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# INNOVATING TOGETHER: IMPROVING BILATERAL RESEARCH COLLABORATION FOR DEVELOPMENT

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# INNOVATING TOGETHER: IMPROVING BILATERAL RESEARCH COLLABORATION FOR DEVELOPMENT *

## Summary Points

1. North-South collaboration in industrial R&D holds important potential for promoting economic growth in the developing world.
2. Such collaboration is mutually beneficial to both Northern and Southern companies. It allows Southern firms to develop technical and business skills and contacts and participate more actively in international trade. And it promotes Northern companies' access to foreign markets by combining their technological expertise with Southern companies' competitive advantages - which include a deep understanding of local needs, conditions and cultures, a greater capacity for frugal innovation, reduced labor costs and easier access to suppliers and other market actors.
3. Despite these benefits, North-South industrial R&D collaboration is rare in light of significant feasibility obstacles.
4. Appropriately designed programs to support North-South industrial R&D can enable companies to take advantage of these synergies.

## Introduction and Purpose

Innovation has enormous potential to advance the developing world. History has demonstrated the predominant role of technological innovation in effecting global development. Technological breakthroughs have revolutionized health[1], food-security[2] and the economic well-being[3] of nations. More recently, one need only look at the experience of the so-called "Innovative Developing Countries" to see how technological innovation can propel economic growth. These countries - including Argentina, Brazil, China, India, Indonesia, Malaysia, South Africa and Thailand - have successfully made major advances in science and technology (S&T) to support their own development. Against this backdrop, it is no wonder that investments in research capacity feature prominently in discussions about achieving economic progress in the developing world.

Millennium Development Goal 8, target 18, charges the international community "in cooperation with the private sector, [to] make available the benefits of new technologies, especially information and communication." This has been interpreted broadly by the 'UN Millennium Project Task Force on Science Technology and Innovation' to include all forms of technological innovation and the associated institutional adjustments (Juma and Yee-Cheong, 2005). It has rightly been

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1 For example, breakthrough vaccines have made tremendous progress in stemming the spread of infectious diseases.

2 For example, the "Green Revolution" of the 1960s-1990s has made great strides in helping to feed the burgeoning populations of the planet.

3 For example, advances in information and communications technology have globalized world trade and provided access to previously inaccessible markets.

argued that "meeting this goal will require a substantial reorientation of development policies to focus on key sources of economic growth, including those associated with the use of new and established scientific and technological knowledge." (Juma and Yee-Cheong, 2005).

Economic change is largely a process through which knowledge is translated into products and services. Although it would be desirable for all developing countries to have functioning S&T systems to link between knowledge generation and enterprise development, this is simply not the case. Even when functioning science and technology (S&T) systems exist, developing nations often lack the capacity to translate research into marketable products[4] (Juma and Yee-Cheong, 2005; Wagner et al, 2001). Cross-border collaboration is therefore crucial.

Many South-South and North-South efforts have been made to foster collaboration in basic research between institutions of higher learning (WHO, 2010; Tshwane Consensus, 2005; Juma and Yee-Cheong, 2005). Building strong networks of this kind is a productive step towards nurturing technological capacity in the developing world. Still, while these efforts are ongoing, a well-defined vehicle for private sector collaboration remains lacking. Fostering cross-border relationships between Northern firms with strong R&D capabilities and Southern firms can serve to build capacity among Southern firms and improve bilateral trade.

Cross-border industrial R&D collaboration - that is, cooperative efforts of firms to co-develop new products or services - is not uncommon in the North-North context. Joint ventures of this type take place between private firms across Europe and North America and beyond. Yet even in the North-North context, governments see fit to incentivize such collaboration to encourage greater linkages. Because of the weaker trade ties between the developed and developing worlds, the need for external intervention to foster collaborative relationships between firms is even more intensified.

### Purpose

The purpose of this paper is to explore the potential of collaborative industrial R&D (CIRD) in a North-South context. This paper represents a "rapid assessment" of notional options and is meant only to provide the foundation for a comprehensive scoping and design process. A more rigorous country-by-country analysis will be necessary before specific program structures can be developed. We hope this paper will provide the intellectual framework for a detailed discussion on specific program models.

