#)].

14. Countries are invited to participate in developing this framework. Volunteer countries interested in providing detailed information on their policy mix for knowledge transfer are welcome to help test initial mappings of the policy approach.

15. The remainder of the document is structured as follows: Section 2 provides an overview of the types of policy instruments that promote knowledge transfer, while section 3 discusses interactions between policy instruments. Section 4 discusses governance approaches to addressing the policy mix. The final section discusses avenues for the 2017-18 TIP work on this topic.

2. Mapping policy instruments to promote knowledge transfer

2.1. What do we know about the policy mix of OECD countries for knowledge transfer?

16. During the last years, a growing number of OECD countries have reoriented their financial schemes to support business innovation by placing a higher emphasis on collaborative projects with universities and PRIs. According to a recent study of the innovation policy mix across 27 EU countries based on the Erawatch TrendChart database (Veugelers, 2015), funding for collaborative R&D programmes is used by all EU countries except three, and takes up an important part of the public budgets for science and innovation. For example, it is reported to be the most important instrument in Germany (46% of total budget), Finland (51%) and Sweden (44%). According to this study, other widely used policy instruments that influence university-industry knowledge transfer are cluster initiatives and technology transfer services (including technology transfer offices, SME-academia networks, research commercialization support, etc.).

17. On the regulatory front, the most traditional form of intervention consists in setting clear rules regarding the ownership of intellectual property rights (IPR) generated from collaborative ventures. Since the introduction of the Bayh-Dole Act in 1980 in the United States, most OECD countries have progressively adopted similar regulatory frameworks regarding the ownership of IPR generated from publicly funded research and the diffusion of commercialization revenue by the different parties involved. More recently, some countries have also developed soft regulations or guidelines to facilitate university-industry links, often providing model contracts for the management of IP in collaborative research projects between universities and industries. A relevant example is the Lambert toolkit in the United Kingdom.¹

18. Recent evidence from the OECD STI Outlook (OECD, 2016a), drawing on country responses to a policy questionnaire, highlights that governments are making increasing efforts to promote science-industry knowledge sharing. During the last years several countries have introduced new funding mechanisms: for example, Sweden and the United Kingdom have provided additional public funding (USD 35 million and USD 725 million respectively) into large-scale partnership initiatives with the potential to raise an equivalent amount of private funding. Ireland has launched the Spokes programme to offer extra funding to existing research centres participating in publicly funded research projects on the condition that they involve industry partners. Besides supporting large scale partnerships, several countries have introduced innovation vouchers to promote university-industry knowledge sharing in smaller projects (e.g. Czech Republic, Portugal). At the EU level, Joint Technology Initiatives (JTIs) have been established as long-term research partnerships and are expected to receive USD 12 billion from the private sector over the next seven years. With regard to indirect financial instruments, tax incentives for R&D are also increasingly being used as a mechanism to leverage private funding for public research (e.g. in Iceland and Italy). Moreover, new governance arrangements and regulations have been enacted in many countries to promote science-industry links. Examples include new requirements for minimum co-financing in public support programmes in Latvia and Netherlands, or a revised block funding allocation mechanism to incentivise third-party funding in Norway. Likewise, many countries have continued to professionalise technology transfer offices (e.g. Colombia, Croatia, the Netherlands, Norway and Slovenia). The number of countries with mandatory open access provisions for publicly funded research has also increased, including new initiatives in Austria, Finland, Germany, Mexico, the United Kingdom, and the United States, among others.

¹ <https://www.gov.uk/guidance/lambert-toolkit>.

2.2 Contextualizing university-industry knowledge transfer

19. The characteristics of science-industry linkages, and the numerous challenges that reduce the innovation-enhancing potential of knowledge transfer, have been highlighted in the recent TIP report on the knowledge triangle (OECD, forthcoming) and also in prior work on the commercialisation of public research (OECD, 2013, OECD, 2003). Without aiming to review all factors here, a number of characteristics and challenges are worth pointing out in view of discussing the policy instruments that can be used to promote knowledge transfer.

Obstacles to knowledge transfer

20. Knowledge transfer is often hampered by a variety of obstacles including lack of demand by firms, misalignment of the research strategies of universities and firms, and cumbersome business environments. From a policy perspective, it is critical to consider how to diminish these barriers to university–industry collaboration (Bruneel et al., 2010).

