Using STIP Compass data to analyse national policy histories

This data story outlines the methodology used to analyse the evolution of the German and Canadian STI policy mixes from 2000 to 2020. The exploratory exercise yielded insights in terms of the feasibility of developing longitudinal datasets through the integration of data from existing STI policy databases. It also discusses some of the more general limitations of current STI policy data and high-level results from the analysis.

The OECD STIP Compass provides access to one of the most extensive publicly accessible data collections on national STI policies. Almost 8,000 unique policy initiatives (using roughly 11,000 policy instruments) currently in operation are covered by the database. The initiative is supported by a comprehensive infrastructure, which allows for the collection, stewardship, and retrieval of qualitative and quantitative policy data from participating countries in accordance with FAIR principles (**F**indable, **A**ccessible, **I**nteroperable, **R**eusable).[i] Policy data can currently be accessed in a variety of ways to accommodate a range of use cases. Some of these include: 1) visualization of policy landscapes through interactive dashboards; 2) perusal of data according to several priority areas through thematic portals; and 3) retrieval of data based on keywords, countries, instruments, themes, or target groups, and in association with related policies, national economic data, and related academic and grey literature.

An Exploratory Exercise

There is a question as to whether STIP Compass data could provide a foundation for the temporal analysis of trends in national STI policy mixes or a view into the policy history of a given country. The development and analysis of longitudinal STI policy datasets could prove useful in several respects. Related activities could support the identification of temporal trends in STI policy features and provide an evidence base to detect correlations with endogenous and exogenous factors, such as the impact of the election cycle or global-scale crises or shocks on the development of STI policy.

Temporal trends may also generate new insights on how STI policy mixes tend to evolve in practice. For example, analysis could explore the extent to which policymakers proactively adapt or phase out existing goals and instruments to align with new initiatives, versus passively adding new initiatives on top of existing ones.[ii] Along these lines, the STIP Data Lab has undertaken an exploratory initiative to understand the feasibility and limitations of conducting temporal analyses using existing STI policy databases. The objective of the initiative was to compare the evolution of two national STI policy mixes over a 20-year period. This exercise complements a [2023 data story](), which outlines two pilot studies undertaken to explore how STIP Compass data might be leveraged to complete comparative analyses. The initiative aimed to compare the evolution of two national STI policy mixes.
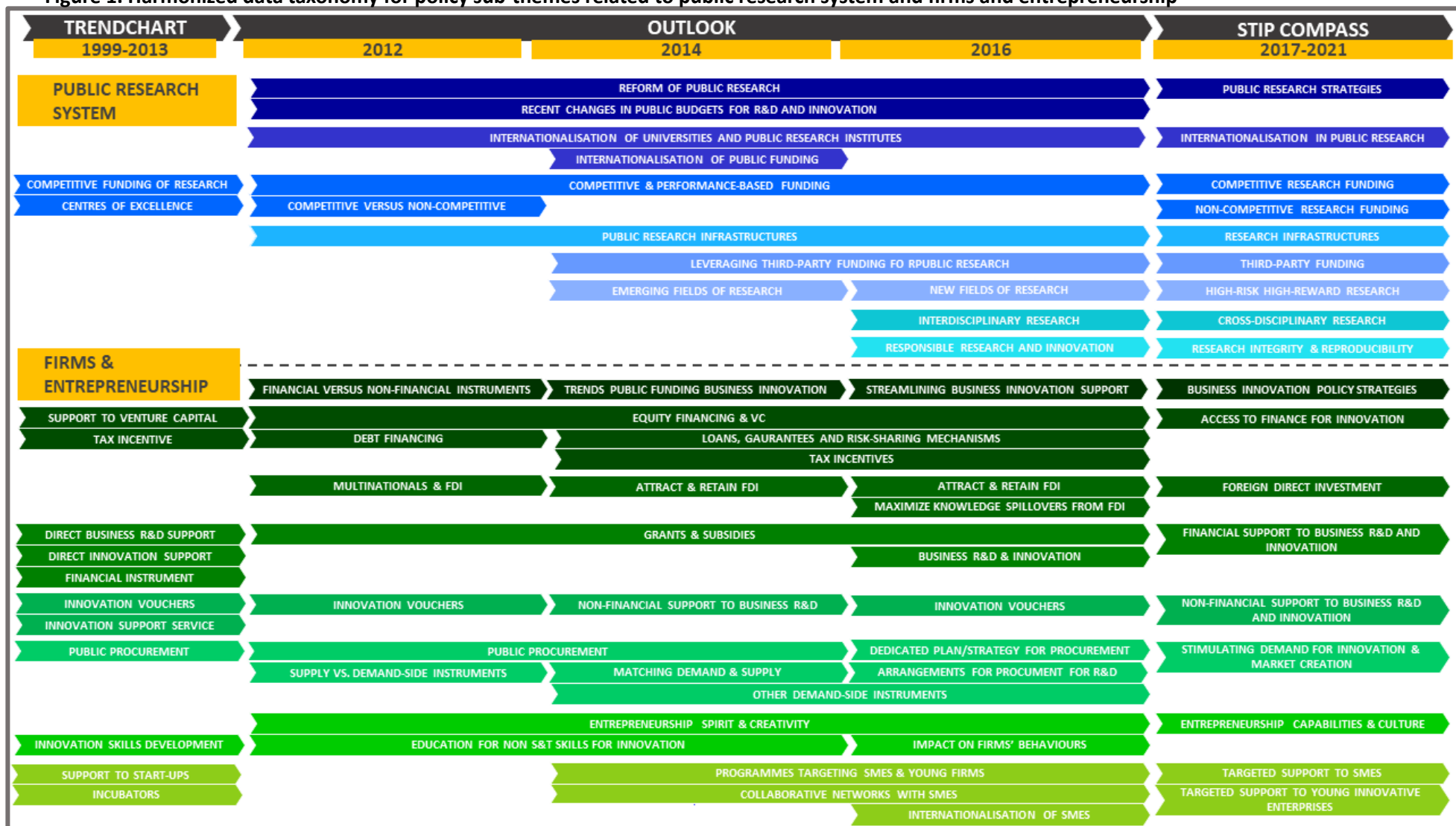
Methodology: Identifying and Treating the Data

This exploratory exercise has been limited to the comparison of two national STI policy mixes to ensure feasibility. Canada and Germany were selected due to their similarities in terms of strong economic growth, high quality of life, and relative commitment to the deployment of STI policy to achieve sustainability transitions. As federalist nations, both are subject to coordination challenges between subnational and national governments. However, distinctions between the general policy style of each government, which may yield insight on different types of policy change. While Germany's policy legacy favours direct supports and the identification of specific technological opportunities, Canada is generally recognized as a market economy, with STI policy utilizing more indirect instruments and initiatives to support broad economic and sectoral development. In addition, both countries have strong histories of reporting national STI policy data.

