Innovation Agencies: The Road Ahead

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Project Outline

I. Overview and Justification

      In spite of a spike in income from agricultural and mineral commodities in the early 2000s, Latin American countries have generally faced stagnating incomes and levels of productivity in recent years. Moreover, total factor productivity (TFP) has only marginally increased in the best of cases, even with some growth in labor and capital (IDB 2014). Figure 1 shows the regional stagnation in TFP; by contrast, over the same period pictured the advanced OECD economies have grown at a steady one percent per year.[1] Similarly, by most other standard measures of innovation (numbers of patents, for example), Latin American countries are global underperformers. Of course, countries in the region typically devote little of their national income – generally under half of one percent of GDP – to innovation-oriented activities, such as research and development (Figure 2; World Development Indicators). OECD average, by contrast, is nearly 2.5 percent.

      Latin American countries have been aware of these trends and, in fact, most of the large countries in the region *do* have a national innovation agency whose goal it is to promote innovation, knowledge, and productivity growth. Several of the agencies even date back to the 1960s. The puzzle is that, in spite of the presence of these agencies, countries in the region continue to fall behind their global competitors in terms of investment, productivity, and innovation. Why is this the case? What do we know about how effective innovation agencies in other parts of the world work? How are the Latin American innovation agencies like or unlike their peers in more innovative economies? These are all questions that have not been systematically researched. To date, there is no broad comparative study of the regional IAs that compares LAC IAs to each other or to the group of globally prominent and IAs, which have effected transformation in their own economies. What follows is a general framework for documenting and comparing the goals, characteristics, and outcomes associated with existing agencies in Latin America and in wealthier countries where IAs have performed well.

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[1] Data from stats.oecd.org. Mean value of .96 percent growth per annum includes AUS, AUT, BEL, CAN, CHE, DEU, DNK, ESP, FIN, FRA, GBR, IRL, ITA, JPN, KOR, NLD, NZL, PRT, SWE, USA.

Fig 1: Total Factor Productivity in LAC, 1992-2014 (1960 = 1)

Legend:
- Argentina
- Bolivia
- Brazil
- Chile
- Costa Rica
- Dominican Republic
- Ecuador
- El Salvador
- Guatemala
- Honduras
- Jamaica
- Mexico
- Panama
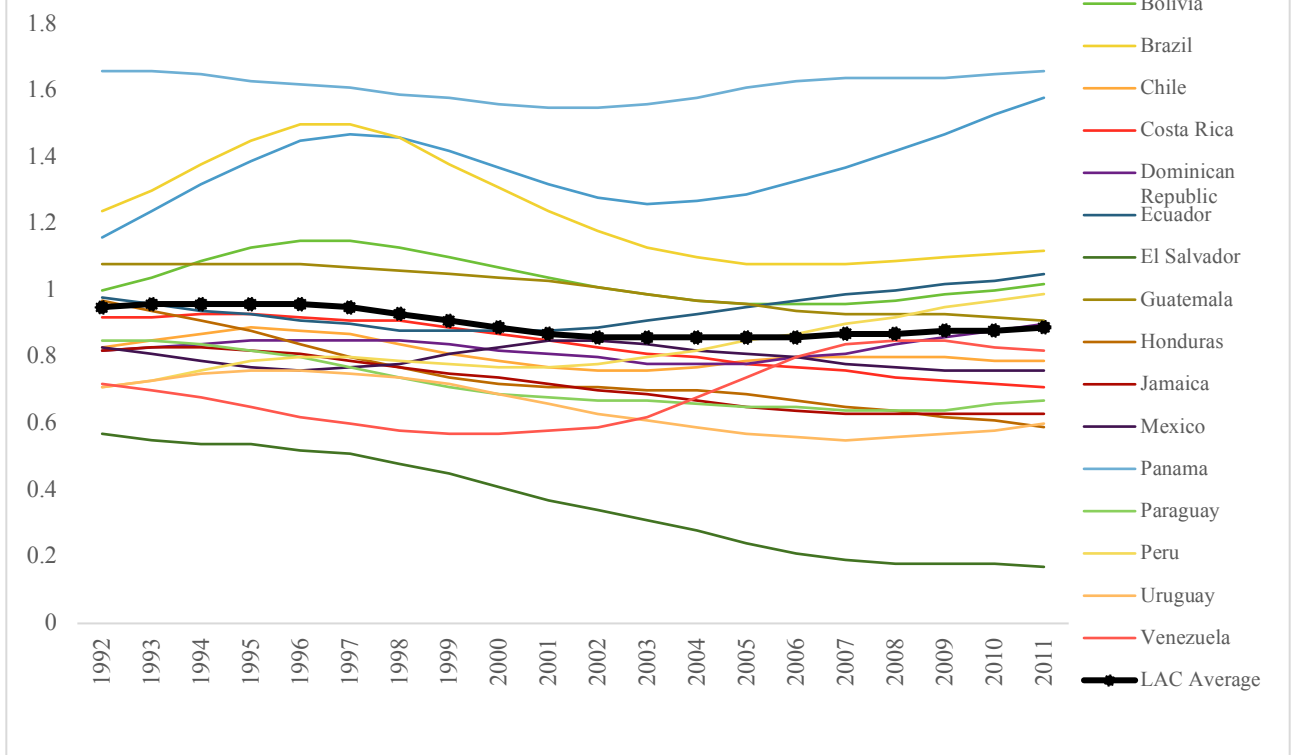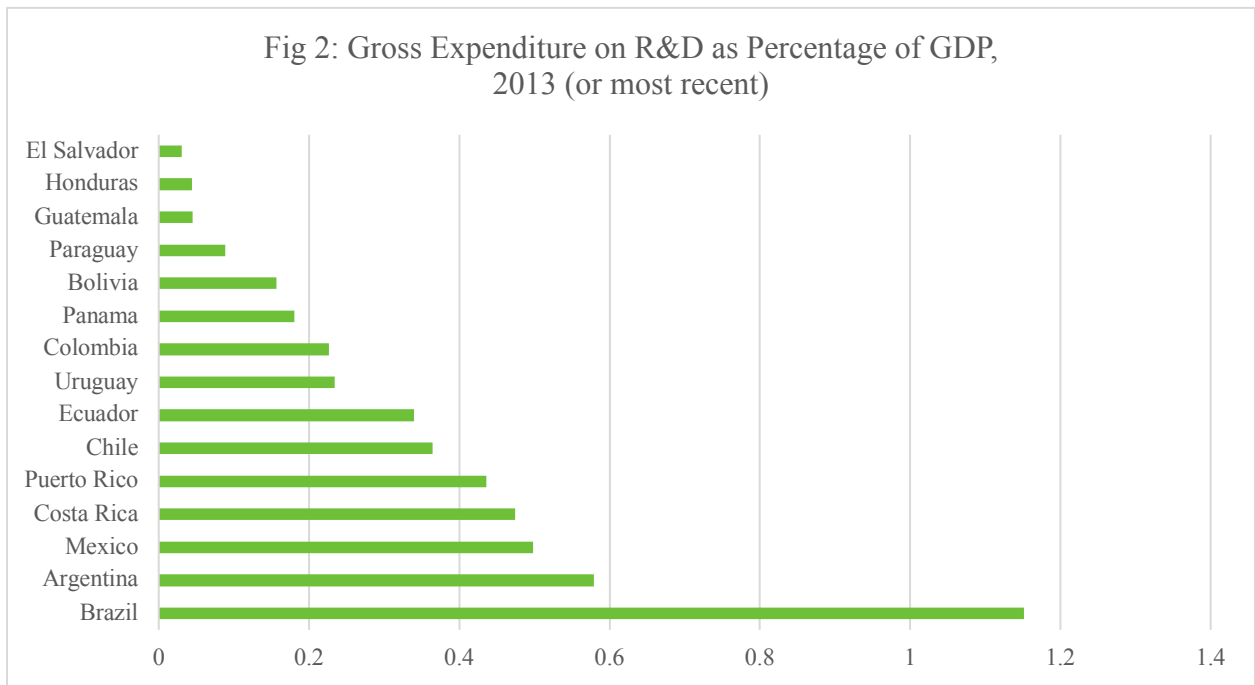- Paraguay
- Peru
- Uruguay
- Venezuela
- LAC Average

