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Research and Development Subsidies: A Need for WTO Disciplines?

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Rethinking International Subsidies Disciplines

Think Piece

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ABSTRACT

At first glance, it almost seems as if governments jointly have chosen to take an attitude of benign neglect toward research and development (R&D) subsidies because they see them as unlikely to harm competition, prefer to keep their policy spaces open in this domain, or as a legitimate domestic policy intervention. This sanguine view does not really hold water, however, for a few reasons. First, it is evident that R&D subsidization could distort trade, and cause injury to competition, depending on the volume of the support and the degree to which it facilitates final-stage market entry or expansion. Second, it is possible that competitive subsidization races among governments could emerge, resulting in an excessive amount of R&D support relative to some welfare norm. Third, implicitly excluding R&D subsidies from international scrutiny would raise dangers of policy failure, such as mislabeling more direct subsidies as R&D support. Fourth, R&D subsidies may be used as implicit protectionism in face of macroeconomic difficulties. Each of these factors calls for some form of agreed and enforced disciplines.

More broadly, the economic stakes in this area likely will rise going forward. Countries increasingly see the development and adoption of advanced technologies as critical for growth in productivity and employment. Developing countries in particular may wish to preserve policy space for R&D subsidies, defined broadly, hoping that their use will encourage higher-value industrialization. Another reason to anticipate increasing recourse to R&D subsidies is that countries at all development levels may wish to use them to deal with growing environmental pressures, including the need to address climate change. Thus, for example, governments may choose to subsidize adaptive R&D to assist local firms to acquire and implement international green technologies. Such policies could be painted as import-substituting interventions by firms concerned about losing export market shares. Yet another reason to expect rising activity in this area is a growing perception that particular countries, especially China, have successfully reinvigorated forms of industrial policy that have achieved targeted expansion in key industries. Included in this description are various supports, whether via direct subsidization or market preferences, of R&D costs within domestic enterprises. Numerous developing and emerging economies seem likely to try to follow this path. A more sophisticated variant of this idea is the increasing interest in forward-looking, targeted industrial policy focused on entrepreneurial discovery and support for regional technological specialization in dynamic market niches. A final observation is that an important premise on which potential disciplines against R&D subsidies are based may be outdated. Specifically, the idea that governments may subsidize R&D strictly on behalf of domestic interests may hold less water in the current world of distributed research and production networks. Consider, for example, the important expansion of global innovation networks (GINs), involving R&D and related activities spread across multinational facilities within firms, sharing such costs across multiple enterprises, and involving participation of universities, public laboratories, foundations, and non-governmental organizations (NGOs). Governments, especially in emerging and developing countries, may wish to facilitate linkages between such international networks and their own firms and researchers. Doing so may require a reconsideration of multiple policies regarding market access and R&D supports. In short, the "new industrial policy" advocated by many innovation economists and policymakers, combined with internationally distributed R&D and production networks, means that traditional views of the benefits and costs of subsidies to innovation are outdated in important respects. This situation is reinforced by the growing need of countries to deploy new technologies for addressing public interest problems.

These are subtle questions, suggesting that some reconsideration of R&D subsidy disciplines is in order—the issue this brief paper addresses. It discusses the basic economics of research subsidies, noting their justifications and potential pitfalls, before overviewing existing WTO practice in this domain and points out the need for additional clarity about the nature of actionable R&D subsidies. It then offer observations on potential dissonances between WTO rules and emerging international innovation models, and goes on to offer some suggestions about modifying the Agreement on Subsidies and Countervailing Measures to deal with public R&D support that has international competitive spillover effects.

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LIST OF ABBREVIATIONS

BERD	business enterprise research and development
DoD	Department of Defense
EU	European Union
GATT	General Agreement on Tariffs and Trade
GDP	gross domestic product
GINs	global innovation networks
IPRs	intellectual property rights
MNE	multinational enterprise
NASA	National Aeronautics and Space Administration
NGOs	non-governmental organizations
R&D	research and development
SCM	Subsidies and Countervailing Measures
TPC	Technology Partnerships Canada
US	United States
WTO	World Trade Organization

INTRODUCTION

The rules of the World Trade Organization (WTO) on permissible subsidization of research and development (R&D) costs traditionally have been permissive. In the first years of the Agreement on Subsidies and Countervailing Measures (SCM), R&D subsidies were included in the "green light" category, meaning they were presumed not to distort trade and therefore were not actionable. Other green-light subsidy areas included regional development assistance and support to comply with environmental laws. These provisions were controversial, however, and the green-light category was allowed to lapse in 2000. Since then, R&D subsidies have been in the amber-light grouping, meaning that they are actionable, either by dispute settlement or unilateral countervailing duties, subject to the demonstration that the subsidies met certain criteria and had injurious effects on another WTO Member.

Despite this change to a more vulnerable legal status, R&D subsidies have been the subject of relatively little WTO enforcement. The few cases, discussed further below, that pay attention to the issue are disputes involving subsidies to aircraft development. However, these cases do not seem to settle whether R&D subsidies per se are a source of injury or prejudice to economic interests. Neither do there seem to be cases in which R&D subsidies specifically were the subject of countervailing duties by a WTO Member. The entire area of disciplines on R&D subsidization, therefore, seems rather unsettled within the WTO. This situation is similar to legal practice in the United States (US), where Congress rarely intervenes in state-level subsidization of enterprises in general, much less in R&D costs (Sykes 2010). The European Union (EU) takes a more aggressive stance toward disciplining state aids, but there is little record in this regard concerning R&D subsidies.