An iterative process was used to create and curate datasets representing the majority of essential national STI policies in operation from 2000-2020 in Canada and Germany. A 20-year span was considered sufficient to identify trends in the evolution or stability of STI policy characteristics. Assembling thorough longitudinal datasets stretching back to 2000 required considerable effort. In addition to STIP Compass data (from the 2017 and 2019 EC-OECD STIP Surveys), the study leveraged a wealth of legacy data from 1) the **European Trendchart survey** (administered from 1999 to 2013 and available for Germany), and 2) t**he OECD STI Outlook Policy Survey** (administered in 2012, 2014, and 2016, available for both countries).[iii] This was further supplemented by desk research, which focused on the 2002-2012 period to fill gaps in the time series.

The STIP Data Lab engaged German and Canadian national experts, who provided guidance on how to focus data collection efforts and gave iterative feedback on the representativeness and completeness of the datasets as they evolved. Based on the advice of national experts, the data collection methodology for the two countries diverged because of different national approaches to system coordination, evaluation, transparency, and availability of relevant source material. This meant additional effort was required to develop and apply a harmonized data model (with common data fields) and a streamlined data taxonomy (i.e. coding of themes, instruments, target groups) to all policy initiatives. TrendChart and STI Outlook data were restructured and recoded to align with the STIP Compass dataset. Figure 1 provides an overview of the harmonized data taxonomy created for policy sub-themes, which shows how similar sub-themes have been consolidated over time, while others were added or discontinued to reflect changing priorities within the STI policy community.

Figure 1. Harmonized data taxonomy for policy sub-themes related to public research system and firms and entrepreneurship

TRENDCHART	OUTLOOK			STIP COMPASS
1999-2013	2012	2014	2016	2017-2021

PUBLIC RESEARCH SYSTEM

	REFORM OF PUBLIC RESEARCH		PUBLIC RESEARCH STRATEGIES
	RECENT CHANGES IN PUBLIC BUDGETS FOR R&D AND INNOVATION		
	INTERNATIONALISATION OF UNIVERSITIES AND PUBLIC RESEARCH INSTITUTES		INTERNATIONALISATION IN PUBLIC RESEARCH
	INTERNATIONALISATION OF PUBLIC FUNDING		
COMPETITIVE FUNDING OF RESEARCH	COMPETITIVE & PERFORMANCE-BASED FUNDING		COMPETITIVE RESEARCH FUNDING
CENTRES OF EXCELLENCE	COMPETITIVE VERSUS NON-COMPETITIVE		NON-COMPETITIVE RESEARCH FUNDING
	PUBLIC RESEARCH INFRASTRUCTURES		RESEARCH INFRASTRUCTURES
	LEVERAGING THIRD-PARTY FUNDING FO RPUBLIC RESEARCH		THIRD-PARTY FUNDING
	EMERGING FIELDS OF RESEARCH	NEW FIELDS OF RESEARCH	HIGH-RISK HIGH-REWARD RESEARCH
	INTERDISCIPLINARY RESEARCH		CROSS-DISCIPLINARY RESEARCH
	RESPONSIBLE RESEARCH AND INNOVATION		RESEARCH INTEGRITY & REPRODUCIBILITY

FIRMS & ENTREPRENEURSHIP

FINANCIAL VERSUS NON-FINANCIAL INSTRUMENTS	TRENDS PUBLIC FUNDING BUSINESS INNOVATION	STREAMLINING BUSINESS INNOVATION SUPPORT	BUSINESS INNOVATION POLICY STRATEGIES
SUPPORT TO VENTURE CAPITAL	EQUITY FINANCING & VC		ACCESS TO FINANCE FOR INNOVATION
TAX INCENTIVE	DEBT FINANCING	LOANS, GAURANTEES AND RISK-SHARING MECHANISMS	
		TAX INCENTIVES	
	MULTINATIONALS & FDI	ATTRACT & RETAIN FDI	FOREIGN DIRECT INVESTMENT
		ATTRACT & RETAIN FDI	
		MAXIMIZE KNOWLEDGE SPILLOVERS FROM FDI	
DIRECT BUSINESS R&D SUPPORT	GRANTS & SUBSIDIES		FINANCIAL SUPPORT TO BUSINESS R&D AND INNOVATIION
DIRECT INNOVATION SUPPORT		BUSINESS R&D & INNOVATION	
FINANCIAL INSTRUMENT			
INNOVATION VOUCHERS	INNOVATION VOUCHERS	NON-FINANCIAL SUPPORT TO BUSINESS R&D	INNOVATION VOUCHERS	NON-FINANCIAL SUPPORT TO BUSINESS R&D AND INNOVATIION
INNOVATION SUPPORT SERVICE			
PUBLIC PROCUREMENT	PUBLIC PROCUREMENT	DEDICATED PLAN/STRATEGY FOR PROCUREMENT	STIMULATING DEMAND FOR INNOVATION & MARKET CREATION
	SUPPLY VS. DEMAND-SIDE INSTRUMENTS	MATCHING DEMAND & SUPPLY	ARRANGEMENTS FOR PROCUMENT FOR R&D	
		OTHER DEMAND-SIDE INSTRUMENTS	
	ENTREPRENEURSHIP SPIRIT & CREATIVITY		ENTREPRENEURSHIP CAPABILITIES & CULTURE
INNOVATION SKILLS DEVELOPMENT	EDUCATION FOR NON S&T SKILLS FOR INNOVATION	IMPACT ON FIRMS' BEHAVIOURS	
SUPPORT TO START-UPS	PROGRAMMES TARGETING SMES & YOUNG FIRMS		TARGETED SUPPORT TO SMES
INCUBATORS	COLLABORATIVE NETWORKS WITH SMES		TARGETED SUPPORT TO YOUNG INNOVATIVE ENTERPRISES
		INTERNATIONALISATION OF SMES	