## Design and Methods

The central hypothesis of this paper is that North-South collaboration in industrial R&D has the potential to benefit developing nations. Before this hypothesis can be properly analyzed, we

4 A 2001 RAND Corporation study defined a ranking system of the S&T capacity of nations: (i) scientifically advanced, (ii) scientifically proficient, (iii) scientifically developing, and (iv) scientifically lagging. As a rule, aside from the IDCs listed above, developing countries were ranked as "scientifically lagging" or at best "scientifically developing" (Wagner et al, 2001).

should first clarify what impacts and outcomes we hope to achieve through these frameworks. This paper is primarily concerned with three classes of impacts: (1) Company growth leading to new jobs (2) Workforce training and the acquisition of new skills and (3) Market-ready products that are tailored to the conditions of life in the South. Breakthrough technologies in the fields of health, environment and agriculture may potentially be an important byproduct of inter-firm collaboration. However, the efficacy of CIRD efforts is not measured herein based on its contribution to those fields.

With a focus on these aims, the upcoming section discusses the principle benefits and challenges of CIRD efforts and expected benefits and challenges of those efforts in the North-South context. This paper assumes that most collaborations of this type will be geared, at least initially, towards the development of products to be marketed in the South[5]. Following a discussion of those benefits and challenges, the paper will then go on to discuss design issues that must be considered in the planning of frameworks to promote North-South collaboration in industrial R&D.

# Benefits of Collaborative Industrial R&D

## Benefits to Participating Firms

Cross-border industrial R&D collaboration is often touted as a win-win proposition for the companies involved. Each firm comes to the relationship with distinct know-how and capacities which are then combined to create a new or improved product, process or service – the whole, in short, is said to be greater than the sum of its parts.

This depiction, however, falls short of capturing some of the major benefits of cross-border inter-firm collaboration, many of which extend beyond technological synergies. Culture, contacts and access are central to market penetration and these issues are intensified in the North-South context.

A deep understanding of local needs, conditions and cultures is essential to the creation of a useful, marketable product for the developing world. Yet in the absence of a Southern partner, Northern companies have no feasible method of amassing that knowledge in a comprehensive and cost-effective way. Southern innovators such as India and China have also developed a reputation for "frugal innovation", that is modes of developing lower-cost technologies and products. Moreover, lower labor costs in developing countries also help lower the cost of R&D. In most cases, Southern firms also have better access to suppliers and other market actors to facilitate the eventual sale of the jointly developed product. Finally, Southern firms are better able to navigate and troubleshoot regulatory and logistical barriers to market penetration.

Northern companies therefore stand to gain a great deal from collaboration with a Southern partner. What then do Southern companies receive? The answer, of course, depends on the

5 In the long-term, this will not necessarily be the case. Indeed, a distinct trend of "reverse innovation" has been gaining ground whereby low-cost frugal innovation is developed in and for the South and later adapted and transferred to the North. See Clean Energy Group (2011).

nature of their involvement and the stage of R&D at which the firms begin collaborating. Some collaboration begins at a very late stage, with Northern firms collaborating with a Southern partner to adapt an existing solution to the needs of Southern markets. In spite of misconceptions, late-stage product adaptation often involves extensive R&D, particularly when redesigning a product for the developing world. Materials, delivery systems, and pricing must all be changed to facilitate affordability, available, access, and adoption. In the case of such late-stage R&D collaboration, Southern companies benefit from well-developed technological know-how and solutions that may have been previously unknown and which they themselves lack the capacity to develop.

Many in the scientific community are critical of collaboration that focuses primarily on adaptation. They prefer a model that engages the developing world in S&T research. However, many developing countries currently lack the capacity to engage in these efforts and an interim role is necessary. By restricting R&D collaboration to cases in which "pure" scientific research can be co-conducted, we may be severely limiting the ability of poorer countries to build capacity through collaboration. The contribution of late-stage collaboration should not be understated.