It is tempting to conclude from this basic review that governments jointly have chosen to take an attitude of benign neglect toward R&D subsidies, because they see them as unlikely to harm competition, prefer to keep their policy spaces open in this domain, or see them as a legitimate domestic policy intervention. This sanguine view does not really hold water, however, for a few reasons. First, it is evident that R&D subsidization could distort trade, and cause injury to competition, depending on the volume of the support and the degree to which it facilitates final-stage market entry or expansion. Second, it is possible that competitive subsidization races among governments could emerge, resulting in an excessive amount of R&D support relative to some welfare norm. Third, implicitly excluding R&D subsidies from international scrutiny would raise dangers of policy failure, such as mislabeling more direct subsidies as R&D support. Fourth, R&D subsidies may be used as implicit protectionism in face of macroeconomic difficulties. There is anecdotal evidence that governments resorted to the use of both R&D subsidization and broader supports to particular sectors during the financial crisis (see Aggarwal and Evenett 2010 for descriptions of R&D policies' and Horlick and Clarke 2010 for a more general analysis). Each of these factors calls for some form of agreed and enforced disciplines.

More broadly, the economic stakes in this area likely will rise going forward. Countries increasingly see the development and adoption of advanced technologies as critical for growth in productivity and employment. Developing countries in particular may wish to preserve policy space for R&D subsidies, defined broadly, hoping that their use will encourage higher-value industrialization. A tradeoff arises, however, for an overly permissive approach may encourage extensive subsidization programs by wealthier countries. That competition could make it more difficult for poorer, resource-constrained nations to mount their own strategies, perhaps increasing their distance from the technological frontier.

Another reason to anticipate increasing recourse to R&D subsidies is that countries at all development levels may wish to use them to deal with growing environmental pressures, including the need to address climate change. Thus, for example, governments may choose to subsidize adaptive R&D to assist local firms to acquire and implement international green technologies. Such policies could be painted as import-substituting interventions by firms concerned about losing export market shares.

Yet another reason to expect rising activity in this area is a growing perception that particular countries, especially China, have successfully reinvigorated forms of industrial policy that have achieved targeted expansion in key industries. Included in this description are various supports, whether via direct subsidization or market preferences, of R&D costs within domestic enterprises, particularly in China (Aghion et al. 2011 make this point in justification of a newly active industrial policy). Numerous developing and emerging economies seem likely to try to follow this path. A more sophisticated variant of this idea is the increasing interest in forward-looking, targeted industrial policy focused on entrepreneurial discovery and support for regional technological specialization in dynamic market niches (Rodrik 2004; Foray 2010, 2015).

A final observation is that an important premise on which potential disciplines against R&D subsidies are based may be outdated. Specifically, the idea that governments may subsidize R&D strictly on behalf of domestic interests may hold less water in the current world of distributed research and production networks. Consider, for example, the important expansion of global innovation networks (GINs), involving R&D and related activities spread across multinational facilities within firms, sharing such costs across multiple enterprises, and involving participation of universities, public laboratories, foundations, and non-governmental organizations (NGOs) (Maskus and Saggi 2013 analyze such forms in terms of

potential for enhancing technology creation and diffusion). Governments, especially in emerging and developing countries, may wish to facilitate linkages between such international networks and their own firms and researchers. Doing so may require a reconsideration of multiple policies regarding market access and R&D supports.

In short, the "new industrial policy" advocated by many innovation economists and policymakers, combined with internationally distributed R&D and production networks, means that traditional views of the benefits and costs of subsidies to innovation are outdated in important respects. This situation is reinforced by the growing need of countries to deploy new technologies for addressing public interest problems.

These are subtle questions, suggesting that some reconsideration of R&D subsidy disciplines is in order, the question I address in this brief paper. In the next section I discuss the basic economics of research subsidies, noting their justifications and potential pitfalls. The third section overviews existing WTO practice in this domain and points out the need for additional clarity about the nature of actionable R&D subsidies. In the fourth section I offer observations on potential dissonances between WTO rules and emerging international innovation models. The last section offers some modest suggestions about modifying the SCM to deal with public R&D support that has international competitive spillover effects.