Note: The figure provides an example of how the data taxonomy for two policy themes (public research system shown in blue and firms and entrepreneurship shown in green) has evolved with the administration of TrendChart, Outlook and STIP Compass surveys. Shades of blue and green have been used to distinguish between different sub-themes.

After assembling an initial list of policy initiatives, subsequent research was required to assess their completeness and identify start and end dates for many of them (see Figure 2). At the conclusion of this stage, 420 unique initiatives had been identified and curated for Germany and 459 for Canada; however, a number of these initiatives could not be included due to an inability to determine start and end dates, which are necessary for a temporal analysis. In the final analysis, 373 unique initiatives were included from Germany and 423 from Canada.

Figure 2. Sources and quality of data in the time series
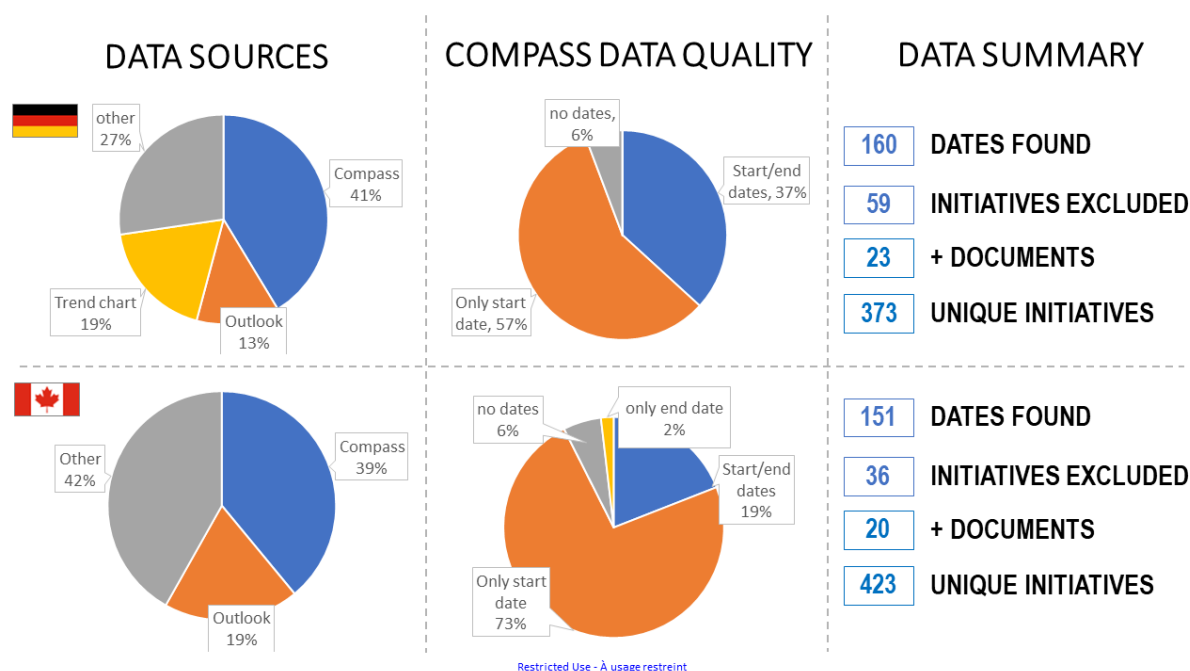
Note: Figure 2 provides an overview of the sources of the data included in the longitudinal analyses and the desk research completed to identify additional initiatives and missing programme start and end dates.

Methodological Findings

The exercise yielded insights in terms of the feasibility of developing longitudinal STI policy datasets and how this might be done via the integration of different data sources. Several challenges may complicate efforts to integrate data from STIP Compass, STI Outlook, and Trendchart into a common dataset. Data from TrendChart and the STI Outlook databases are much less structured relative to the STIP survey data. This can make it difficult to compare different policies without significant cleaning to restructure the data. In addition, there are differences in their data models, which means that some data fields have not been consistently collected across all three surveys. Data taxonomies also differ across the datasets, varying in terms of target groups, instruments and themes. However, despite the use of different terms, there is substantial alignment across the core codes and their definitions. This means analysis across the datasets is possible, but analysts will need to clean, scan, reformat, and recode the data to ensure that a common data model and taxonomy are applied.

There were also valuable findings in terms of the limitations of using established repositories of national STI policy data, which may require users to consider the types of analyses that this data may be best suited to. Some of these limitations include:

I) Data Completeness: Mapping complete national policy mixes over time is a difficult exercise.

First, what is included under the STI umbrella can be subjective, particularly when topics are nascent or at the periphery of the STI policy area. STI-related policies that fall under the management of non-STI policy domains, such as energy, environment, or education ministries, among others, often are not captured in STI policy databases. Capturing some of these more tangential initiatives may require survey respondents to have a deep understanding of the national STI system or to engage other parts of the national government in reporting on relevant initiatives The extent to which this is done successfully in practice varies across countries. **Second,** it can be difficult to find start and end dates for individual programmes due, in part, to tendencies for programmes to be introduced without a formal timeline for evaluation and/or termination. This prevented the inclusion of some initiatives in the temporal analysis undertaken. **Finally,** datasets are more likely to reflect recent and larger-scale programmes due to difficulty in finding necessary information to facilitate the inclusion of older initiatives.