For developing countries with the scientific capacity to engage in early-stage research- and particularly Innovative Developing Countries (IDCs)- cross-border collaboration might begin at a far earlier stage. In the case of collaboration in early stage R&D, Southern companies might benefit from more extensive scientific or technological expertise and training. They might also gain access to facilities and labs not available in developing countries. The research skills and experience obtained through this cooperation can later be used to develop new technologies either alone or in collaboration with new partners.

More important perhaps, Southern companies potentially stand to gain significant business training and corporate experience. For many Southern firms, particularly smaller ones, working closely with a Northern company represents a "crash course" in Northern corporate culture. In the course of collaborating with companies in the industrialized world, Southern companies are likely to gain insight into the work culture and norms of Northern companies which has the potential to serve them in future business dealings in the developed world. Even Southern companies with extensive business dealings in the developed world are likely to learn a great deal about Northern product and project management and design processes. For small companies in developing countries, this training and experience is of major significance for future growth and relationships.

## Spillover Benefits

Other parties benefit from these programs as well. A significant portion of the "social benefits" of new knowledge and technology are not captured directly by the firms that invest in R&D (Jaffe, 1996). The full social rate of return includes not only the private return - the return or profit earned by the firms undertaking the R&D - but also benefits to the firms' customers and to other companies. Parties not actively involved in the R&D collaboration might experience significant spillover benefits of three varieties: knowledge-spillover, market-spillover, and

network-spillover. These spillover benefits are the rationale for government intervention in CIRD collaborations (i.e. the overall public contribution of R&D collaboration is undervalued by the firms involved who measure benefits based only on their own private returns).

***Knowledge Spillover*** **-** Knowledge spillovers result when a given company experiences an increase in knowledge as a result of another company's research. That increased knowledge allows the former company to improve its products or lower its costs, increasing profits. These profits are part of the full social rate of return even though they are not captured by the firm conducting the research.

It might be argued that knowledge spillovers will occur independent of any collaboration between companies. Indeed, this is often the case in the North-North context and has been cited as one of the primary market failures in corporate investments in R&D. Alfred Marshall, one of the founders of modern microeconomics, long ago argued "the secrecy of business is on the whole diminishing, and the most important improvements in method seldom remain secret for long after they have passed from the experimental stage" (Marshall 1920). Yet, while North-North knowledge diffusion remains widespread, Southern access to existing knowledge remains restricted. The World Health Organization Expert Group on Research and Development Financing, commenting on the lack of knowledge diffusion from rich to poor countries noted:

> "[E]ven knowledge that is not formally restricted in this way [through intellectual property rights] fails to be diffused. '… one of the most significant aspects in economic development is not knowledge's over-dissemination, but instead the opposite, even in the absence of explicit intellectual property rights. Knowledge – something economists have expended so much effort studying how to restrict – turns out, puzzlingly, to be one of the most difficult things to disseminate.'" (WHO, 2010; Quah 2001).

Cross-border collaboration helps to facilitate such knowledge transfer from North-South to the benefit of many local companies. Benefits of this kind have already been realized in the capacity-building successes of North-South R&D collaboration in the field of agriculture and health, facilitated by aid agencies and funds[6].

***Market Spillover*** **-** Once the technology is commercialized, the general public reaps some of the benefits of the R&D as customers. Innovative technologies will result in improved products, lower production costs or both. Customers capture these benefits in the form of lower costs or higher quality. The more competitive the market in which these products are sold, the greater will be the public's share in these benefits. The social return is often the highest in the case of component products and materials; these are purchased by other firms and incorporated into a multitude of products, resulting in the diffusion of benefits to the public in a range of contexts.

For poorer countries, these cost reductions are of major significance. The lower cost of essential goods could mean the difference between life and death. In the case of consumer technologies,

6 See e.g. the Generation Challenge Program of the Consultative Group on Independent Agriculture Research and the Innovations for Agricultural Value Chains in Africa project of the Meridian Institute Project, both reviewed in Clean Energy Group (2011). For an in-depth discussion about the benefits of cross-border collaboration in health, see also WHO (2010).

lower prices may render products affordable that were previously out-of-reach financially. These might be used to generate more income, promoting economic growth.