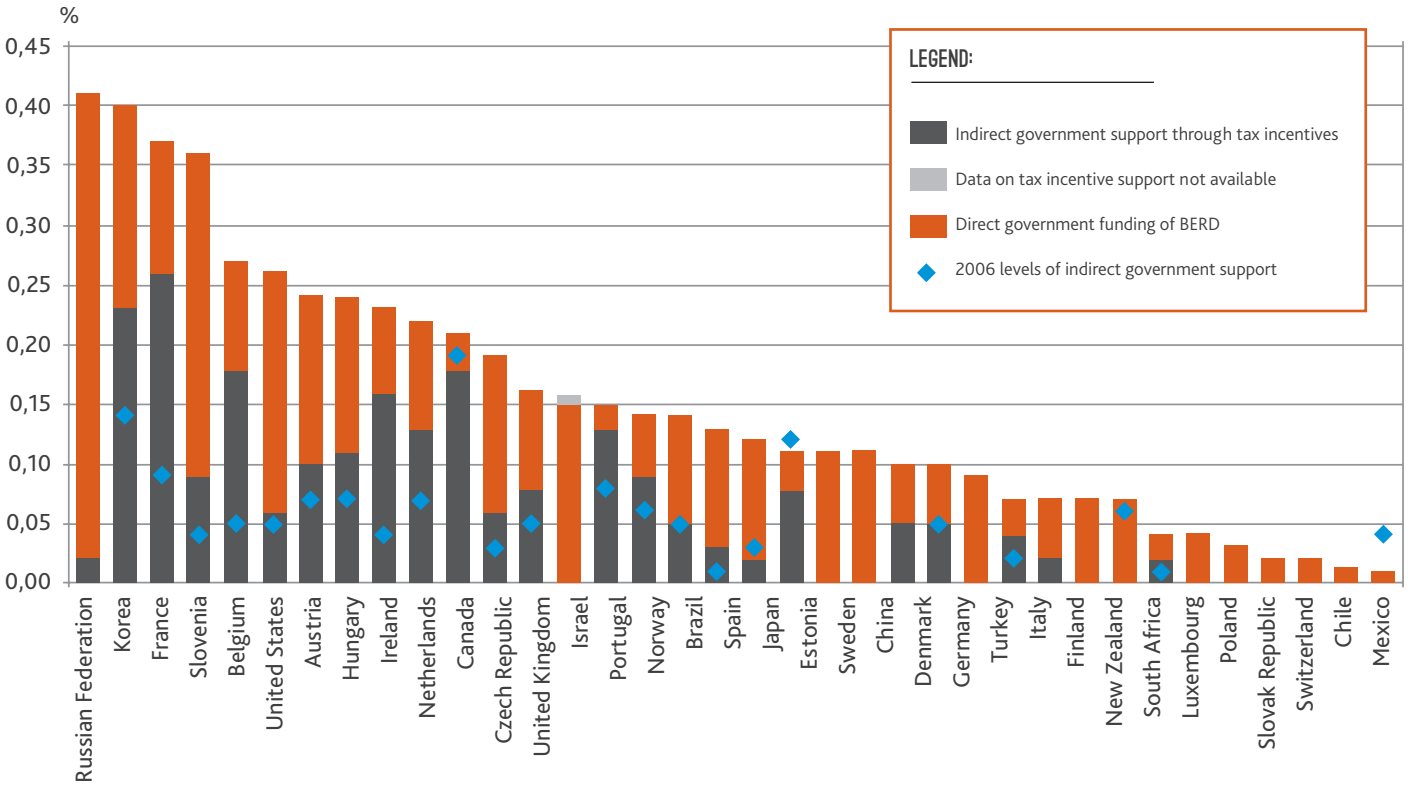
BASIC DATA AND THE ECONOMIC ISSUES

There is a large variation across countries in the extent of public support to private research. As shown in Figure 1, in 2012, total government support for business enterprise research and development (BERD) ranged from about 0.4% of gross domestic product (GDP) in the Russian Federation and the Republic of Korea to virtually zero in Mexico (OECD figures, covering both members and a number of additional countries). This support comes both as direct payments and indirect benefits through R&D tax incentives. Korea, France, Ireland, Canada, and Australia rely heavily on the

FIGURE 1:

Business Enterprise Research and Development, Direct and Indirect Government Support, 2012 and Indirect Government Support, 2006 (Or nearest year, percentage of GDP)

Source: OECD Science, Technology, and Industry Scoreboard (2013).



latter approach. It is interesting to note in Figure 1 that 16 countries saw the value of these tax incentives (relative to GDP) rise from 2006 to 2011, suggesting that the fiscal crisis and ensuing problems may have increased public interest in such indirect support, or at least in sustaining R&D expenditures in the recession (2006 levels are shown as diamonds). In any event, whatever WTO rules may be relevant in this context did not reduce support over this period.

The economic argument for public support of private research is straightforward (generally attributed to Arrow 1962, but the idea is far older, as are such subsidies; Maskus 2006 expands the argument in a global context). It may be expensive to invest in the R&D needed to develop a new technology or product. The knowledge generated through R&D, however, is essentially a public good in that it is non-rival in use and may be difficult to exclude others from using it. In the absence of some research support or protection for the resulting information, private agents will underinvest in such knowledge relative to the socially optimal rate. Society may suffer a considerable dynamic loss in that fewer technologies and new products reach the market over time. Put differently, the social returns to R&D tend to be considerably higher than the private returns, a claim that is well supported empirically, both in the aggregate and for many types of goods. In short, the private market fails to organize sufficient incentives to procure optimal levels of research investments and knowledge products, and pathways to them.

This general observation takes on new salience in light of recent thinking about industrial policy. Many innovation specialists contend that the key to industrial transformation and growth is facilitating "entrepreneurial discovery," in which entrepreneurs and innovators experiment with developing new solutions for specific market problems, often supporting niche discoveries. However, in contexts with limited financial development and extensive imitation capacity, as may be found in many developing economies, the appropriability problem can be severe and potential entrepreneurs may choose not to undertake the discovery risks.

There are, in principle, four means of overcoming this market failure. First, on the demand side, the government may attempt to raise the excludability of knowledge through granting intellectual property rights (IPRs), or limited exclusive rights to make, distribute, or use new technologies and products, to inventors and creators. These rights may solve the dynamic innovation problem but at the potential costs of limited user access and could raise barriers to follow-on inventions. Moreover, in the context of "entrepreneurial discovery," it is likely inappropriate to use broad patents or other formal exclusion rights since the dynamic innovation process benefits from relatively easy imitative entry.

Second, the government might prefer to sustain widespread access by awarding publicly funded prizes or market guarantees to the first to develop a successful new product, while not awarding exclusive rights. Each of these approaches bears its own difficulties. The scope of, and limitations on, IPRs are difficult to tailor to specific industry needs, and may offer either not enough protection or too much protection to induce appropriate invention streams. Adequate market guarantees and prizes are also challenging to determine ex ante, while the fact that they reward just one inventor can set up inefficient and duplicative research programs.

Third, on the supply side, public authorities may choose to foster research directly through its own investments, either through publicly funded laboratories or research grants to university scientists. In general one would expect such funding to be aimed at basic research questions, the results of which may or may not be broadly applicable to many follow-on innovative products. Basic research suffers the most from the externality mentioned above—its results are not easily excludable (nor should public policy strive to make them so) and have the highest social returns, making its organization by purely private firms largely infeasible.