II) Comparability: STI policy initiatives vary in terms of their importance or significance across various dimensions; however, a standardised ''unit of measure'' is missing.

Lack of a consistent dimension to weigh or compare the significance of different initiatives impacts the quality of the analysis that can be done. Inconsistent reporting of budget data prevents the use of financial information to weigh policies by monetary allocation. A lack of data on non-monetary dimensions, such as specifics of the policy development process or evaluation efforts also prevents comparison via the use of alternative units of measure. For example, Schmidt and Sewerin use 'policy intensity' which includes an analysis of policy objectives, scope, integration, budget, implementation and monitoring to quantify significance. However, applying such a concept to a large dataset (i.e., several thousand policies) would likely require significant adaptation to improve feasibility.[iv]

III) Duplication and Overlap: The same programme may be included in the dataset multiple times.

Translation of programme names into English led to slightly different namings in different years, resulting in duplication. Overarching and sub-programmes were also a source of overlap and duplication. Connections between programmes often were not evident without extensive research and a deep knowledge of the national STI system. This has been addressed in more recent iterations of the STIP Compass survey, which now allows policymakers to identify ''parent'' initiatives.

IV) Implicit Bias: The data is largely sourced from contacts in national governments.

STI policy data is generally reported by national governments and the inclusion of other stakeholders, such as academic or think-tank representatives in this process would be time consuming and complex. Biased data may arise from narrow or varied reporting in terms of what constitutes STI policy, or aspirational or idealized representation of programming. National contact points and survey respondents also often change after each edition of the survey, which may impact consistency in how different elements of the data taxonomy are applied.

V) Depth of Analysis: Analysis is limited to the creation of new and phase-out of existing initiatives

Changes occurring within initiatives may not be captured by the data submitted to STI Policy databases by national contact points. The significance of this constraint is dependent on the extent to which existing programmes have evolved since inception, which is likely to vary across different countries. There is also limited background information on the policymaking processes used to support policy development, management, evaluation and adaptation or termination.

Users can take steps to mitigate the impacts of some of these limitations. Challenges posed by data completeness and comparability can be addressed, to some extent, through use of proportions rather than policy counts to analyse trends in policy mix composition. Users may also consider using statistical adjustment, such as regression analysis, to address inconsistencies and data incompleteness, among other issues. Desk research can help to address completeness, duplication, and improve depth of analysis.

Analytical Findings

Policy reform style and programme length

Results indicate a foundation of long-term (10+ years) and indefinite (without an end date) programming persisting in both policy mixes. The proportion of this type of policy is significant in Canada, accounting for 55% of the policy mix in 2000 and growing to roughly 85% as of 2020 (see Figure 3). This could be indicative of tendencies to introduce new goals and instruments without terminating or materially reforming existing instruments. Large numbers of indefinite and long-term policies are also evident in Germany but taken together appear stable at approximately 60-65% of the policy mix. However, relatively large proportions of short-term (under 5 years) and medium-term (5-10 years) policies may indicate that mechanisms to update instruments and objectives may be more common in German policymaking processes.

Figure 3. Programme length and policy reform style in Canada and Germany
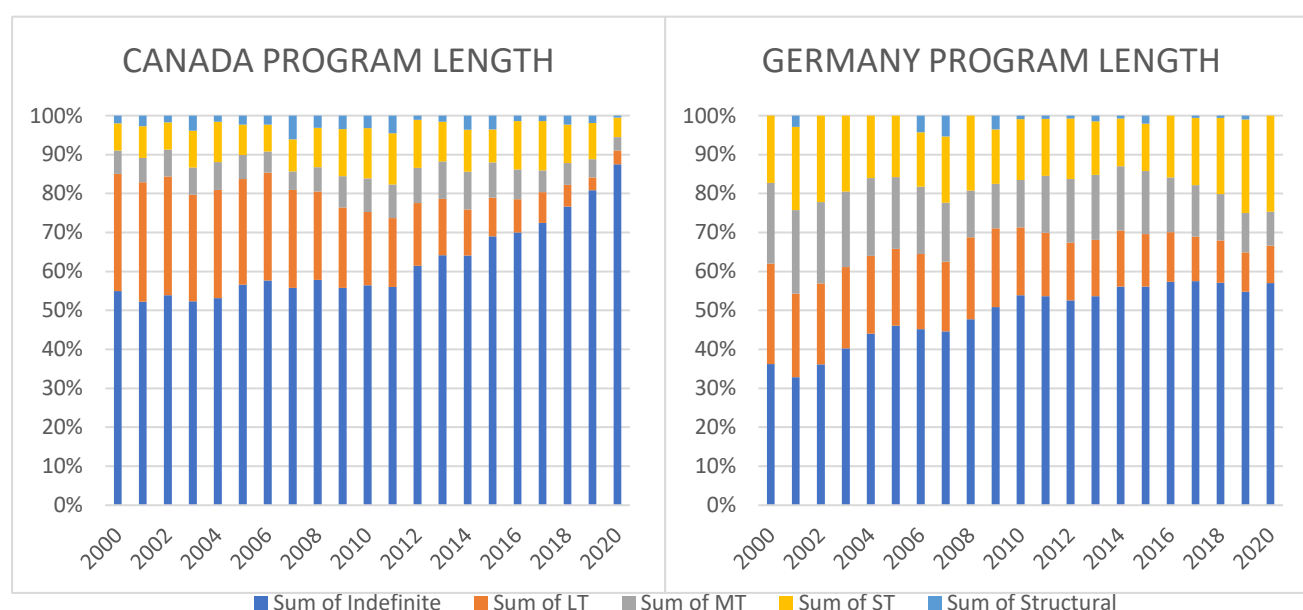
Note: Figure 3 shows change in the composition of STI policies in Germany and Canada in terms of programme length. Data were segmented into five different categories. Structural instruments, defined as those that make a permanent, often legislated change to the STI system are counted only in their year of introduction. Indefinite instruments, defined as those without an end date, were counted in their year of introduction and subsequent years to 2020. Remaining policies were categorised as short-term (ST) or under 5 years, medium-term (MT) or 5-10 years, and long-term (LT) or over 10 years.