21. Firms are commonly interested in more applied research that may lead to new products or processes. Outcomes such as publications may not be relevant from a business standpoint: what matters most is how the new knowledge derived from collaboration with universities or PRIs can contribute to the firm’s performance through new products and more effective processes (Pertuzé et al., 2010). Conversely, university scientists may be more interested in research that does not directly lead to new products and processes and actively seek to publish their work. Other typical barriers include lack of information, transaction costs of finding the right partner and misalignment of expectations, in particular with regard to intellectual property (IP) rights (OECD, 2013). The business environment may also be an obstacle to knowledge transfer if, for instance, lack of access to finance does not allow for engaging in collaborative innovation ventures.

Different channels of knowledge transfer in different contexts

22. The circulation of knowledge between universities and firms does not occur only through direct channels (e.g. collaborative research, contract research, provision of specialised services, IP transactions, spin-offs, etc.) but also through indirect channels (e.g. publications, conferences, networking, facility diffusion, etc.).² Acknowledging the variety of linkages is particularly important for public policy to adequately support knowledge transfer and the diversity of its motivations, activities, and outcomes. Support for more formal linkages may have lower benefits than expected if informal linkages are weak and not supported. Evaluating the success of policies aimed at supporting knowledge exchange may fail to find impacts simply because of tracking only certain types of transmission channels. As discussed in [DSTI/STP/TIP\(2016\)12](#), most statistical data sources track more formal channels relevant to specific industrial sectors but do not look into more informal channels.

23. The channels for knowledge transfer differ substantially across scientific disciplines and industrial sectors ([DSTI/STP/TIP\(2016\)12](#)). In the past, public policies have tended to focus too much on just a few channels of knowledge transfer, relevant to only some sectors and scientific fields, and to only some types of universities and firms (Gulbrandsen et al., 2011). However, given the heterogeneity in university-industry linkages, policymakers should attempt to foster the variety of channels for knowledge transfer across different types of industries, thus allowing heterogeneity to flourish.

² The different types of formal and informal university-industry linkages have been analyzed in further detail in recent TIP projects [[DSTI/STP/TIP\(2016\)12](#)].

24. The more relevant channels for knowledge transfer will depend on the specific context under analysis. For example, Lall (1992) argued that the priority for countries at early stages of development is to build basic human capital, while as industrial development proceeds the need for more sophisticated training grows, and so does the need for research efforts to build absorptive capacity. Likewise, in the case of immature national innovation systems where linkages are inexistent, policies should focus on networking and establishing first contacts even if weak. When linkages are present, then the focus of policies would be to deepen existing linkages, aiming to foster an evolutionary shift from informal, sporadic interaction to formal, sustained collaboration.

Changing demands from industry and society

25. With the transition to a more knowledge-based economy (OECD, 2013), promoting university-industry linkages has become one of the key focuses of science and innovation policy across OECD countries. In parallel, the growing attention to societal challenges for priority setting in science and innovation policy (in areas like climate change, transport, energy, healthy ageing, etc.) has raised demands for university-industry knowledge transfer. As discussed in the latest STI Outlook (OECD, 2016a), a number of megatrends that characterise the global socioeconomic environment are expected to shape future research efforts, including demographic growth and ageing population; increasing scarcity of natural resources (including water, food and energy supplies); climate change and environmental sustainability; changes in labour markets induced by digitalization and automation; health-related challenges and growing inequalities. Moreover, digital technologies have revolutionised the way that economic interactions and business models are organised, and it is expected that these transformations will intensify in the future through new technological developments in the fields of the internet of things, big data analytics and artificial intelligence (OECD, 2016a). These megatrends can be expected to have an influence over university-industry knowledge transfer practices and policies.