Finally, the government may offer direct or indirect subsidies to the R&D efforts of private firms intending to sell their new products or technologies in the marketplace. Such subsidies may be justified on a number of grounds, such as helping firms overcome barriers in testing and compliance, reducing risk aversion on the part of private financial markets, and providing breathing space as firms grow and build a market.

It is primarily this last form of subsidization that potentially raises issues of trade conflict. Where public resources pay for what might ordinarily be thought of as private product development costs, particularly for entering foreign markets or expanding international market shares, there may be trade damages alleged. Research subsidies, in some circumstances, could act as a substitute domestic protection mechanism as tariffs are cut (Caiado and Berghaus 2012). They could also reduce a home firm's costs or raise its productivity, expanding its trade at the expense of other competitors. In extreme cases, such subsidization could act to forestall entry by international competitors, potentially raising issues about whether it is anti-competitive.

More formally, a coordination problem can arise, potentially calling for international agreements (Bagwell and Staiger 2002). Governments acting to maximize domestic welfare (or reacting to domestic political economy pressures) will not take into account the impacts of their R&D subsidies on foreign prices or profits. Left unchecked, governments would individually pay subsidies that are excessive relative to what would be jointly optimal, even accounting for any information spillovers that might exist. In a dynamic environment, authorities could engage in a strategic subsidies game to the extent that temporary domestic profit advantages may be extended through taking business from foreign competitors (Impullitti 2007). In either case, an argument arises for a coordinated solution to avoid excessive subsidization.

A further problem, of course, is that arguments for intervention to subsidize R&D presume that governments are particularly able to recognize unexploited opportunities to develop beneficial technologies, where markets may not. However, the decisions of authorities may be subject to political capture, generate costly rent seeking, or other forms of policy failure. In this sense, a set of agreed disciplines act as a commitment device to prevent ill-advised subsidy policies.

WTO RULES AND JURISPRUDENCE

The last paragraphs describe the prevailing public wisdom about the potential dangers of competitive subsidization. In practice, these arguments apply most directly to subsidies that directly encourage excessive production or stimulate exports, which most readily generate trade conflict. It is useful to review briefly what the existing SCM rules and formal disputes say about R&D subsidies.

As noted above, the SCM Agreement originally determined that R&D subsides were in the green-light category but they have been actionable since 2000. The SCM sets out two principles determining whether action against a subsidy may be taken. First, for support to constitute a subsidy it must be a financial contribution made by a government, sub-national government, or other public body that confers a benefit to its recipient. Financial contributions may come in many forms, including grants, loans, equity injections, tax incentives, the provision of goods and services, and procurement contracts. A "benefit" is typically construed to be an advantage that would not be available in the marketplace to the recipient. Second, any policy meeting this definition of subsidy is subject to SCM rules only if it is specifically provided to an enterprise, industry, or group of enterprises or industries. The notion is that specificity is necessary to demonstrate a misallocation of resources, for if a subsidy were widely available in the economy, it would not generate a significant allocative effect in production or exports. Note that these provisions apply to all potentially actionable subsidies, including those paid to support R&D, environmental protection, or regional development. A final observation is that subsidies paid contingent on export performance or on the use of domestic goods over imports are prohibited by the SCM. It is conceivable that certain R&D subsidies could be construed in this way, as in the Canada-Aircraft case below.

Despite their coverage in the SCM, R&D subsidies have rarely been subjected to WTO scrutiny. Just three cases, all involving aircraft, have addressed the issue. These are the dispute brought by Brazil to contest Canada's subsidization of a regional aircraft producer and the two-way set of Boeing-Airbus disputes between the US and the EU, discussed further below.[1]

The concentration on aircraft is not surprising in that the industry involves high entry costs and huge investments in both R&D and physical capital. Moreover, aircraft production requires intermediate inputs, many of them also high technology, from a wide array of suppliers. This means that aircraft subsidies could have broader impacts on technology development and employment, with the potential for large spillovers. As such the industry has been an obvious target for strategic interventions by governments in countries capable of marshaling the necessary resources. Indeed, China and Russia heavily subsidize their domestic aircraft industries and both have plans to enter the market for large civil aircraft.

It is instructive to extract whatever lessons these cases offer about how WTO dispute settlement bodies interpret subsidies in the R&D space (for more extensive analyses, see Shin and Lee 2013; Horlick and Clarke 2010; Kienstra 2012). The Canada-Aircraft case arose from the competitive rivalry between Canada's Bombardier and Brazil's Embraer, both manufacturers of smaller civilian passenger aircraft for regional transport. Brazil filed a WTO complaint in 1997 alleging that Canada was offering R&D subsidies to its aircraft industry that amounted to illegal export subsidies. Specifically, the Technology Partnerships Canada (TPC) program offered loans for investments in projects resulting in high-technology products for export, with repayment required only in the event of successful development. Brazil argued that this amounted to an R&D subsidy that effectively subsidized exports, given its targeted nature. Canada countered that the TPC was offered to all potential high-technology sectors and was therefore not specifically targeted, meaning it did not violate the specificity requirement of the SCM. The WTO Panel found that the program was an impermissible export subsidy because it entailed a financial contribution, conferred an economic benefit, and was effectively contingent on exports. This ruling was largely upheld by the WTO Appellate Body and Canada was instructed to change the terms of its support programs.