Fig 2: Gross Expenditure on R&D as Percentage of GDP, 2013 (or most recent)

II. Innovation Agencies

Governments can successfully promote the adoption and generation of innovations in domestic industry, and dedicated innovation agencies are a means by which both emerging and already wealthy countries have successfully intervened to spur innovation. What specific steps an innovation agency takes necessarily depends not only on the characteristics of a country but also on the nature of the technologies it seeks to promote and the global structure of related industries and their markets. To understand how these IAs have operated, the first point of reference is the programs that were put in place allowing for the rapid "catch-up" by the so-called developmental states in East Asia. These late-developing states, were able to leap forward technologically by promoting technology transfer, imitation, and competition by entire industries (Amsden 1989, 2001; Johnson 1982; Wade 1990). The catch-up strategy of development was enabled by a "specific state structure" that promoted long-term economic planning and the engagement of large vertically-integrated conglomerates (Breznitz 2007; 14). This structure – a centralized pilot agency – functioned by understanding the long-term needs and lowering the risk of conglomerates rapidly adopting existing technologies and competitively entering export markets based on scope and scale. Historically, these kinds of pilot agencies have been largely served for encouraging catch-up and incremental innovation (Breznitz and Orston 2012).

It is, however, understood that this kind of particular state structure is unlikely to be effective in the current economic and technological environment. In the first place, production has been fragmented globally, such that entire supply chains are not necessarily located in the same country. Instead, countries increasingly specialize in particular production stages, rather than on developing complete supply chains within conglomerates. Second, although there is still much growth by imitation to be encouraged, the leading edge of technological innovation has begun changing increasingly rapidly.

To the extent that innovation agencies are engaged in spurring innovation at the technological frontier, the traditional approaches to promoting productivity growth are inappropriate. Rapid innovation-based growth at the leading edge of technology development require agencies that are structured and operate differently. Wong (2011) distinguishes between "risk" and "uncertainty" in technological innovation. Risk refers to situations where there may be failure, but the probability of failure is known or calculable; uncertainty denotes situations where that probability is unknowable. "Catch-up" development entails risk but little uncertainty

because it primarily involves the adoption of existing technologies (or incremental changes), while innovation-based growth at the technological frontier includes uncertainty, because comparatively little is known about future products or markets for new technologies. Because of uncertainty generated by rapid innovation, a distinct kind of flexible agency is necessary to support innovation and growth: an experimentalist and co-evolutionary agency (Breznitz 2007). Effective innovation agencies in these conditions have been shown 1) to not be the objects of political interference because of their low profiles and scarce resources, 2) to develop novel instruments that are not "taken" (i.e. used by) other agencies, and 3) to cultivate strong networks with complementary but nontraditional organizations because of the agency's peripheral status (Breznitz and Ornston 2012). In the first place, it is important that IAs be guided by technocratic understandings of industries' needs and by objective evaluation of programs rather than by political calculations. Political interference by entrenched public or private sector interests undermines the capacity of an IA to openly experiment and fairly assess instruments. In the second place, without a wealth of resources to draw upon, these peripheral agencies must explore alternative instruments for facilitating innovation, creating a basis for culture of ongoing experimentation. Finally, because they are outside the primary apparatus of the state and limited in resources, they tend to opportunistically build cooperative networks with organizations that they could draw upon for ideas and support in the development and deployment of novel innovation programs. Critically, these characteristics made these poorly funded agencies in Finland and Israel "institutionalized loci of experimentation, pioneering radically new science, technology, and innovation policies," that could be scaled-up in times of need (Breznitz and Ornston 2012; 1223).