2.3. The diversity of policy instruments to promote knowledge transfer

26. Policies to foster knowledge transfer comprise a variety of policy instruments aimed at providing incentives, infrastructures and support services that contribute to enhancing university-industry links (Correa and Zuñiga, 2013; Yusuf, 2007). In particular, policy instruments commonly used across OECD countries include the following:

1. Subsidies or grants (i.e. *direct* financing) for collaborative R&D between university and industry. These may include generic grants for R&D projects, challenge-driven competitions, as well as large programmes or technology platforms involving consortia of universities and firms to promote research targeted at finding solutions to respond to challenges of strategic industries or societal challenges.
2. Tax-incentives (i.e. *indirect* financial instruments) for companies that fund collaborative research or purchase services from universities.
3. Financial support to university start-ups and spin-offs, targeted to university researchers and/or students. This support can be provided in different ways, including public venture capital, business plan competitions, etc.
4. Implementation of performance-based funding systems of universities and PRIs that reward linkages with industry, for example by providing additional funding earmarked for R&D based on the number of contracts with industry, patent transactions, spin-offs, start-ups, etc.
5. Public procurement of technology, including pre-commercial procurement, whereby firms are encouraged to collaborate with universities or PRIs to develop innovative solutions.

6. Innovation vouchers for small firms to purchase research services from a set of accredited research teams from universities and PRIs.
7. Public funding made available to develop infrastructures and intermediary organizations such as technology transfer offices (TTOs), science parks, and business incubators.
8. Regulation regarding the level of autonomy of universities and PRIs with regard to industry relations.
9. Regulations regarding the ownership of IP resulting from university-industry research and the allocation of IP revenue from publicly funded research.
10. Regulations regarding the setting-up of spin-off companies by university researchers and students, including the university's role as shareholder, the distribution of revenue, implications for academics' salaries and working conditions, etc.
11. Regulations regarding the career track of university researchers, with specific rewards for building linkages with industry, mobilizing research funds from private sources, earning income from patent licensing, and participating in spin-offs.
12. Regulations regarding sabbaticals and mobility programmes that allow university researchers to join industry and vice versa for temporary projects.
13. Regulations regarding open access of publicly-funded research.
14. Outreach activities that raise awareness of the importance of collaboration, such as conferences and seminars to inform of the different policy instruments available and to share good practices.
15. Networking events where representatives from firms, universities and PRIs are brought together to get to know each other, so that firms can express their technological needs and academic researchers can present the results of their recent research. This includes expositions and technology fairs where researchers can present their discoveries and prototypes, and firms can scan for relevant technologies. The government may act as a broker or intermediary, helping firms find the right partners at universities, and vice versa.
16. "Collective road-mapping" or "networked foresight" initiatives bringing together actors from business and academia to identify technological opportunities and priorities for future research funding. More broadly, university-industry collaboration should feed into the definition of innovation policies, and not just into the implementation stage of innovation activities.
17. Voluntary guidelines and codes of conduct, for example regarding the management of IP developed through collaborative projects.

2.4. Classification of policy instruments

Types of instruments, target groups and supply- vs. demand-side instruments

27. Those policy instruments can be classified according to the type of instrument (financial instruments, regulations and soft instruments) and the main actor targeted by the policy (i.e.

universities/HEIs, firms or both),³ (Table 1). Also, a distinction can be made between *supply side* policies that focus on supporting firms and research centres in the generation of new knowledge that may eventually lead to new products and services, and *demand side* policies which focus on stimulating the demand for innovative products, thus providing incentives for firms to innovate by reducing risks.

Table 1. Classification of policies to promote university-industry knowledge transfer

	Main target	Supply vs. demand-side
<i>Financial instruments</i>		
R&D grants (1)	Firms/Universities	Supply side
R&D tax incentives (2)	Firms	Supply side
Financial support to academic spin-offs (3)	Universities	Supply side
Performance-based funding of universities (4)	Universities	Supply side
Public procurement of technology (5)	Firms	Demand side
Innovation vouchers (6)	Firms	Demand side
Funding of infrastructures for knowledge transfer (7)	Firms/Universities	Demand/supply
<i>Regulatory instruments</i>		
Statutory autonomy of universities (8)	Universities	Supply side
IP ownership and licensing (9)	Firms/universities	Demand/supply
University spin-offs (10)	Universities	Supply side
Career track of university professors and researchers (11)	Universities	Supply side
Sabbaticals and mobility schemes for researchers (12)	Universities	Supply side
Open access to publicly-funded research results (13)	Firms/Universities	Supply side
<i>Soft instruments</i>		
Awareness-building (14)	Firms/universities	Demand/supply
Networking events (15)	Firms/universities	Demand/supply
Collective road-mapping / networked foresight (16)	Firms/universities	Demand/supply
Voluntary guidelines and codes of conduct (17)	Firms/universities	Demand/supply

Notes: The table comprises the main policy instruments for knowledge transfer but not necessarily all. Numbers after policy instruments refer to previous list where they were described in greater detail.