The EC-Aircraft and US-Aircraft cases arose from a decades-long dispute between the rivals and their governments, at one point culminating in the 1992 Agreement on Trade in Civil Aircraft. That agreement set out certain benchmarks for maximum R&D support but failed to avoid an accelerating bilateral dispute in subsequent years. In its 2004 WTO complaint the US claimed that the EU (and particular member countries) had violated the General Agreement on Tariffs and Trade (GATT) 1994 and the SCM through a panoply of subsidies to Airbus, including launch aid, support

1 DS 222, *Canada – Export Credits and Loan Guarantees for Regional Aircraft; DS 316, European Communities and Certain Member States – Measures Affecting Trade in Large Civil Aircraft* (6 Oct 2004); and DS 317, *United States – Measures Affecting Trade in Large Civil Aircraft* (6 Oct 2004), and DS 353, *United States – Measures Affecting Trade in Large Civil Aircraft (*Second Complaint; 27 June 2005).

for facilities development, debt forgiveness, preferential loan terms, equity infusions, and loans and grants for R&D costs. At the same time, the EU countersued, claiming that Boeing's research costs were effectively subsidized through contractual arrangements as a supplier of aeronautics and related technologies to the National Aeronautics and Space Administration (NASA), the US Department of Commerce, and the Department of Defense (DoD).

The WTO Panel in EU-Aircraft found that many of the alleged R&D subsidies from national and sub-national European governments were specific as defined by the SCM. These were financial grants and loans targeted directly at Airbus and its suppliers. These were found also to have conferred a benefit to their recipients because the terms were more favorable than those available in the market. However, the Panel's determination of whether the US-based "like products" (Boeing aircraft) suffered material injury or US interests suffered serious prejudice through such elements as trade diversion and price suppression focused on the totality of the specific subsidies, rather than the R&D components.

The Panel in US-Aircraft found that Boeing had received actionable R&D subsidies through its procurement contracts with NASA and DoD and that these had caused serious prejudice to EU interests. Among other things, these arrangements offered contracts and grants and access to public research facilities to Boeing in return for performing research related to civil aircraft. In effect, Boeing was both the recipient of the support and the beneficiary of the research results. Similarly, Boeing benefited from a DoD procurement contract supporting research into technologies of use for both military aircraft and civil aircraft. The Appellate Body largely upheld the Panel report, agreeing that EU interests had suffered serious prejudice in the form of lost sales and price suppression and here tied these effects in part to the R&D subsidies.

In summary, one can ascertain some principles from these cases. First, R&D support that is specific and contingent on export performance is presumably an illegal export subsidy, though perhaps not subject to unilateral countervailing responses. Similarly, from Canada-Aircraft, it appears that R&D subsidies to projects that are near-market ready with high export potential are problematic. Second, in EC-Aircraft the determination suggests that direct financial supports to R&D in a specific industry, both at the national and sub-national levels, are held illegal. Third, also illegal are indirect supports in the forms of highly specific procurement contracts and project assistance in R&D, in which the contract recipient is likely also to be the main beneficiary, as in US-Aircraft.

These principles are useful in understanding how the WTO views R&D subsidies under the existing SCM Agreement. The essential findings in Canada-Aircraft, that exports cannot be effectively linked to R&D subsidies, and in US-Aircraft, that R&D procurement arrangements and contracts cannot exist primarily to benefit the contract recipient, seem reasonable and appropriate. They discipline policies that may cause direct trade damage or offer an undue competitive advantage. They do not seem to preclude other approaches to R&D support that might be contemplated by developing countries seeking to take advantage of new approaches to industrial policy, as discussed next. Similarly, the finding in EC-Aircraft, that direct grants and generous loans offered to a specific company and its suppliers were actionable, seems unobjectionable on its face.

The lack of WTO complaints about R&D subsidies and the limited scope under which they are found to be violations in these cases suggest that countries retain considerable space to support private research. Indeed, the primary conclusion to reach in this area may simply be that WTO rules do not impede research support programs except those clearly aimed at inducing exports or those that provide highly specific and identifiable benefits to a particular enterprise and its suppliers. As such policies would run afoul of basic SCM principles in any case, it is difficult to discern any specific roadblocks to R&D subsidies outside these narrow limits.

NEW CHALLENGES

This rather optimistic interpretation may, however, run into challenges going forward. As noted earlier, there are (at least) three emerging and interrelated technological trends that may push policymakers to push against these limits in substantive ways—the need to address public goods problems, such as environmental challenges; the establishment of global innovation networks; and increasing interest in a reinvigorated form of industrial policy. All of these may be seen as viable means of building industrial and technological capacity, especially in emerging and developing countries. The next section discusses these trends and asks whether they might collide with WTO restraints.

PUBLIC GOODS AND TECHNOLOGY TRANSFER

There are mounting needs in emerging and developing countries to effectively address a number of pressing social problems—public health, education, environmental protection, and others.

The area most closely related to the issue of public subsidization of R&D is the environment, especially efforts to combat climate change. As discussed elsewhere, the primary medium-term avenue toward achieving such goals is for developing countries to import newer technologies that may be adapted to local needs (Maskus 2010; Glachant et al. 2013). There are a number of barriers to effective

cross-border green technology transfer, but of particular concern here are two basic facts. First, much like the problem of essential medicines, the potential market demands for effective green technologies in poor countries may be insufficient to encourage the private R&D needed to address environmental degradation. Second, even if such technologies were available, private firms in developing countries may lack the resources and capacity to acquire and adapt them. Localized adaptation is critical because there are micro differences in climate conditions, soil characteristics, the carrying capacity of water resources, commodity preferences, and other factors. Investments in adoption and adaptation may require substantial fixed costs that deter local firms from upgrading their techniques in ways that reduce environmental damages.

These dual market failures—inadequate innovation incentives and costly adaptation—call for policy intervention, the most direct and effective of which is likely to be direct subsidization. In principle, the innovation problem might be solved by cooperative global financing mechanisms aimed at paying R&D costs, offering prizes, or other mechanisms. The wide heterogeneity of technological needs relevant for environmental protection, however, raises difficulties for this approach, the resolution of which may require public grants to development costs in specific countries or regions. While it is conceivable that such support could be construed by WTO partners as specific subsidies with export potential, this outcome seems unlikely if the support is focused on primary research in designated problem areas or typologies.