In the countries that they have most successfully fostered the rapid innovation based industries, innovation policies have helped develop products, processes, services, and industries that did not yet exist and whose business models and markets had to be created. Accordingly, innovation policy needs to be based on continuous experimentation, not on long-term, static and detailed economic planning. In other words, policymakers in innovation agencies must rapidly come up with new initiatives, kill those that do not work, scale up those that do, and then, as new industries grow, keep adjusting the incentives in a co-evolutionary process to keep pace with a target industry's dynamic needs and capabilities (Breznitz 2007; Breznitz and Ornston 2012). There is not one universal design principal for innovation agencies that allows them to be able to

accomplish this; instead a variety of factors can encourage or frustrate the ability of an agency to flexibly develop policies that address the changing needs of their private sectors. Further, as the global fragmentation of production has led some locations to focus on specific stages of production in particular industries, economies need a very different set of innovation capacities and the institutional systems that supports and stimulates them.

Is the establishment of effective innovation agencies in Latin America is possible? Latin American countries are distinct in many respects from countries in other regions in ways that are likely to inhibit the formation of effective IAs. For example, most Latin American countries have a strong tendency toward economic dualism, are dominated by conglomerates that seek shelter from markets rather than upgrading (Schneider 2013), are socioeconomically more unequal than any other region of the world which presents distinct challenges (see Amsden 1992). However, there are ample signs that, despite the conditions that might inhibit innovation in Latin America, there is hope that IAs may be successful there as well. Many LAC are heavily reliant of the exploitation of natural resources (like Finland, where Tekes worked in a traditionally resource-dependent economy); most have bureaucracies that are qualified as relatively ineffective (like Israel, which also suffered from the same fault but had an effective IA with OCS); multinational corporations have a major presence in the economies of many Latin American countries (but they were used as a source of strength in Ireland); very small firms are predominant (like Taiwan, which was characterized by development of small firms). With that in mind, we identify some general best practices that are have emerged from the nascent scholarship on IAs.

First, a critical feature of effective innovation agencies is that they are *experimentalist* in their modes of operation. An experimentalist orientation is very important to successful IAs because their effectiveness derives not from a particular formulaic or standard structure but from a willingness and ability to adapt to new economic conditions and be "flexible facilitating agents" rather than static and directorial (Breznitz 2007). Experimentalism includes a number of features that should be embodied in various operational characteristics of the innovation agencies. First, it includes the flexibility to initiate new programs or to adjust old ones as necessary in the face of changing economic conditions (Breznitz 2007; Breznitz and Ornston 2012). This, of course, pairs with the willingness and political capacity to both *wind-down* existing programs that do not advance the agency's mission and the ability to *scale-up* effective programs that do.

Second, and relatedly, they should be *co-evolutionary*, which refers to the capacity to adapt innovation programs to changing conditions in the private sector. When IAs develop and deploy successful programs, the private sector necessarily changes in response. As these changes occur, the IA's programs can become obsolete and require either elimination or updating. As with experimentalism, this requires IAs to continually assess the programs they deploy in order to determine when they have outlived their usefulness or have become less suited to emerging conditions in the private sector.

Third, being *self-evaluative* or knowing which programs/policies work as intended is central to being able to experiment and enlarge successful programs or kill failing ones. Thus, the ability to accurately and objectively assess the effectiveness of a program relative to its goals is an absolute necessity. In short, since much of what innovation agencies do is experimental and evolutionary, an important part of the agencies' learning and self-evaluation processes should be to gauge whether programs are effective or not, as well as whether the agency takes enough risks in attempting to develop programs. Along with this, they must have the flexibility and discretion to be *self-correcting* (fourth) by adjusting programs based on the results of evaluation.

Fifth, as the preceding implies, they must be *insulated* from pressures from both their political overseers and from the private sector. First, innovation agencies should view failed programs as opportunities to learn; however, failed experiments can be politically difficult for appointed officials with short time horizons. The admission of failed programs is understood to reflect badly on the Ministers who oversee IAs, even if the closing of a particular program is the right decision in terms of agency effectiveness. At the same time, they need autonomy from private sector pressures and "capture" as well, which can affect the ability of an agency to make decisions to deploy or cut programs. Government programs often create "constituencies" in the private sector that desire the continuation of the programs. Cutting ineffective programs that benefit powerful private sector actors can thus be politically uncomfortable for IAs. Therefore, agencies need a degree of insulation from both political actors with short time horizons and risk (failure)-aversion, as well as from private sector actors with vested interests who might have personal motives – financial or political – not wholly consistent with the stated mission of the agency.

Sixth, although they should be insulated from pressure from the private sector, they must also have some normalized mechanism for *monitoring the private sector* in order to tailor interventions well and understand industrial developments. Some have framed this as "embeddedness" (Evans 1995) or "multiple embeddedness" of state actors within the private sector in more network oriented states (O'Riain 2004; Block 2008), but this relationship also depends upon the relations between firms in the private industry (Samford 2017). Ultimately, in the age of evolutionary innovation agency, the mode of remaining in close contact with the private sector may differ and change; without some working conduit to groups of firms, IAs will fail.

Seventh, IAs need to be *able to network* and draw together interested parties from government, private sector, interested domestic and international actors in cooperative networks. Following Breznitz and Orston (2012), this is important for both the development of novel interventions and for the resources to scale them up if they are found to be effective for promoting innovation. A long line of research on organizational networks has found value in being able to use network connections for social and material resources. IAs, which are often small and resource poor, similarly benefit from those network resources.