Generic versus targeted policy instruments

28. Policies for knowledge transfer may be generic or targeted to a set of designated sectors or technologies. A more targeted approach is consistent with wider industrial and innovation policy frameworks aimed at *smart specialization* (Foray, 2014) and with recent claims for *selective* policy interventions aimed at setting the *direction* of change rather than just addressing market failures (Mazzucato, 2016). Likewise, instead of targeting the whole population of firms, policies may focus on linking universities with a certain type of firms (e.g. start-ups, SMEs, large firms, foreign multinationals, etc.). For example, some policy instruments such as innovation vouchers generally target SMEs. On the

³ For example, governments can provide tax incentives to firms on the condition that they collaborate with universities (the main target here is the firm) or funding to those universities that demonstrate strong ties with industry (the main target being the university).

university side too, policies can aim at engaging not only top ranked universities, but also less research-intensive universities that may focus on different channels for knowledge transfer.

Short-term versus long-term oriented policy instruments

29. Another relevant dimension for analysing the policy mix for knowledge transfer relates to the time horizon of policy instruments, i.e. whether they are oriented to short-term linkages (setting up a first contact) or forming long-term linkages (long term collaborations in research). Short-term links generally consist of on-demand problem solving with predefined results, while long-term collaborations are more strategic and open-ended (Koschatzky and Stahlecker, 2010). Some relevant policy reports have argued that public policies should focus on fostering long-term links between universities and firms (NCURA, 2006).

2.5. Adapting policy instruments for knowledge transfer to a changing context

30. Policy instruments for knowledge transfer will also need to adapt to changing contexts including digitalisation, the development of global networks and other trends affecting industry and research institutions and consequently their interactions. One relevant dimension of change stemming from digitalisation is the emergence of new spaces for knowledge transfer that take the form of *digital platforms, networks* and *online communities* (Corrocher, 2011; West and Lakhani, 2008; Yoo et al., 2012). These digital spaces help to match supply and demand for technology by connecting firms with global networks of public research centres, individual scientists and freelancers to solve specific technological problems (Markman et al., 2008). Box 1 provides examples of such platforms; a number of governments and universities have also built such platforms.

31. This kind of digital platforms bring along important implications for knowledge transfer policies. In particular, given the large number of competing platforms that have emerged offering similar services, the following questions arise: How can integration and collaboration of the different platforms be promoted for the benefit of national innovation performance? Should governments intervene to promote these private-driven platforms or should they perhaps develop their own platforms? How can scientists working at public research organizations be motivated by their institutions to participate further in these kinds of open innovation platforms? How should technology transfer offices of public research organizations interact with these digital platforms?

32. Regarding the spread of *global innovation networks*, some governments have launched programmes to promote science-industry linkages with foreign, world-class universities and PRIs. Such programmes have been implemented, for instance, in Chile (Klerkx and Guimón, 2017) and Portugal (Hird and Pfothenauer, 2016). Taking into account the international dimensions of industry-science linkages may require rethinking not only instruments themselves but also how the conditions for policy support explicitly and implicitly take into account cross-border collaboration.