Additional research revealed that in German policymaking processes, there is a tendency for new initiatives to be introduced with a tentative end date and institutionalized evaluation cycles. Programme conclusion is generally paired with formal evaluation, which may include soliciting feedback from external experts and/or civil society, and the potential adaptation and renewal of the initiative. Effects of this are reflected in the evolution of the policy mix to include transformative STI policy characteristics, such as public participation in policymaking.

The 'German Resource Efficiency Programme' (ProgRess) is one example of institutionalized policy learning. The programme was established in 2012 and was renewed in 2016 and 2020. Its evolution has demonstrated a "broadening and deepening of objectives and measures to promote resource efficiency".[v] The first version of the programme focused primarily on public awareness and raw material efficiencies, while ProgRess II downscaled support for the fossil fuel industry and mainstreamed renewable energy technologies. Public engagement has also been included as a key aspect of the development process with inception of the online Citizens' Dialogue in 2015.[vi]

Review and evaluation processes were institutionalized in the Canadian system through the 2007 Government Expenditure Management System, which required ex ante instrument proposals to define expected results,[vii] and the 2006 Federal Accountability Act, which mandated the ex-post review of the relevance and effectiveness of funding.[viii] However, data curation indicated a tendency for Canadian instruments to be introduced without defined end dates. Only 20 percent of the 215 unique initiatives identified using 2017-2019 Compass data included both a start and end date (see Figure 2). Recent efforts have been made to streamline instruments with several programmes consolidated under the Strategic Innovation Fund in 2018 and the Alliance Grant program in 2019.

Trends in policy themes

Trends in policy themes suggest that up until 2006, STI programming in Germany was heavily oriented towards firms and entrepreneurship. At this point, there was a substantial decline in related initiatives, which may correspond to the 2006 introduction of a structural measure to harmonize SME-oriented programming. Around this time, the proportion of initiatives focused on supporting the public research system and/or research and innovation for society also began to increase. It is possible that the efforts of policymakers to target a range of specific targets contributed to these trends by making the policy landscape more fragmented. A substantial proportion (40-50%) of the German policy mix has consistently been targeted towards facilitating knowledge transfer.

**Figure 4. Trends in German Policy Themes from 2000-2020**
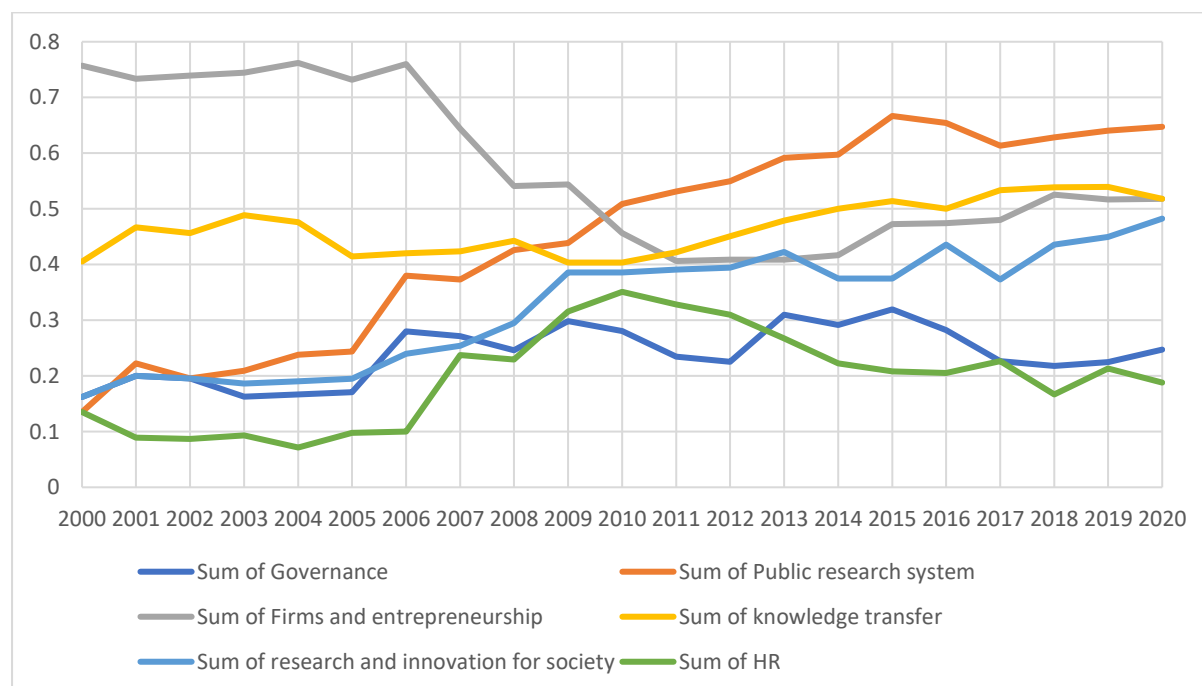
Note: Policy themes noted in Figures 4 and 5 refer to policy areas outlined in the STIP Compass data taxonomy. The vertical axis notes the proportion of initiatives associated with respective policy areas. The sum of proportions generally exceeds 100% per year because initiatives are often coded to several policy areas. The Firms and Entrepreneurship policy area is an

abbreviation of Innovation in Firms and Innovative Entrepreneurship. The Knowledge Transfer policy area is an abbreviation of Science-industry Knowledge Transfer and Sharing. The HR policy area is an abbreviation of Human Resources for Research and Innovation.

In Canada, the composition of themes present in the STI policy mix has remained relatively consistent across the twenty-year period. The majority of initiatives support the public research system, while most other themes, i.e., firms and entrepreneurship, knowledge transfer, research and innovation for society, and human resources, have made up 25-35% of the policy mix from 2000-2020. Until 2019, governance was least well-represented and remained roughly 20% of the Canadian policy mix until 2015, when it began to increase relative to the other themes.