There is not one universal design principal for innovation agencies that allows them to be able to promote innovation and technological growth; instead a variety of factors can encourage or frustrate the ability of an agency to flexibly develop policies that address the changing needs of their private sectors. These seven general characteristics are among the most important that have been identified in previous scholarship. However, in spite of these complexities facing the design of policies that promote innovation, there is no existing analytical framework enabling a systematic analysis of the goals and operation features of IAs; instead, policymakers tend to imitate trends that seem to work elsewhere, whether or not they fit local conditions. Therefore, this document provides a framework for conducting this comparison, drawing on what we know about IAs outside of Latin America.

III. Dimensions of Comparison

The task of developing a comparative study of innovation agencies in Latin America and beyond can be broken into two processes, documentation/characterization and evaluation/assessment:

- The first of these tasks is to identify and *characterize* the overall mission or broad strategy of each agency and to *document* the operational elements of the innovation agencies.
    - *What is the innovation context in which the agency is situated?*
    - *What are stated intentions of the agency?*
    - *What are the internal operating features of the agency that are intended to achieve this goal?*
- The second task is to *evaluate* the relative effectiveness of the agency within the context of the national economy. This should be an *assessment* with reference to both: 1) the intent (or strategy) of the agency in its environment (i.e., what we call "external suitability"); 2) how those operational elements of each agency accord, or fail to accord, with its goals (i.e., what we call the "internal coherence" of the agency), and 3) general indicators of effectiveness, such as increase in innovation investment and outputs, the return on public investment, and so forth.
    - *Does its mission/strategy situate the IA in a role that is important to the functioning of the national innovation system? Or address a historical weakness?*
    - *Are the operational features well-suited to the agency's mission?*
    - *Do the instruments and features of the agency work (vis-à-vis their own goals and external measures)?*

Both of these processes are important for developing a systematic comparison of IAs. Because agencies have different goals and are structured differently, there is a need to document the variation in their characteristics. In other words, it makes little analytical sense to compare across agencies without first establishing what their goals are and how they are structured to achieve those goals. IAs in other regions display are great deal of variety, and there is no reason to assume that in Latin America they are homogenous. Accordingly, the first goal is to be able to relate them to one another (and perhaps categorize) based on characteristics and goals.

The second vector for comparison is evaluative. First, this should allow for the identification of patterns regarding external suitability, internal coherence, and actual performance. Ultimately, case comparisons based on this framework should lead to the production of a "playbook guide" for innovation policymakers to consult as they tailor innovation policies to their specific context and stage of growth; this guide will document the potential agency features, where those might function well or not, existing pathologies of matching strategies to context (external suitability) and features/instruments to strategies (internal coherence), and how well particular instruments function.

III.A. Economic and Innovation Setting

The most basic starting place for a study of innovation agencies is to take stock of the economic and political conditions within which each IA operates (and has historically operated). This domestic environment includes, for example, the structure of the economy, which can be partially captured by the share of different sectors in the domestic economy, the extent to which traditionally high-tech industries vs. lower tech industries predominate, and the historical growth of productivity. The current and historical nature of the national innovation system and industrial development policy are also important contextual elements. National innovation systems (NIS) are considered to be the network of institutions and organizations geared toward generation and diffusion of technologies (Nelson 1995, CJE). These are considered to consist of academic institutions, private enterprises, public sector organizations, and the relationship between these organizations. While necessarily treated qualitatively, important indicators of the NIS also include expenditures on R&D by business and government and levels of human capital development. The existing innovation system and productive profile of the economy are obviously important given that those are what IAs typically alter. In situations where an economy is heavily-based on low value-added commodities or has historically been low in terms of R&D activities, the task of raising the level of the innovation is bound to be more difficult. Commodities exporters (e.g., Ecuador) face a distinct set of challenges from economies based on light industry and services (e.g., El Salvador); commodity exporters have potential to build innovation upon the exploitation of commodities and related products (as CORFO has in Chile), while it makes more sense for a service-based economy to pursue a distinct strategy. The same is true of countries that have large differences in training and educational attainment. In general, given the current state of technology development in Latin America, the IAs there may be more focused on the *absorption* of technologies that are new to their markets or on process innovation than they are on *inventing* technologies at the edge of the technological frontier.

Because it is inextricably linked to the domestic economy, the global economic environment also necessarily shapes how innovation agencies must operate. In particular, the nature of the trade regime and the relationship with foreign investors are important in shaping competitive forces and international technology flows. For example, the presence of multinational investors may provide the opportunity for the transfer and development of

capacities to local firms, but only under circumstances that impel multinationals to work with local firms. Moreover, countries in Latin America demonstrate high variance in joining of preferential trade agreements. For some countries, such as Mexico as a signatory to NAFTA, these may have the effect of strongly tying them into trade and investment relationships with their partners. In general, given the neoliberal bent of some governments in LAC and the heavy reliance on commodity crops and minerals in many others, it is likely that a comparison of regional IAs will find them to be less ambitious in their goals than other global IAs. In short, understanding the basic economic and policy environment is critical to situating an IA within its national innovation system and grasping *how* the agency is positioned to promote innovation.

III.B. Mission and Strategy

In terms of comparing innovation agencies, it is valuable to consider the overall goals of agencies in order to:

1. Situate them relative to comparable institutions in other countries;
2. Assess them in terms of whether their operational features are coherently oriented toward those goals.
3. Evaluate them in terms of how well an agency is progressing toward fulfilling its overall goals.

Although there are potentially other meaningful distinctions, we propose two features that on often distinguish IAs from one another: first, the extent to which they focus on particular sectors (vertical focus) versus being broadly oriented and cross-sectoral (horizontal focus). The second, is the extent to which they seek to alter the economy, from simply raising productivity in existing firms and sectors on one end, to encouraging a paradigmatic shift aiming to reorient the economy on the other. IA missions should be matched with the actual structures and instruments used to pursue those goals.

Horizontally-oriented agencies seek to assist a wide range of industries and services, often with interventions that are generalized and can have effects across the economy. Rather than pushing the development of a particular industry, they intend to raise the level of a particular kind of activity across the economy. For example, The Office of Chief Scientist in Israel is a horizontally-oriented agency on maximizing R&D; defined as new product research and development activities across the economy. The idea of raising levels of "entrepreneurship" skills among potential and actual business people is similarly horizontal.