***Network Spillover*** **-** Most important to CIRD are "network spillovers". This term has been used to refer to two types of spillovers, both striking benefits of cross-border CIRD. Network spillover might refer to cases in which the commercial value of one technology is dependent on the creation of additional technologies that can only be developed by other firms. Because the appropriability of the R&D investment of each product in the so-called "network" is dependent on the actions of third party firms, each firm will be unlikely to invest in the R&D unless a formal collaborative R&D venture has been established (Jaffe, 1996).

CIRD programs are designed precisely to facilitate joint undertakings of this kind. North-South collaborations enable Southern companies with partial solutions to bring their products to market in collaboration with Northern companies whose technologies serve as a complement. In addition, they allow other Southern firms to develop and commercialize technologies that interact with the new product, thereby facilitating the success of firms not directly involved in the cross-border collaboration.

The term "network spillover" might also be used to refer to networks of contacts established by one firm as a result of the efforts of another firm. Thus, suppose Firm A and Firm B are both firms operating in country X and seeking to do business in country Y. Firm A's successes in building partnerships and accessing the Y market are likely to spill over to Firm B. Firm B will have a less difficult time establishing contacts, accessing business partners and achieving product recognition following Firm A's successes. The larger Firm A and the smaller the market in question, the more likely this will be the case. As more firms from country X tap into the Y market, this becomes truer still.

In the case of North-South CIRD, a Northern partner A co-creates technology with a Southern partner. Through that partner, the Northern firm ostensibly gains access to sales and distribution channels, research facilities and a host of strategic market parties. Those contacts might later be used in the context of future business dealings by A or other companies in A's network of contacts seeking to do business in the same Southern country.

In sum, CIRD programs have the potential to generate many benefits to developing nations. They might result in new jobs, a better-trained workforce and new products that are suited to local needs. And they have the potential to strengthen local Southern companies and overall rates of trade by expanding networks of private sector contacts. The next section briefly discusses the feasibility of North-South collaboration in industrial R&D in light of anticipated challenges.

## Feasibility of North-South Collaborative Industrial R&D

Given the extensive benefits to Northern and Southern companies, one might expect to see more cases of joint industrial R&D initiatives. Yet, such partnerships are relatively rare in comparison to North-North collaboration. Several major challenges impede the development of such relationships. Chief obstacles include: (1) Lack of familiarity with needs and opportunities (2) Difficulty finding appropriate partners (3) Issues of trust (4) Communication and coordination challenges and (5) Financing-related issues.

1. ***Lack of Familiarity with Needs and Opportunities:*** Northern firms are far less aware of market needs and opportunities in the developing world than in the developed world. As a result, many are unaware of the potential application of their own technologies in Southern markets. Even if they are aware that such potential exists, they might not have the tools to measure the market-related opportunities and costs or they may fail to engage in such efforts. Absent such information, they lack the motivation to seek Southern partners for co-development of products.

2. ***Difficulty Finding Appropriate Partners:*** Cross-border collaboration in R&D presupposes the existence of a foreign partner willing and able to cooperate in the development of new technologies. Yet in the case of North-South collaboration, companies are often at a loss as to how to find appropriate partners and/or how to evaluate whether potential partners are suitable for the proposed joint venture. Existing networks of contacts on both ends are less likely to facilitate matchmaking than in the North-North context. Tools such as the European Enterprise Network (EEN) which facilitates matchmaking of companies across Europe are either absent in the context of North-South collaboration, underdeveloped, or underutilized. Northern firms thus lack the contacts to identify and locate appropriate partners in the South for collaboration purposes.

   In many instances, Southern firms will not have the information needed to seek Northern partners. Late-stage adaptation of technologies is the most likely form of cross-border collaboration with less-developed nations without a well-established S&T capacity. And aside from the IDCs, most developing nations fall within this category. When collaboration seeks to adapt existing technologies to new markets, it is the nature of the technology that will define the appropriate local partner and not vice-versa. Southern firms cannot be expected to anticipate these technologies or imagine their own role in adapting them. When Southern firms play this role of tailoring existing technologies, they are therefore unlikely to be ones to initiate the partner search.