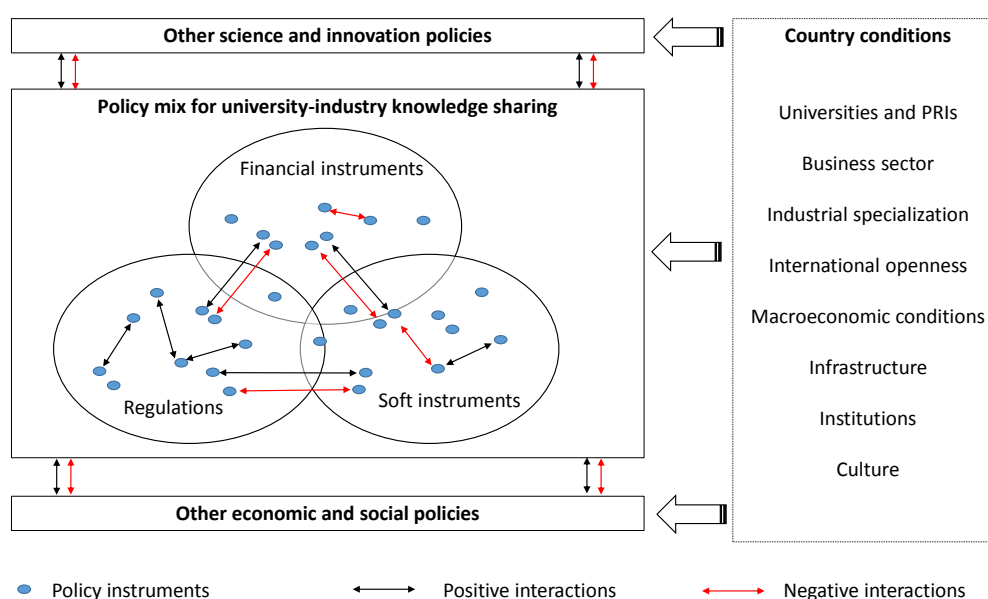
Box 1. Examples of digital spaces for knowledge transfer and its policy implications

- Yet2 (www.yet2.com) has developed a digital marketplace to connect buyers and sellers of technologies, including a compendium of promising technologies available for sale and a list of challenges posted by firms as technological challenges that they need to solve. The company also provides firms different kinds of out-licencing support services, open innovation platforms and patent transactions services.
- InnoCentive (www.innocentive.com) provides a platform where companies and scientists can register either to seek for technologies by running challenges or to address those challenges and sell their technologies. The company has developed a “challenge driven innovation methodology” and offers firms different kinds of custom and premium services.
- IdeaConnection (<https://www.ideaconnection.com>) provides a digital marketplace for open innovation services whereby teams of diversified problem solvers with different skills work to solve firms' public or confidential challenges. It also hosts a specific platform for grand challenges with national or global impact.
- Kaggle (www.kaggle.com) is a platform for data prediction competitions that allows organizations to post their data and have it scrutinized by the world's best data scientists. The competition host provides the raw data and a description of the problem. Participants experiment with different techniques and compete against each other to produce the best models. After the deadline passes, the competition host pays prize money in exchange for the winning model.
- TopCoder (<http://www.topcoder.com>) is a global community of design and technology experts that provides on demand crowdsourcing of software development, application development, algorithms and analytics.
- Other popular digital platforms based on open innovation, crowdsourcing and challenge-driven competitions include Atizo, Brightidea, Chaordix, Exnovate, GEN3 Partners, Ideaken and Qmarkets, among others.

3. Assessing the interaction between policy instruments

33. Policy instruments are not implemented in isolation. Hence, aside from adopting optimal individual policies, the potential interactions between policies are critical to outcomes. As depicted in Figure 1, such interactions occur between the different policies that conform the policy mix for knowledge transfer, as well as with other innovation policies and the broader economic and social policies.

Figure 1. Interactions between policy instruments and policy domains



3.1. Enhancing positive interactions

34. The combination of several policy instruments may increase their individual impacts. For example, grants for collaborative university-industry research projects can work better if accompanied by enhanced support services and guidelines for IP management (OECD, 2016b). Several evaluations also find that grants for collaborative R&D projects between universities and firms will result in more joint projects if combined with policies that promote exchange of post-graduate students to gain experience of project management in an industrial context (Cunningham and Gök, 2016).

35. The development of infrastructure for knowledge transfer (i.e. incubators, science parks, TTOs) has more impact if accompanied by other regulatory and financial instruments. For example, a recent OECD review of innovation policies in Lithuania argued that the development of science parks is more efficient if combined with reforms in universities' regulations for technology transfer (OECD, 2016c). With regard to financial policy instruments, business incubators work better if accompanied by financial instruments to provide early stage financing for entrepreneurs, for example through public venture capital funds for scaling up. This is especially important in laggard countries where the business environment is weak and financial markets are underdeveloped. In the absence of such complementary policies, science parks often become pure real estate ventures with unsustainable financials, as discussed in a recent World Bank review of university-industry collaboration in Sri Lanka (Larsen et al., 2016).