Vertically-oriented agencies are those that focus on a specific set of technologies or a much narrower range of industries (possibly a related set of industries that supply each other). Taiwan's ITRI, for example, reached success by focusing on ICT and, within them, specifically on semiconductors. The distinction between vertical and horizontal in this context is best thought of as a *tendency* rather than as a dichotomous distinction, given that many IAs may have a mandate that includes both narrow and broad targeting. The distinction here is important because there is a relationship between an agency's ability to excel at these two different approaches and a particular set of operational features, tools, and skills.

Second, innovation agencies can be thought of as sitting on a continuum between being oriented toward "upgrading" or toward "transformation." This distinction refers to the degree to which the agency aims to alter the existing nature of the economy. On the "upgrading" end of the continuum, agencies target existing firms and industries and seek to promote the development or adoption of more productive technologies, sometimes with the goal of opening opportunities for new industries. Examples include agencies such as Spring (Singapore) and VINNOVA (Sweden). We can think of upgrading in several different manners: the absorption of new technologies into an existing mature industry (e.g., additive manufacturing for prototyping in auto parts suppliers), enabling the same set of activities (e.g., component manufacturing) in new industries (for example, biotechnology), or as the development of downstream activities that add further value to currently produced goods and services (e.g., processing of fishes in Chile).

Transformative IAs stimulate the development and growth of industries that are entirely new to their countries. While this was accomplished in Taiwan by ITRI's heavy involvement in research and development of ICT, there are other mechanisms by which this transformation might be accomplished (shrewd use of foreign investment being one example). Although Latin American IAs have yet to be systematically studied, we suspect that it is probably that they will tend toward the "upgrading" side of this continuum.

Within their general mission, agencies have a specific set of strategic objectives that are intermediate steps toward their broad goal. Canada's IRAP, for example, identifies targeting SMEs, providing applied/pragmatic research assistance, and collaboration with other research organizations as elements of the agency's approach to the broader mission of accelerating business growth. A comparative project should also document these intermediate objectives, based on their mission statements or other policy documents. These are important because they expose the strategies that the IA intends to pursue, which in turn links the broad mission to the operational characteristics of the agency.

III.C. Operational Characteristics

Each innovation agency has a set of operational characteristics, which are the functional means by which the agency pursues its innovation goals. We propose that these features can be divided into five categories (detailed below): Organization, Governance, Financing, Coordination, and Instruments. Beyond the need to document an array of relevant details of these features, there are two primary concerns related to the assessment of these operational features.

First, are these operational features structured in an effective manner to promote the broad mandate of the agency? That is, are they "internally coherent" vis-à-vis the mission and objections of the agency? There is, after all, no guarantee that the operational features of an agency are appropriately designed to meet its goals. For example,

- A lack of flexibility in governance may hobble the generation of new programs;
- Certain kinds of incentives may be poorly designed to fit the outcomes desired (for example, Canada's R&D tax credits have grown in the last thirteen years while business R&D investment has declined to historic lows);
- Governance structure without autonomy may curtail the extent to which the agency can operate flexibly in response to changing market conditions;
- The training and experience of staff are not ideal for the kinds of functions they preform within the agency.

There are, in short, many possible mismatches. Assessing the fit between the operational features and mission across IAs not only allows for the identification of common mismatches but also allows for the highlighting agencies where there is a tight fit between operational features and mission.

The second concern is whether the operational features function effectively, individually or as a whole. The Instruments are the most straightforward to assess in terms of their effectiveness, but there is enough known about IAs that other elements can be evaluated as well. Regarding *governance*, for example, too little flexibility in the design and implementation of innovation programs and instruments is inimical to strong performance. This can be a consequence of either heavy-handed oversight or political intervention. *Financing* need not be very generous – and scarce resources have been shown to be desirable for ensuring experimentation – but it needs to be reliable and insulated from political manipulation. Poor *coordination* with other organizations – though not *all* – in the innovation ecosystem is

important, given the likelihood of needing to work with other organizations to scale up effective programs, to avoid overlap, to draw on the expertise of others (e.g. for particular research needs), and so on. Coordination between levels of government is also important for federated countries, where subnational governments also have programs of their own (Canadian IRAP, for example, has at times struggled to coordinate with initiatives developed at the provincial level). Finally, in terms of *organization*, there are multiple areas of assessment, spanning from whether there are appropriate kinds and levels of staff to the balance of discretion with accountability to organizational learning. In short, each of operational feature can be evaluated in terms of its suitability to the goal of the agency as well as against the features of effective agencies.

III.C.1. Governance

Governance refers to the manner in which the IA is controlled and directed, as well as the relationship between the agency and any supervisory ministries. As stated above, heavy-handed oversight and veto control can be inimical to the ability of an IA to be experimentalist and flexible. Naturally, an IA must be held accountable for pursuing its mandate, so there must be a means of balancing that accountability with the agency discretion. What is the agency's legal status and what, if any, ministries are legally in control of the IA? To what extent is the agency autonomous to design its own instruments or to alter its own strategic goals (in either de facto or de jure terms)? Flexibility, in particular, is understood as a very important element of IA operation; to what extent is this curtailed or facilitated by governance structures?

Also included in this feature is the relationship with the private sector. Clearly, the agency must not be "captured," or take actions based only on the private interests of particular industries or firms. At the same time that control over decisions is maintained within the agency or ministry, the agency needs to retain meaningful ties to the private sector in order to effectively design and implement programs and to monitor the technological and economic "horizon."