The adaptation problem, however, is, almost by definition, specific to locations and even firms. Here one could imagine a situation in which a government pays a portion of the costs of a domestic agrobiology firm to purchase a water-saving or low-pesticide seed variety and undertake the experimentation needed to modify the variety for local conditions. Other possibilities could entail subsidizing the costs of adapting the battery of electric motorcycles to prevailing humidity gradients, and lending public funds to purchase the specialized machinery needed to produce energy-saving wearable fabrics.

Would such policies violate SCM rules? As described, they are specific to particular industries or firms and could generate a cost advantage that would expand exports and damage the interests of competitors abroad. Thus, they seem potentially actionable under existing rules. The question becomes articulating or reinforcing a set of principles under which subsidies would be presumably exempt from disciplines, even if disputes may be needed to ascertain that status in particular cases. In the context of green technology adaptation, those principles might be built on three questions. First, how localized is the need for technology adoption? The more localized this need, the more lenient we would imagine the policy discipline, for the subsidy would then be aimed at covering a fixed cost in a limited market with presumably little export spillover potential. Second, is the primary intent of the subsidy to address a clearly defined environmental problem, rather than export support? Third, is access to the research subsidy open and available on a competitive basis? Indeed, one useful approach to such subsidization in green technologies is for governments to stage competitions for grants, with applicants demonstrating a clear need and a potentially successful market (Maskus 2010 describes how such grants might be structured).

GLOBAL INNOVATION NETWORKS

In narrow terms, the concept of GINs refers to the establishment of multiple R&D facilities at different locations within a multinational enterprise (MNE). This globalization of innovation is efficient in permitting enhanced R&D management, specialization, and exchange of information among affiliates and parent (OECD 2008). The recent growth of these networks has paralleled that of vertical production chains as MNEs find numerous ways to geographically specialize their activities. It is easy to see from Figure 2 that a significant share of national R&D in many countries is sourced from abroad, attesting to this globalization.

More broadly, innovation networks incorporate many actors, including MNEs (which may collaborate in R&D), high-technology startups, universities and public research laboratories, venture capitalists, specialized technology brokers, standard-setting organizations, and government agencies. These networks emerge as different participants recognize the gains from research specialization and collaboration (for example, in licensing, public-private partnerships, and international research alliances). These broader networks have multiple commercial and public objectives, ranging from basic revenue to knowledge creation and the solution of global public problems requiring complex research investments. Figure 3 shows that, especially within emerging countries, a notable share of R&D funding comes from international organizations and universities.

Government policymakers in many countries increasingly see attachment of their institutions and enterprises to GINs as key sources of competitiveness, growth, and technology transfer (Ernst 2006). Authorities in developing countries might wonder how to encourage their own enterprises (or even universities and technical workers) to participate in these networks to generate both inward technology flows and more domestic innovation. To be sure, this question relates primarily to the broader economic and investment climate, governance, and trade, human capital, and labor market policies. In at least two circumstances, however, one can imagine governments engaging in certain forms of R&D subsidization related to GINs. First, national and sub-national authorities may offer support to share the costs of building research facilities, acquiring laboratory equipment, and training local professionals, much as happens with US state-level subsidies to the location of production facilities. Second, there is solid evidence that international circulation of technical workers, both within MNEs and

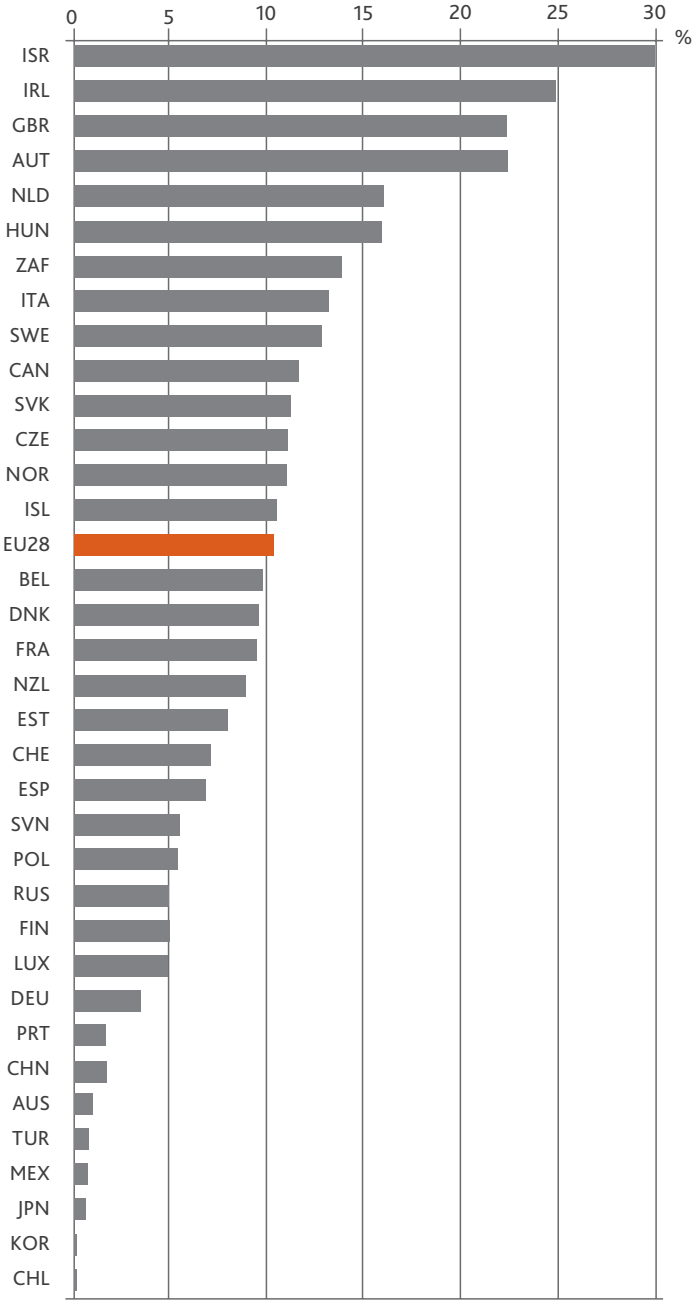


FIGURE 2:

Business Enterprise Research and Development Funded from Abroad, 2011.