36. The combination of demand and supply side measures may also contribute to the efficiency of the policy mix (Guerzoni and Raiteri, 2015), but the evidence available is limited (Cunningham et al., 2016). In line with TIP work on systems innovation, Kivimaa and Kern (2016) have emphasized that policy mixes to address grand societal challenges (such as the transition to renewable energy) will be more efficient if support to the 'creation' of new innovations is combined with measures to facilitate structural change that change consumer demand to new more sustainable products.

3.2. Avoiding negative interactions

37. Negative interactions between policy instruments for knowledge transfer also need consideration. In particular, the coexistence of different financial instruments targeting simultaneously the same population of public research institutes, universities and firms can create confusion and result in higher administrative costs. Moreover, when similar financial instruments are offered both by the national and the regional governments, this might lead to undesired situations where the same collaborative project is funded twice.

38. Similarly, the development of new infrastructures or intermediary organisations for knowledge transfer might create an overly complex system. For example, the development of regional technology transfer offices or hubs as autonomous or even private-sector driven organisations, which provide services to several universities and PRIs, may facilitate knowledge transfer by building the necessary critical mass to provide professional services across a range of industries and knowledge transfer services. However, the diversity of technology transfer institutions (TTOs from universities, regional/sectoral TTOs, private organizations, etc.), when combined with the lack of a coherent information system, increases the complexity of the system for different stakeholders (research groups, firms, etc.) and may lead to coordination-failures, as discussed in the OECD review of innovation policies in France (OECD, 2014a).

39. Also, policy instruments that focus on a specific channel of knowledge transfer may exert a negative effect over other alternative channels. For example, an excessive emphasis given to technology commercialisation through patent transactions can work in detriment of other modes of knowledge transfer such R&D collaboration, contracting and two-way mobility of researchers, as it was found for example in an OECD review of innovation policies in Malaysia (OECD, 2016d).

40. Moreover, there may be negative interactions between regulatory instruments and efforts to build new infrastructure for knowledge transfer. For example, the development of technology transfer offices (TTOs) will not be efficient if career incentives for university researchers continue to focus only on publications or if university employment regulations hamper spin-offs by prohibiting academics from holding a second post, as it was found in the OECD review of innovation policies in Colombia (OECD, 2014b).

3.3. Addressing interactions with other policy domains and country conditions

41. Other innovation policy instruments that do not aim directly at promoting knowledge transfer may shape university-industry relations. These includes all policies that affect what innovations are undertaken, including health, energy and environmental policies as they influence the demands for certain types of technologies (Caiazza, 2016). The same applies, for example, to regulatory reforms of financial markets that may increase (or decrease) access to finance by start-up companies. It also includes the wide number of policies that affect conditions for research and innovation, such as labour market policies, competition policy, etc., by shaping the innovation context.

42. General country conditions and level of economic development also play a role in the outcomes. For example, in contexts where industries have weak absorptive capacities, the same support for universities to reach out to industry is likely to be less successful and may require different support tools aimed at boosting industry's capacities. The heterogeneity of universities in different national contexts should also be considered. In this regard, recent TIP work on university characteristics and regional innovation performance [[DSTI/STP/TIP\(2016\)13](#)] has found that there is a strong concentration of universities within countries, with many smaller universities and a few very large institutions that concentrate the bulk of academic research. Smaller and less research-intensive universities often rely on different channels for knowledge transfer, focusing less on patent transactions or joint research projects,

and more on student entrepreneurship and informal networking. Governments should be sensitive to this heterogeneity when designing the policy mix for knowledge transfer.

43. Recent TIP work has underscored that university-industry links and the mechanisms for knowledge transfer are significantly different across sectors [[DSTI/STP/TIP\(2016\)12](#)]. For example, the pharmaceutical and chemical industries rely more extensively than other sectors on technology transfer through patents, drawing heavily on scientific research in the fields of life science, medical science and chemistry. Therefore, a priority for knowledge-diffusion policies in these industries is to improve the regulatory framework for patent transactions, while supporting institutions such as technology transfer offices. In contrast, firms operating in other sectors, such as knowledge-intensive business services, rely to a larger extent on informal channels for linking with universities, with a focus on tacit knowledge, recombination of existing knowledge, and specific problem-solving (see also Johnston and Huggins, 2015).

44. Interestingly, some have argued that policy mixes for innovation are too cohesive, suggesting that most countries were deploying very similar combinations of instruments irrespective of their innovation position and that more attention should be paid to assessing the adequacy of policy mixes to specific country conditions (see e.g. Veugelers, 2015). Better systematic information on the policy mix is, however, needed to validate such views.