III.C.2. Financing

The nature of their financing is a critical feature of the manner in which innovation agencies are able to pursue their organizational ends. We would seek to understand not only the levels and sources of funding for the agency, but also such features as its stability (or reliability). While sufficient levels of funding are obviously necessary, previous research indicates that more is not

necessarily superior in all cases. Smaller, peripheral agencies such as the Israeli OCS, have benefitted from limited funding in the sense that they must move efficiently to cut programs that are ineffective, and create broad collaboration (and hence sustained networks) in order to scale-up successful initiatives. In terms of reliability, it is critical for IAs to have funding that is reliable both in the sense that it arrives as expected and in the levels expected. Because stability and political insulation are important, the mechanisms by which the agency is funded are also significant because some forms of financing are more easily altered than others. Are the agency's funds secured by long-term, dedicated budget line or is the mechanism less secure? Finally, given that decisions made by the agency may be politically unpalatable – e.g. closing an ineffective but popular program or ultimately unsuccessful program experiment – it is important for the funding for IAs to hold up in face of political disputes and to be insulated from short-term political pressures. In sum, IAs need a reliable funding, that 1) can be mobilized quickly for the deployment or scaling-up of a particular program, 2) can be risked on programs with uncertain outcomes, 3) is not so large as to make the agency a target of political or business manipulation, 4) is not generous enough to allow the agency to keep failed experiment alive, and, 5) require collaboration with other actors in order to scale up efforts.

III.C.3. Coordination

Coordination refers to the nature of the connection of the IA in question to the broader national innovation system in which it is embedded and the extent to which the agency is able to work cooperatively with other organizations. Of particular interest are: 1) the relationship to other development ministries or agencies with shared interests in innovation, and 2) the relationship with the private sector. In the first place, it is ideal that the IA have a working relationship with other ministries, agencies, and organizations both at the national and local levels. Good coordination can help make possible actions such as cooperative efforts to scale up an effective program. It can also help avoid problems such as duplicate programs, confusion, and agency rivalries (as has been reported, for example, in Ontario's innovation system). In the worst case scenario, innovation agencies and others can work at cross-purposes. In documenting the coordination of each IA, we should seek to understand the extent of cooperative ties maintained with other parts of the government (ministry of economy, ministry of education, and so forth) as well as the means by which that coordination is maintained. Are the agencies coordinated

through formal or legal frameworks or simply informal relationships between agency executives?

Second, coordination with the private sector actors is also very important for IAs, but this involves a difficult balance between the agency being too responsive and not responsive enough to the private sector. There is a well-known concern with public agencies being "captured" by the private sector; in the case of capture, private sector actors have undue influence over the agency and policies are not deployed in manners that provide the broadest social good. At the same time, however, having close ties to industries and firms is important so conditions and problems facing the particular industries can be understood and suitable, well-tailored policies developed. This kind of coordination – or some other means of gathering specific, current information about industries – is necessary to raise the likelihood that the private sector responds in the right way to policy initiatives. The key to maintaining close enough contact but avoiding capture relies on the mechanisms for monitoring the economic "horizon" as well as assessment and accountability, which are outlined in other sections.

III.C.4. Organization

Organization in this context refers to human resources, assessment and learning, and other internal processes. In terms of human resources, the size and educational and professional background of staff members in IAs is linked to the effectiveness of the agency when using specific tools or pursing particular targets. For example, a vertically-oriented agency, need to have a much deeper and specific technological and technical knowledge, at the extreme even taking on much of the R&D in-house similarly to ITRI (Taiwan). In a horizontally-oriented agency, such skills can be acquired as needed to evaluate specific projects or programs, a good example is the Israeli OCS use of external project evaluators with technical abilities on part-time basis in order to ensure that bureaucrats without specific technical expertise are making the right granting decisions for proposed projects coming from private industry. IRAP in Canada recruits staff with some technical expertise, business experience, and a broad set of contacts, so that they are able to either assist businesses directly or locate an organization that can assist. Moreover, the means by which the agency retains critical staff through wages and promotion is central, in light of the need for skilled and knowledgeable personnel. In short, there is not a single model for how to recruit staff, as this will depend upon the goals and instruments used by the agency.

What *is* clear, however, is that successful IAs have found ways to recruit and retain human resources with high bureaucratic competency and technical expertise that fits with their missions, goals, and actual programs.

IAs need mechanisms for evaluation, learning, and accountability in order to ensure the success of their own instruments. Regarding evaluation, an experimentalist agency must have the capacity to assess whether their programs work as expected or not. And then, as discussed above, alterations must be made if evaluations of a program or of a firm's participation are negative. The nature of these assessments will differ depending upon the type of program, but they *must* be in place. To give a single example, staffers in Canada's IRAP have a high degree of discretion in their interactions with particular firms. They can determine how case work with a firm should continue, or if work with the firm should be terminated. Accountability for this discretion comes from an IRAP review committee, which examines case files to evaluate the decisions they made by staff.

There are a variety of indicators available for the documentation of staff skills and recruitment and for mechanisms for assessment and accountability. However, since IAs need to be co-evolutionary in nature, in many, if not most areas there is a need to have a qualitative narratives and case studies of projects that are perceived as being very successful, as well as descriptions of evaluation mechanisms and accountability measures. If possible, narratives of programs that have been approved, assessed, and then cut for lack of success would be particularly helpful. Finally, because the perceived value of the agency is important for cooperation and influence, the nature of public perception of the agency – and the extent to which the agency attempts to shape that reputation – should be taken into account.

III.C.5. Instruments

"Instruments" refers to the particular policy interventions that an IA deploys in the interest of innovation and development. Beyond documenting the nature and reach of the instruments that they employ, there are two elements to be assessed: 1) whether those instruments are appropriately structured given the goals of the agency, and 2) whether they are effective tools or not. In the interest of both of these aims, we propose categorizing the portfolio of tools employed along two axes: instrument targets/goals and instrument means. Regarding an instrument's goals, these are the element of the innovation ecosystem that the intervention is intended to affect.