Figure 5. Trends in Canadian Policy Themes from 2000-2020
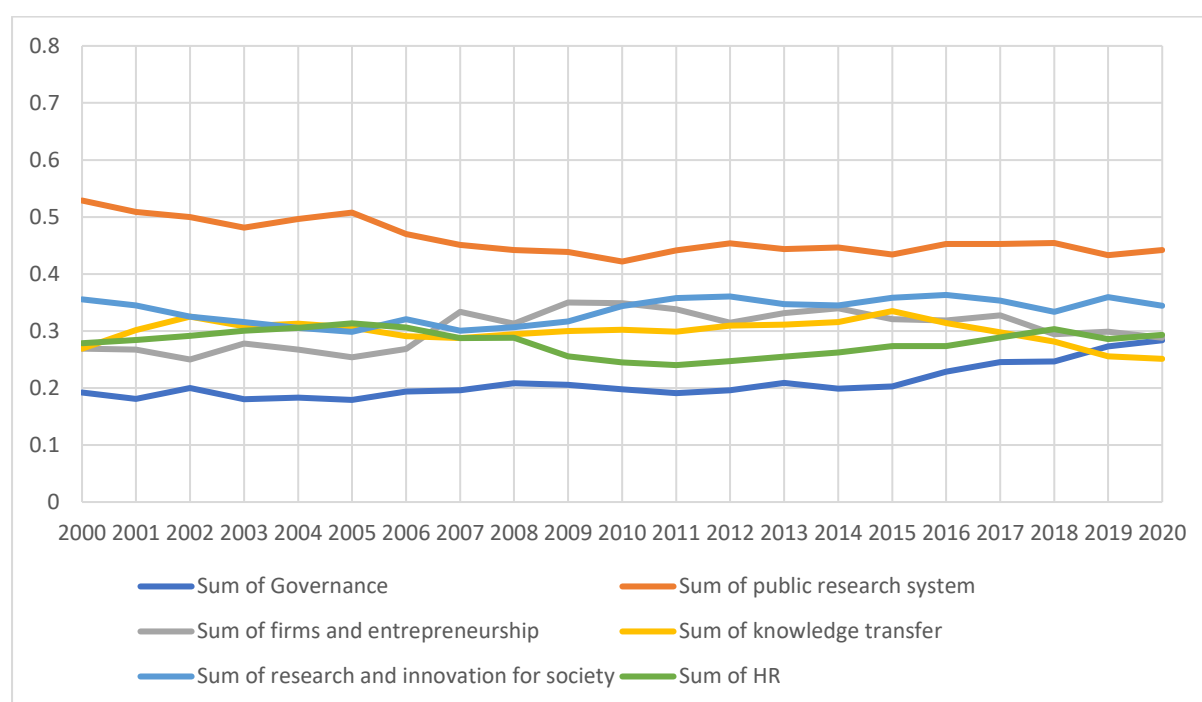
Trends in policy instruments

In both the Canadian and German policy mixes, the majority of initiatives use instruments that provide direct financial support or support for collaborative infrastructures. Despite reports that from 2006 to 2019, tax incentives for business R&D almost doubled (from 36 to 60%) across OECD countries,[ix] indirect financial instruments have remained the least common form of support in both countries from 2000-2020. This is not surprising as countries often introduce a handful of tax incentive schemes, which can equate to a sizeable proportion of national GDP. Germany is also an outlier in this respect, only introducing its first R&D tax credit in 2020. The Canadian instrument mix has also remained remarkably stable, with the only major change being a gradual decline in collaborative infrastructure by roughly 10% from 2000-2011.

Figure 6. Trends in Canadian policy instruments from 2000-2020
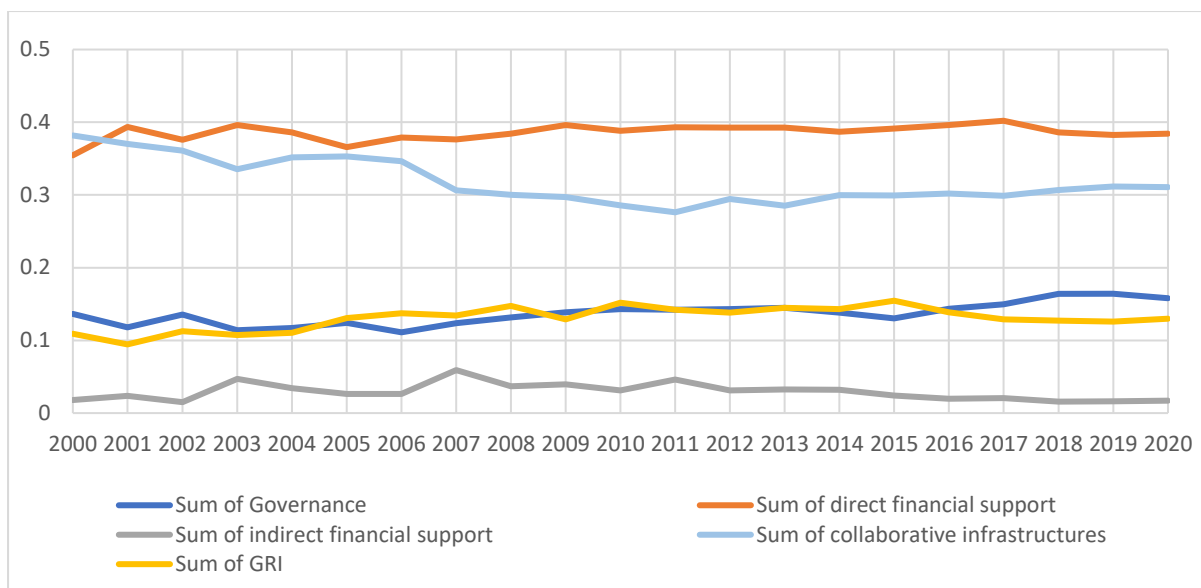
Note: Policy instruments noted in Figures 6 and 7 refer to policy instrument categories outlined in the STIP Compass data taxonomy. The GRI instrument category is an abbreviation of Guidance, Regulation and Incentives.