Source: OECD Science, Technology, and Industry Scoreboard (2013).

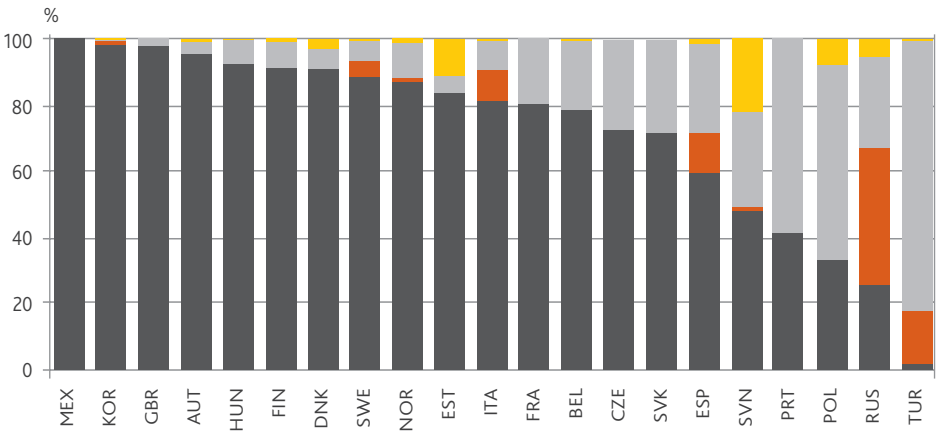


FIGURE 3:

Business Enterprise Research and Development by Source of Funds from Abroad, 2011

LEGEND:

- Foreign business enterprises
- International organisations
- Government and higher education
- Other / Not elsewhere classified

Source: OECD Science, Technology, and Industry Scoreboard (2013)

across scientific and technical institutions, is a significant source of technology diffusion to developing countries. Thus, authorities may wish to facilitate such mobility of their own countries' workers through travel grants and salary contributions, even within private firms, which might be viewed as a specific R&D subsidy.

Again, would such policies attract potential SCM disciplinary disputes? In principle, support for research facilities and training should escape concerns at the WTO unless the subsidized programs were directly targeted at specific MNEs or the research support was thinly disguised to incentivize exports, whether within the firm or to arm's length markets. Some vigilance may be warranted to avoid outright mercantilism in this context, but a position of forbearance seems sensible for generally available programs aimed at integrating an economy's research structure with GINs. With respect to labor mobility subsidies, they seem unlikely to be overly specific and any connection to exports would seem indirect and should, therefore, escape WTO scrutiny.

Indeed, laxity in this area seems justified for at least two economic reasons. First, the knowledge and information, even if quite applied, generated in GINs is likely to migrate across borders by the very nature of innovation networks. Here, local subsidies can generate international technology gains that could well exceed short-term costs to rivals. Second, given the ability of skilled labor circulation to generate information spillovers and build local technical capacity, there is a similar non-market payoff to mobility support, perhaps especially in GINs involving both private and public initiatives.

NEW INDUSTRIAL POLICY

The idea of a reconstituted "new" industrial policy finds its origins among economists in the influential work of Hausmann and Rodrik (2002), who explained economic development as a process of self-discovery. Their insight is that economic development is an uncertain process in that developing countries may not know what they may be good at producing in the early stages of industrialization or transformation into modern sectors. In this context, a period of "self-discovery" regarding domestic costs can be socially valuable for it permits potential entrepreneurs to experiment in areas of technology acquisition, adaptation, and innovation. However, such activities are likely to be readily imitated, implying that developing countries are likely to engage in too little ex-ante investment and entrepreneurship and too much fragmentation ex post. Their policy prescription is to encourage experimentation through both forms of appropriability (not necessarily strong IPRs) and public supports, while finding means of rationalizing and concentrating the production mix after the process matures.

While the empirical evidence and generalizability of these ideas remains subject to considerable debate among economists, they have led directly to increasing proposals for countries to engage in newer forms of industrial policy, focused primarily on R&D, entrepreneurship, discovery, and vertical targeting of new technologies.[2] The leading example of this approach is an extensive proposal for the EU to engage in "smart specialization," which means using policies to encourage innovation and entrepreneurship at the activity level, with a primary objective of building industry specialization in various locations through dynamic agglomeration economies (see Foray et al. 2009; Foray 2010 for summary descriptions of the approach). Smart specialization aims to prioritize R&D and technology development in particular sectors, fields, and locations while sustaining basic entrepreneurial incentives in product and technology markets. The emphasis is on vertical concentration of policy resources through full complexes of prioritized sectors, supporting R&D and innovation in several stages of design and production. The policy is described as "smart" in that well-designed policies could facilitate the realization of economies of scale and scope, while capturing key technology spillovers within and across agglomerated regions. The intent is to achieve both efficient R&D specialization and at least localized knowledge diffusion by supporting applied technological activities near basic research facilities, such as universities, public research labs, and entrepreneurial accelerators.