These can vary from R&D promotion to human capital development to increasing trade. The instrumental means – or the manner in which the instrument intervenes – can be placed on the opposite axis. These can range from direct grants to networking/coordination. This approach allows each instrument to be plotted according to its combined means and ends. In addition to identifying the particular instruments an agency has employed, this allows for easier evaluation of the effectiveness of an instrument as well as identifying matches (or mismatches) between broad agency goals and the actual instruments they use. For example, an IA that expressing its goal as raising the levels of private R&D, but employs instruments that increase labor capacity through training and education can be identified as having misaligned mission and instruments. Table 1 describes the instrument targets and means of interest.

Table 1: Instrument Targets and Means

Instrument Target	Description
Knowledge (Creation and Transfer)	Generate new technologies or facilitate the acquisition or adoption of existing technologies by domestic firms
Labor (Human Capital Formation)	Raise the level of labor capabilities through education, training or retraining, and similar programs targeting human capital.
Research and Development (Firms)	Increase the capacity of firms to conduct their own R&D activities in-house or to contract with outside organizations to conduct necessary research
Entrepreneurship	Develop a culture of entrepreneurship among potential and actual businesspeople with the goal of increasing firm formation and growth
Innovation System	Establish or strengthen organizations that are pieces of the national innovation systems, including research laboratories, universities, business support organizations, subnational government agencies
New Sector Development	Support the establishment or growth novel industrial sectors, ranging from promoting the import of new machines or techniques, or incubator space, computers, internet infrastructure that are necessary for small start-ups with novel products or services
Trade Promotion	Raise levels of trade – predominantly export – of particular goods by improving the productivity or improving access to information about foreign market conditions

Instrument Means	Description
Grants	Direct financial contributions to firms or organizations (generally non-repayable)
Credit Financing	Provision of credit or subsidized interest on credit
Investment	Direct investment in company shares, either with or without intent to control; venture capital

Information	General provision of relevant information through regularized forms of communication to firms, innovation organizations
Coordination/ Networking	Active efforts to draw together firms, organizations, and/or agencies to promote contact, information sharing, and coordination among them

Combining the means and targets of the individual instruments yields a table describing 35 different combinations to which individual instruments used by IAs can be matched. For example, the instrument used most heavily by the Canadian IRAP are non-repayable grants to SMEs for the conduct on R&D on approved projects. To the same end, the agency also provides advisory services in which they help SMEs understand their technological barriers and link the enterprises to appropriate research labs or other organizations that can assist in addressing those barriers.

		Instrument Targets						
		Knowledge creation / transfer	Labor (HK formation)	R&D and innovation for firms	Entreprene-urship	Innovation systems	New sector development	Trade promotion
Instrument Means	Grants			IRAP – SME grant				
	Credit financing							
	Investment							
	Information							
	Coordination / networking			IRAP – advisory service				

Given that IAs may employ any number of instruments (IRAP in Canada uses four permanent instruments, for example, while CORFO in Chile employs dozens), it is important to also consider the relative importance of each kind of instrument for the IA's portfolio and the characteristics (number, size, sector) of the beneficiaries. Finally, the manner in which the instruments function – from agency outreach, to the selection of beneficiaries, to the timing of benefits, to the monitoring of the project outcomes – are important to understand, given that the manner in which the IA intervenes in the private sector is based upon available instruments.

Finally, assessment obviously depends on the extent to which instruments actually do

create the outcome that they intend. What observable outcomes of each instrument are there? To follow on one of the examples above, IRAP provides business grants to SMEs to conduct R&D with the broader goal of increasing business growth. How much increased growth can be attributed to the funding? The outcomes in question will differ with regard to the goal, but insofar as it is possible, observable outcomes should be documented.

IV. Structure and Variables for Case Studies

In developing a set of variables for comparison, we assume the dual goals of being able 1) to document the primary characteristics of innovation agencies in such a manner that they can be compared to one another, and 2) to assess the success of the IAs given their goals, their operational features, and their outcomes. Just as it makes little analytical sense to lump all IAs together as an undifferentiated group in terms of objectives, organization, and instruments, it is problematic to assess them against a single set of performance benchmarks. As such, we propose a framework that situates variables of interest into a set of guiding questions: What is the general purpose of the agency? What are its specific objectives within that purpose? How is the agency structured to address those goals? The purpose is to provide a systematic enough examination of the IAs that it could offer a guide or "playbook" for policymakers to assess their own IA and have some basis for progress. In Table 2, the general variables of concern - both in terms of IA characteristics and IA performance - are situated under the relevant guiding question; disaggregated elements of those characteristics (if necessary) are provided in the third column; quantitative and descriptive indicators (i.e., data to be collected) corresponding to each of these elements is listed in the final column.

Some of the data identified in the final column are quantitative measures, but we would *stress the importance of qualitative or narrative indicators* (such as the stated purpose of the agency, its development over time, background of agency staff, or modes of self-assessment). In addition, due to the dynamic and evolutionary goals of IAs, which means that much of their desired impact is behavioral changes of innovative agents, we strongly advise employing a narrative of "client cases" as part of the assessment tools, both for our study and for the IAs themselves. One of the basic mistakes of many IAs is relying only on quantitative measures, which then skew the incentives of the IA away from their main goal (dynamic, behavioral, and evolutionary change), to that of "hitting the mark" in a set of partial proxies such as patents, return on investment, or jobs created.

Because of the likelihood of changes in agency structure, mandate or environment over time - and the consequent difficulty of interpreting "snapshot" data in a meaningful way - we propose the gathering of data over the last 15 years. For quantitative data, this may mean figures for each of the last 15 years (if there is significant difference) for each of the indicators; for qualitative data, it may mean indicating whether there was a significant change over time or

developing a narrative around *how* or *why* changes occurred. It would also mean that every effort should be made to interview the people responsible at these agency (and hopefully some clients) during that period.