In Germany, the proportion of governance instruments trended upwards following launch of the first Hightech Strategy (HTS) in 2006, which was introduced to facilitate the expansion of R&D expenditures to 3% of GDP and to coordinate federal and subnational STI policy and investments. It has since been renewed three times in 2010, 2014, and 2018 and replaced in December 2023 with the Future Research and Innovation Strategy.

Figure 7. Trends in German policy instruments from 2000-2020
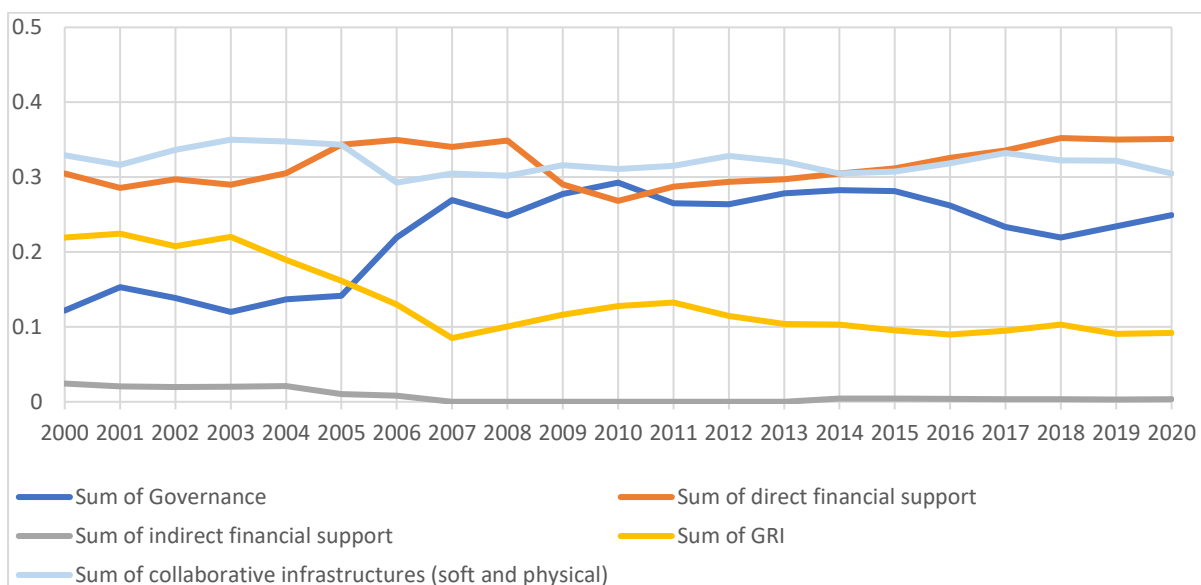
Trends in target actors

Large proportions of the Canadian and German STI policies in place from 2000-2020 have targeted supporting research and education institutes, as well as firms. In Canada, a comparable proportion has also consistently supported researchers, students and teachers.

Figure 8. Trends in German policy target actors from 2000-2020
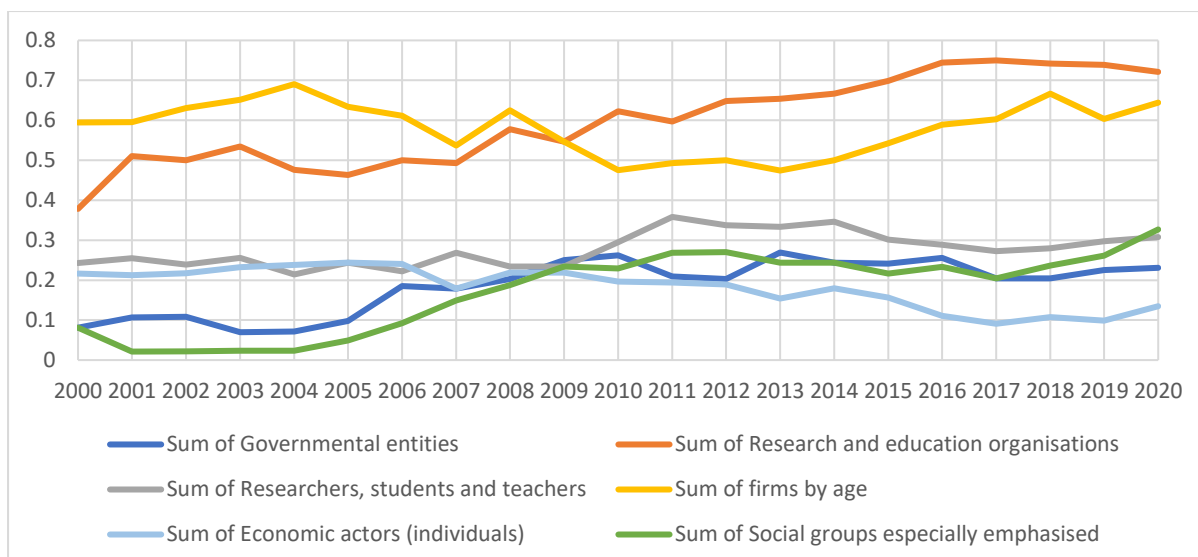
Note: Target actors noted in Figures 8 and 9 refer to direct beneficiary (target group) categories outlined in the STIP Compass data taxonomy. Firms by size and intermediaries have not been included.