Any R&D-focused industrial policy faces evident risks, including duplicating effort, wasting resources, and private rent capture. Smart specialization emphasizes five principles to overcome these risks—(1) prioritize activities where local entrepreneurs have already discovered dynamic opportunities; (2) focus on whole technological activities rather than narrowly defined horizontal sectors; (3) encourage modernization of industries in ways that could achieve structural evolution and diversification of regional economies; (4) place time limits on the public support; and (5) undertake serious evaluation of policy results (Foray 2010). If designed properly, advocates argue, this approach should facilitate the emergence and growth of new activities that will support multiple innovations and extensive spillovers, modernize and diversify local economies, and establish important technological networks and clusters.

While this approach is gaining policy momentum in the EU, it has yet to be implemented. Variants of it may be found in policy prescriptions for encouraging local innovative activities and spillovers in the development policies of many economies. Whether widespread success in this regard is achievable is an open question, with its likelihood depending on numerous factors such as market size, preferences, endowments, and the coherence of R&D policies within a complex structure of legal and economic influences. The primary point for the analysis in this paper is that smart

2 Aghion et al. (2011), for example, call for the European Commission to target growth in green technologies and high-technology sectors, while reaching a better accommodation among state aids, subsidies, and competition policy.

specialization is a leading example of growing international interest in using public resources to induce technological development and related spillovers. This situation directly suggests that R&D subsidization is likely to increase in importance going forward.

REVISITING SUBSIDY PRINCIPLES

As noted earlier, the relatively relaxed position of WTO rules regarding R&D subsidies—in essence that actionable support needs to come directly from public resources, confer a specific benefit, be paid to near-market ready projects, and/or be conditioned on growing exports—provide a sensible policy foundation. In my view, one should be cautious about disrupting this apparent equilibrium.

At the same time, the new challenges described in the last section potentially raise concerns about the consistency with even these basic rules of R&D supports erected to address them. Would a green subsidy to adopt new technology in an exportable crop be permitted? What about a sub-national grant to a multinational firm to establish an R&D facility in a particular city to improve the quality of inputs that get traded within and across production networks? What about a subsidy made available within a region to firms that agree to adopt and implement a production process derived from a nearby nanotechnology complex, itself subsidized? With such issues in mind, what might be suggested as useful principles for WTO subsidy rules, as a coordinating device, in limiting the trade damages from such policies without unduly restricting desirable development incentives? This is a complicated question, with room for further thinking and research. At this point, however, the following principles seem worth advancing.

First, it seems important to assess the primary intention of a subsidization program. Support policies that clearly intend to expand exports directly or replace imports should remain unavailable. But support that has a primary intention of solving a recognized environmental problem or linking domestic firms and research organizations with international networks, even if they indirectly expand export capacity, are aimed at resolving market failures. While governments need to transparently announce and demonstrate such aims and outcomes, these subsidies addressing externalities should, in most cases, escape WTO scrutiny.

Second, it seems useful to clarify further what the concept of specificity means. A direct subsidy to, or research contract with, a beneficiary firm remains inappropriate, as does fiscal support for R&D to horizontal competitors within a prescribed industry. However, where the subsidies and other support, such as infrastructure and laboratory buildings and equipment, aim to develop and modernize industrial activities around the adoption of a general purpose technology, they should not be held specific in the SCM sense. Such policies are the essence of smart specialization and also can help build attachment to GINs.

Third, there should be assurances that the subsidies in question aim truly at mitigating market failures or establishing long-lasting research and technical capabilities, rather than propping up inefficient production in the short term. In this context, governments announcing an intention to subsidize should justify their actions by setting out clear guidelines and benchmarks for success, while limiting the length of time during which subsidies will be paid. Subsidization programs should be subject to rigorous ex-post evaluation procedures, both to find out what works and to assess effects on domestic and international competition.

Fourth, one strong indication of whether a subsidy program is protectionist, or aims at addressing market and technological problems, is its openness to competition. In the realm of public research grants, many have argued for opening a proposal competition to international teams of researchers to increase scientific and technological efficiency (see Maskus 2010; Maskus and Saggi 2013 for a discussion). Competition is equally important at the applied and adaptive levels of research. Thus, subsidy awards might be made based on open competition among firms with experience in particular areas, and who have already developed relevant research findings and demonstrated applicability.

CONCLUDING REMARKS

Since 2000, R&D supports have been actionable in principle, but rarely challenged in fact. Only in the aircraft industry, where major subsidies to cover large fixed R&D costs and where exports are natural outcomes of large-scale production, have they been found problematic to date. This bespeaks a fairly relaxed attitude to most subsidies, even those that seem to support late-stage development activities. It may be that this attitude reflects awareness that R&D subsidies can be usefully deployed to address a variety of market failures—lack of appropriability, a need to address public goods problems, local economic development, and the like. In that context, a general approach favoring policy sovereignty remains sensible except where there are clear cross-border economic damages arising from a specific and protectionist subsidy.

As noted here, however, there are reasons to anticipate increasing use of R&D supports going forward, whether to develop, attract, and adapt climate change technologies, integrate domestic firms with GINs, or encourage localized specialization in technological activities. Some subsidies for these reasons may be protectionist and others may be legitimately aimed at market difficulties. The latter two areas in particular may not have been anticipated by the drafters of the SCM Agreement. Thus, the question of whether the WTO framework for disciplining R&D subsidies should be enhanced is not straightforward.

In this paper I have set out a few basic principles that might be beneficially used to sort out damaging and inappropriate subsidization from more properly designed programs. Whether such principles should be written into a revised agreement, or kept as guidelines for WTO (and other) jurisdiction, is far from clear. My preference would tilt toward the latter.

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