IV.B. Analytical Structure and Variables

Based on the discussion above, Table 2 lays out the structure for the analysis of individual agencies below. Each numbered Guide Question is marked with a D for Documentation or A for Assessment (also shaded in the table) in order to distinguish between the dual goals of the analysis. Critically, because these agencies can (and should be expected to) change from year to year, in order to capture the evolutionary dynamics of the IA in question, data should be gathered for as much of the last 15 years as possible.

Table 2: Analytical Structure and Variables

	Guide Question	Variables of Interest	Disaggregated Elements	Indicators
0-D	How would one characterize setting –the "national innovation system" and productive structure – of the country?	Domestic environment	1. Structure of the Economy 2. National Innovation System 3. History of Industrial Policy	1a. Sectoral shares; 1b. High vs low tech goods 1c. current and historical levels of productivity 2a. Description: general NIS 2b. Domestic GERD/BERD 2c. Educational attainment 3. Description: historical industrial policy
		International environment	4.Trade regime 5. International business	4. Openness of trade; major partners 5. FDI; size, presence of MNCs
1-D	What is the broad mission of the IA in its environment?	Mission/Strategy	1. Transformative vs. Upgrading 2. Vertical vs. Horizontal development 3. Other	1a. Strategy document and narrative of the development of the agency 1b. To what extent is IA intended to support under-developed sectors vs. inertial support of existing ones? 2a. Identify stated purpose of IA in strategy document / described by agency executives 2b. Document sectoral distribution of funding/projects 3. Identify other elements of mission

2-D	What are the strategic goals of the IA?		1.Strategic Objectives	1. Identify the specific objectives of the IA
3-A	To what extent are the goals and design of the agency "externally suited" to the domestic NIS and to the global conditions?			1. Describe how the IA with its mission/goals fits into economic environment? Does it address apparent gaps? Has mission evolved to address emerging needs? In what respects might mission seem inappropriate to setting?
4-D	What are the operational features of the IA? How does the agency pursue its broad mandate/mission?	Organization	Staff 1. Size of staff 2. Make-up of staff 3. Training/Professionalism of staff 4. Competitive wages 5. Promotion / tenure	1. Number of staff 2. administration vs. field agents/other 3a. background of staff / recruitment requirements; use of outside consultants with technical expertise 3b. Biography of director, particularly background in industry 4. Average wage, relative to comparable positions in public and private sectors 5. Potential for promotion average job tenure
			Learning 6. Self-monitoring Mechanisms	6a. Qualitative description of three most successful cases of innovation 6b. Description of regularized means of agency self-assessment / learning 6c. Describe other agency perceptions of agency; to what extent is it influential and prestigious among bureaucrats 6d. describe private sector perceptions of agency; to what extent do private sector actors respect agency and follow its lead? 6e. Description of cases in which does agency cut failed programs

5-D		Governance	Within public sector: 1. Bureaucratic autonomy and oversight 2. Veto Power 3. Insulation from political pressures in management	1a. Description of governance structure of agency (on paper and in practice) 1b. Describe degree of autonomy 2. Is veto power/direction exercised by overseeing minister/ministry or other official? (de facto, not just de jure) 3. Describe whether political influence in exercised and how
			Relative to Private sector	4. Describe general relationship/points of contract with private industry 5. Describe mechanisms for private sector to influence decisions 6. What mechanisms are available for monitoring economic "horizon" or private sector technology development/use
6-D		Financing	Budget Level: 1. Amount of funding 2. Stability/Predictabilty	1. Size of budget relative to economy; Description of use of budget (i.e. balance b/w too little to be effective and too much to be cooperative) 2. Identify fluctuations in funding; threats to continued funding
			Financing Mechanism: 3. Source of funding; 4. Autonomy of funding	3. Nature of budget line (i.e. freestanding/part of larger agency) 4. Identify if protected/dedicated budget line or subject to political manipulation

7-D		Coordination	1. Relationship with other agencies in public sector	1a. Number/type of agencies with working relationships with agency 1b. Description of relationships of relationships with other institutions 1c. descriptions of informal partnerships/formal coordination with other agencies; 1d. Divided STI and Innovation/Entrep. agencies?
			2. Coordination with private sector	2a. Describe formal mechanisms for coordination with industry (collaborative projects, participation on committees, business group consultation, etc.) 2b. Characterize informal coordination with private sector.
8-D		Instruments:	What instruments does the IA employ?	1. Identify each instrument by target and means (on instrument portfolio table). 2. Overall portion of budget to each instrument 3. Beneficiaries of instruments (generally firms) by number, size, amount of benefit
			How does each instrument work?	4. Describe how is instrument promoted /outreach 5. Describe how potential beneficiaries are screened / selected 6. Describe mechanism by which individual projects monitored and available recourse for underperformance? Describe cases of cut-off, if available 7. Describe how overall effectiveness of instrument is monitored 8. Describe timing structure for finance instruments: how quickly is instrument available, how long-lasting?

			9. How long has the program been active and has it changed in character over time?
		Observable outcomes	10. Identify outcomes: changes to sectoral makeup of economy, employment (type or amount), amounts or value-added to exports, to location of firms in global value chains, growth, conduct of R&D, or whatever based on the objectives of the agency
9-A	To what extent are the operational features and the broad mission "internal coherent"?		1. Describe the extent to which the features fit together to promote the mission of the agency? What elements appear to be out of sync with each other or with the broader mission? Has this shifted with time?
10-A	Do the instruments and features of the agency work (vis-à-vis their own goals and external measures)?		1. What do aggregate measures of IA impact indicate about the impact of the agency? These will vary, but potential measures: changes to R&D expenditure (funding levels, and describe nature of expenditure); Scaling up of small firms; Number/success rate of startups; Levels and make-up of employment; kinds of jobs available; etc. 2. Describe other agency perceptions of agency; to what extent is it influential and prestigious among bureaucrats 3. describe private sector perceptions of agency; to what extent do private sector actors respect agency and follow its lead?

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