Trends in the German target groups largely correspond to policy theme trends presented in Figure 4, with the most noticeable similarities evident between research and education organisations-public research system and social groups-research and innovation for society. Since introduction of the HTS, the proportion of German STI policies targeted to social groups has increased from 10% in 2006 to over 30% in 2020. This may be due to an increasing focus on integrating equity, diversity and inclusion into STI policy and soliciting the participation of the public in STI activities and policy development. At the same time, policies targeted to social groups have consistently made up 25-30% of the Canadian STI policy mix. Semantic analysis of the qualitative data also indicates that the proportion of Canadian policies focused on Indigenous Peoples surged from 2015-2019. This coincides with the release of the Truth and Reconciliation Commission's final report in December 2015, which detailed recommendations for the Government of Canada with the aims of acknowledging and addressing the legacy of the Indian Residential Schools system.[x]

Figure 9. Trends in Canadian policy target actors from 2000-2020
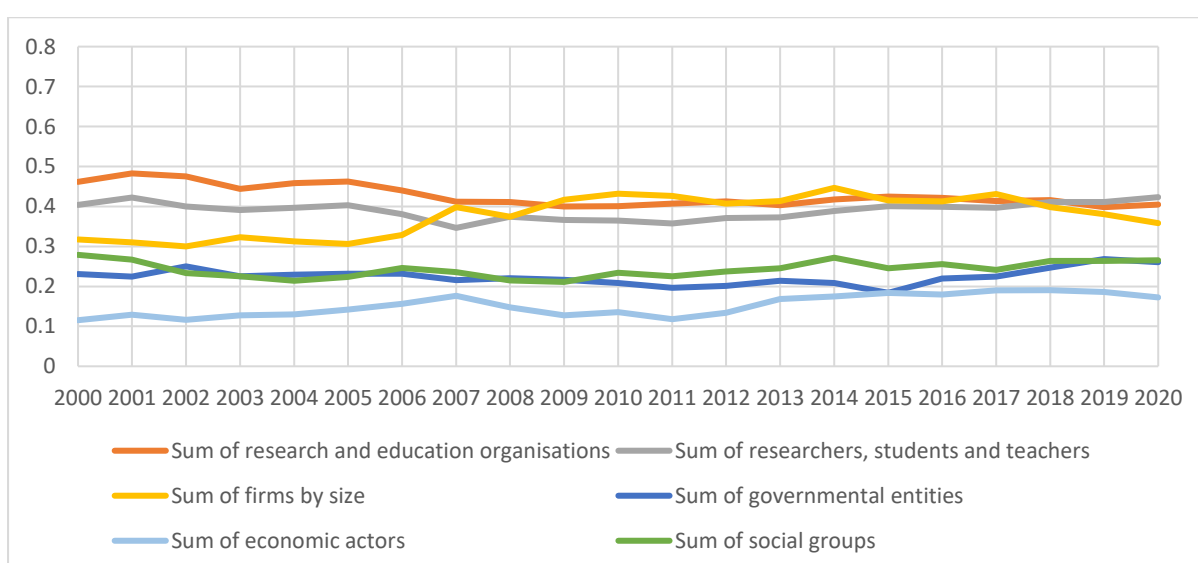
Conclusion

The exploratory exercise highlighted several barriers to mapping and analysing national STI policy histories. These included challenges in developing longitudinal datasets (e.g., differences in data taxonomies and data models used by different surveys, difficulty finding programme start and end dates, etc.) and limitations of the data (e.g., completeness, comparability, duplication and overlap, bias, and depth). While analysis across established datasets (i.e., STIP Compass, Outlook and Trendchart) is possible, analysts will need to clean the data to ensure that a common data model and taxonomy are applied. With the 2025 edition of the STIP Survey there will be five data points (from 2017-2025) aligned with the STIP Compass data model, which may also allow for the analysis of policies over a shorter timeline.

Despite limitations, results of the analysis provide several unexpected insights on how the German and Canadian STI policy mixes have evolved over the last 20 years. The Canadian policy mix has remained relatively stable regarding the composition of the policy mix by theme, instrument type, and target actor. Comparatively, the composition of the German policy mix has been more varied. It is possible to infer potential relationships between several noticeable changes in the policy mix composition and related changes to the German STI policy system. For example, an increase in the proportion of governance instruments and initiatives targeting social groups coincides with the introduction of the first Hightech Strategy in 2006.

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[i] Wilkinson, M. et al. (2016), "The FAIR Guiding Principles for scientific data management and stewardship", Scientific Data, Vol. 3/1, https://doi.org/10.1038/sdata.2016.18.

[ii] Kern, F. and M. Howlett (2009), "Implementing transition management as policy reforms: a case study of the Dutch energy sector", *Policy Sciences*, Vol. 42/4, pp. 391-408, https://doi.org/10.1007/s11077-009-9099-x.

[iii] Outlook and EU INNO-Policy Trendchart data is available for download via the STIP Data Lab website. Historical policy data dating back to 1999 is also searchable using the STIP Compass O.N.E. Sight search engine.

[iv] Schmidt, T. and S. Sewerin (2019), "Measuring the temporal dynamics of policy mixes – An empirical analysis of renewable energy policy mixes' balance and design features in nine countries", *Research Policy*, Vol. 48/10, p. 103557, https://doi.org/10.1016/j.respol.2018.03.012.

[v] Citation from page 14 of Wilts, H. et al. (2016), Benefits of resource efficiency in Germany, Wuppertal, https://epub.wupperinst.org/frontdoor/index/index/docId/6295.

[vi] Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (2016), *German Resource Efficiency Programme II: Programme for the sustainable use and conservation of natural resources*, BMUB.

[vii] Department of Finance Canada (2007), *The Budget Plan 2007: Aspire - to a stronger, safer, better Canada*, Public Works and Government Services Canada.

[viii] Department of Finance Canada (2006), *The Budget Plan 2006: Focusing on priorities*, Public Works and Government Services Canada.

[ix] OECD (2024), *INNOTAX: Tax Incentives for R&D and Innovation*, https://stip.oecd.org/innotax/ (accessed on 20 August 2024).

[x] Truth and Reconciliation Commission of Canada (2015), *Honouring the Truth, Reconciling for the Future*, Library and Archives Canada Cataloguing in Publication, https://ehprnh2mwo3.exactdn.com/wp-content/uploads/2021/01/Executive_Summary_English_Web.pdf (accessed on 20 August 2024).