45. Regional and local governments are also very active in this area to complement national government initiatives in various ways, adding an additional element complexity to the policy mix mix.

3.4. Expanding versus streamlining the policy mix

46. The efficiency of a policy mix may increase by adding complementary policy instruments, but only up to a certain point (Braathen, 2007; OECD, 2010). Even in the absence of overlaps, using too many policy instruments may lead to excessive complexity, higher administrative costs for the government, and confusion for target firms/universities. Concentrating available budgets in fewer may contribute to better fostering industry-science linkages. Facing limited budgets, the choice of a policy mix always involves complex decisions on how to distribute available funding among the different policy instruments. For example, choices must be made regarding whether to prioritise collaboration of universities with established firms (matching grants, consortia) or new firms (spin-offs, incubators); between providing grants to firms or developing science parks, etc.

4. Governance of the policy mix for knowledge transfer

4.1. Relevance of governance to addressing the policy mix

47. The governance of research policy is critical for a cohesive policy mix, including issues of vertical and horizontal co-ordination of different levels of government (e.g. national and regional levels). Moreover, consultations with core stakeholders for industry-science linkages (notably universities, PRIs and private firms) can be critical to optimise the policy mix. With increased autonomy granted to universities, the impact of public policy on these institutions and the types of tools with largest impact is also changing and requiring joint governance models.

4.2. Approaches to governing public research

48. Preliminary findings from the TIP work on the governance of public research policies [[DSTI/STP/TIP\(2016\)14](#)] point to a number of relevant trends and approaches towards policy co-ordination:

- Research and innovation councils, which are public institutions outside of ministries and agencies whose mandate includes tasks such as priority setting, policy advice and policy coordination regarding HEIs and PRIs, are a widely used. Councils exist in 30 of 34 (88%) OECD countries; but their roles differ. In 18 of 30 (60%) countries, the council is tasked with policy co-ordination across ministries and agencies, and also between government and non-state stakeholders. In 23 out of 30 countries with councils (or 77%), the council is also involved in developing strategic priorities, and in 16 out of 30 (53%) cases, the councils conduct evaluation of policies. The councils of Canada, Denmark, the Netherlands and Sweden have an exclusive advisory role, while in the Czech Republic, Japan, Korea, Mexico and Turkey councils take decisions on budgetary allocations for HEIs and PRIs. Most councils in OECD countries include private sector representatives (in 27 of 34 or 90 and less often civil society organisations in 11 of 34 or 37%).
- STI strategies or plans are also used in nearly all OECD countries. These strategies often address specific themes and identify priority research fields, notably energy, health and life sciences, ICT, nanotechnology and advanced materials. Most countries also have additional STI strategies in place (24 of 33, 73%), often with a more specific regional (including a focus on smart specialisation of EU countries) or thematic focus.
- Outreach to industry is also widespread. In 21 of 30 (70%) countries, public university boards – the main decision-making body of universities in charge of priority setting – include private sector representatives. University boards in 22 of 30 countries include private sector representatives (Figure 2).
- Public universities are quite autonomous across the OECD: They are free to decide on their internal structure in 25 of 30 countries (83%), have the ability to create legal entities (e.g. spin-offs) and enter industry partnerships in 23 of 29 countries (79%), and can freely allocate block funding in 18 of 28 countries (64%). This autonomy is complemented by a trend towards the use of performance-based elements in the public funding of universities.

Figure 2. External participation in public university boards [Preliminary results]

	AUS	CHE	GBR	ISR	NZL	USA	AUT	BEL-FL	CAN	ESP	FIN	ISL	NLD	NOR	POR	SWE	DEU	FRA	DNK	JPN	LVA	ITA	GRC	CHL	CZE	HUN	LUX	MEX	POL	TUR	Share of countries with boards	Share of countries with boards (%)	
						USA-MA	USA-CA										DEU-BW	DEU-NW	DEU-BB														
Private sector	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X										70%	70	
Civil society	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X				X									60%	60	
Foreign experts	X	X	X	X	X	X	X															X									23%	23	
No formal representation																							X	X	X	X	X	X	X			23%	23

Note: This figure corresponds to question "Do stakeholders participate as formal members in councils/governing boards of HEIs?" Information is missing for Estonia, Ireland, Korea, Slovakia and Slovenia. There is no formal stakeholder participation in HEI boards in Chile, Czech Republic, Hungary, Luxembourg, Latvia, Mexico, Poland and Turkey. Percentages are expressed as a share of countries which have formal external stakeholder consultation in HEI boards (N=30).