3. ***Trust:*** Knowledge- and resource-sharing demands confidence not only in a counterpart's technical and business capabilities but also in its fidelity to the relationship. Trust of this level is rare between companies in a given country and even more difficult to foster with a company operating overseas. In Southern markets where corporate culture, social norms and business practices are markedly different from those familiar to Northern firms, this issue is

likely to be magnified. Lack of confidence in the protection afforded by the legal system in foreign countries against contract infringement and intellectual property theft (as is often the case in the developing world) exacerbates the problem considerably.

4. ***Communication and Coordination:*** Collaboration requires ongoing and effective cross-communication between the parties involved. In the case of North-South industrial collaboration, such communication is hampered by several factors, chiefly: (i) language barriers, (ii) disparate time zones and (iii) geographic distance. In addition to the above (iv) varied cultural norms (including workplace culture) often inhibit coordinated efforts even in the absence of the other factors.

   Language barriers are a major impediment in countries in which a large percentage of businesses do not have the capacity to work in English, which elsewhere often serves as the lingua franca for international business dealings. Vast geographic distances frustrate the convening of face-to-face meetings, influencing the efficacy and efficiency of joint projects. For certain industries, distances also impede the capacity to make joint use of laboratory facilities or spot-check progress of field tests and experiments. Finally, contrasting cultural norms encumber understanding on all levels – from manager to unskilled laborer – and at all stages.

5. ***Financing:*** Appropriate levels of funding for R&D are a well-known problem in the context of global financial constraints. In many cases, financing may be more difficult to obtain when the target market for the end-product is the developing world. Venture capital firms and other private sources of financing might shy away from funding such endeavors because of their own lack of familiarity and confidence in these markets.

In sum, several major challenges stand in the way of North-South industrial collaboration in R&D. Any government or third party mechanism aiming to foster such relationships must consider these challenges and endeavor to mitigate their impact. The upcoming section discusses decision points to consider in the design of models to promote North-South industrial R&D collaboration.

## Results

As we have established, left to its own devices the private sector is unlikely to maximize the potential of collaborative industrial R&D opportunities. This is due in part to fundamental market failures (i.e. the lack of sufficient private incentives due to the gap between the private rate of return on these investments and the social rate of return) and in part to practical issues (i.e. obstacles hindering the establishment and maintenance of the collaboration itself). Intervention will thus likely be necessary in order to catalyze North-South CIRD.

But what model can best serve these aims? This section sets forth four potential models for encouraging North-South collaboration in industrial R&D. After discussing the strengths and weaknesses of each model in the North-South context, this section goes on to lay out some additional design decisions that should be considered in selecting a model to foster North-South collaboration.

As noted in the introduction to this paper, this overview is meant only to provide the foundation for future analysis and decision-makings. A more comprehensive process of scoping and design should include a country-by-country analysis of limitations and opportunities.

## Options for Government-Facilitated Industrial R&D Collaboration

### Option One: Incentives Only, No Active Funding Program

This option would involve a series of incentives – tax-based and regulatory – to encourage collaboration between the developed and the developing world. Examples might include: full tax exemptions or tax credits for all joint-R&D expenses, more liberal definitions of deductible expenses for joint R&D projects, fast-track review of requests for administrative approvals for field testing/clinical trials, tax incentives to contribute to research funds etc. The aim of these incentives would be to make it easier and more profitable for companies engaging in joint industrial R&D to collaborate. According to the Millennium Project Task Force on Science, Technology and Innovation, this approach is now popular in developing countries to promote corporate R&D investments for the public welfare (Juma and Yee-Cheong, 2005).

The basic strength of this approach from the perspective of governments lies in the low-cost implementation. Little or no new staffing would be necessary in order to implement these policies and they require no active budget. From the perspective of participating firms, these incentives entail little or no effort. There is no lengthy application process and in the case of tax-deductions or credits, there is no delay in the receipt of benefits. The central weakness of this approach is that it does little to mitigate the major challenges listed above aside from the financing-related obstacles. The other primary challenges - lack of familiarity with needs and opportunities, issues of trust, communication and coordination, and difficulty in finding appropriate partners - all remain formidable impediments to collaboration. Thus, while this model might help encourage existing plans to collaborate on R&D, it is unlikely on its own to be sufficient to stimulate such collaboration.