For the United States, USA-MA refers to the state of Massachusetts, USA-CA refers to the state of California.

For Germany, DEU-BB refers to the state of Brandenburg, DEU-BW refers to the state of Baden-Württemberg, DEU-NW refers to the state of North-Rhine Westphalia.

Interpretation of the figure: The first row shows that in all countries except Italy, Greece, Chile, Czech Republic, Hungary, Luxembourg, Latvia, Mexico, Poland, and Turkey the private sector is represented in boards of HEIs. Information is not available for Estonia, Ireland, Korea and Slovenia.

5. Advancing our knowledge of the policy mix for knowledge transfer: objectives for the TIP project

49. This report has provided a tentative framework aimed at mapping the policy instruments for knowledge transfer and an initial discussion of the mechanisms to improve governance and coordination. This document is a first contribution to the broader 2017-18 TIP project on the policy mix for knowledge transfer, which comprises the following three objectives:

- To provide a framework and a set of tools for mapping policies for knowledge transfer and their interactions across OECD countries, which allows better understanding trends of the policy mix and the differences across countries.
- To reflect on the governance structures of public research for knowledge transfer in place across OECD countries, analyse differences and similarities, and identify good practices.
- To discuss what policy coordination approaches are most suitable towards having an adequate policy mix for knowledge transfer.

50. As discussed in this report, evidence on the policy mix for knowledge transfer and the differences across countries is still limited. The data collection process on the type of innovation policy instruments used by OECD member states is set to improve through new initiatives such as the EC/OECD International Survey on Science, Technology and Innovation Policies (STIP survey). Yet the indicators collected are not exhaustive and information is still limited regarding the relative importance given to the different policy instruments and qualitative aspects that differentiate national approaches, a critical issue for understanding the policy mix. This hampers the capacity of OECD governments to benchmark their policy mix for knowledge transfer and learn from other countries.

51. Consequently, building on the proposed analytical framework, this TIP project will aim at developing a questionnaire that could be used in the future to collect relevant information for a more systematic mapping of knowledge transfer policies across OECD countries, similarly to what was done for the work on the governance of public research developed in the context of the impact assessment module [\[DSTI/STP/TIP\(2017\)9\]](#). The questionnaire would address jointly the variety of financial, regulatory and soft policy instruments that may be used to promote science-industry knowledge transfer. For example, based on the list of policy instruments outlined above (Table 1), participating countries could initially be asked to reply on the following questions: 1) which policy instruments are currently being used in the country; 2) what is the division of competencies between national and regional governments for the different policy instruments; 3) what are the core characteristics of the different policy instruments and how do they interact with other policies, and 4) how important are specific scientific, sectoral, and technological priorities for these policies.

52. However, it should be noted that the actual application of this questionnaire to all OECD countries is beyond the scope of this project. The focus during 2017-18 will be to develop the questionnaire, based on a comprehensive analytical framework and on initial pilot studies conducted with volunteer countries. Such pilot studies will offer critical inputs to develop the analytical framework and the final questionnaire that could then be deployed across all OECD countries if deemed interesting at that point. The pilot studies will also be useful in order to integrate into the final report a set of case studies reflecting national experiences to illustrate good practices in designing and implementing the policy mix. Attention will also be given in the country case studies to how policy coordination can be improved, notably with regards to governance structures of public research and with regards to national-regional coordination.

53. In addition, country case studies will be useful to illustrate specific dimensions of the policy mix, of the interactions between policy instruments, and of the next generation of policy instruments to promote knowledge transfer. Some examples of possible topics that could be covered in different country case studies include an assessment of recent cluster initiatives focusing on how they combine different policy instruments to promote university-industry knowledge transfer.

54. Regarding the role of governance for the policy mix, the validated information collected for the OECD countries will be analysed in national approaches and how these depend on different country characteristics (see [DSTI/STP/TIP\(2017\)10](#)).

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