### Option Two: Grant Program Using a Centralized International Agency

Under this model, a team comprised of companies from both the developed and developing world jointly apply for a grant to a centralized international agency to finance all or part of the proposed collaborative research. A grant scheme might be employed instead of, or in addition to a regulatory or tax-regime incentive system. A centralized international agency is likely to be adopted only in cases in which several countries are participating (as opposed to two). The single agency would then review applications and disburse funding to the teams of firms. Grants might be restricted to bilateral teams (North-South) or to multilateral teams (North-South-South or North-North-South). Participating countries would provide the funding which might be subsidized by an international aid agency. Developing countries might or might not be exempted from contributing their share.

The basic strengths of this approach lie in the experience and knowhow of the international agencies and their likely commitment to the cause. A centralized agency would be better able to track broad trends in industrial collaboration and there would be little or no concern about misdirection of funds. In addition, a central agency might allow countries to overcome diplomatic constraints to collaboration. On the other hand, an international agency is likely to be less flexible and more bureaucratic, resulting in delays in the disbursement of funds and other administrative difficulties. In the context of private sector activities, such hurdles could prove fatal to the planned collaboration. In addition, an international agency would be less in touch with local needs and particularized opportunities for synergy in specific bi-lateral contexts.

The largest drawback of this program, perhaps, is the likelihood that the weakest countries would be constantly rejected either because (i) their applications would be compared to those of developing countries with stronger R&D capabilities or because (ii) firms from least-developed countries would not know how to navigate the application process. In commenting on the similar experience of the Global Fund to Fight Aids, Tuberculosis and Malaria, the Clean Energy group pointed out that a few more capable countries consistently receive funding while others are consistently rejected (Clean Energy Group, 2011). These concerns might be mitigated by a quota system and/or provision of assistance to firms from these countries in filing applications.

## Option Three: Bilateral Grant Program

This model would involve either a bilateral fund or two parallel national funding mechanisms[7], jointly reviewing applications for North-South industrial R&D collaboration. The implementing agencies, each operating in its own national boundaries, would be responsible for all interaction with their own respective firms, including in the disbursement of funds.

Models of this nature are already being implemented throughout the developed world[8] and in certain developing countries, particularly IDCs. The Global Innovation and Technology Alliance (GITA) in India, the Ministry Of Science and Technology (MOST) in China and Foment to Innovation in Brazil are some agencies responsible for implementing bilateral frameworks of this type. For the most part, these programs are too new for their impact to be properly gauged. The budgets for these programs typically come in the form of matching funds pledged by each respective nation to finance subsidies provided to its own firms.

This model is advantageous inasmuch as it allows each country to shape its own criteria for eligibility and funding. In so doing, it allows developing countries to be actively involved in shaping their own future development, the importance of which has been recognized by the world community in the Paris Declaration on Aid Effectiveness and the Accra Agenda for Action (Paris Declaration on Aid Effectiveness, 2005; Accra Agenda for Action, 2008). However, unmatched

7 Programs need not be administered on the federal level. For instance, Israel currently has a series of bilateral R&D collaboration agreements with local implementing agencies in Jiangsu, Shanghai, and Shenzhen in China.

8 The largest of these is EUREKA, a pan-European inter-governmental framework for cross-border industrial R&D collaboration. The program was established in 1985 and currently has 39 national members. Cross-border efforts are coordinated by national project coordinators in each country who serve as the point of contact for local applicants. SMEs receive funding primarily under EUREKA's "Eurostars" programme for Small-to-Medium enterprises. See http://www.eureka-network.org.

(and often mismatched) eligibility and funding requirements may fail to provide a coherent and workable grant structure for cross-border teams. Moreover, developing nations may lack the administrative infrastructure to implement a program of this type effectively.

### Option Four: National Grant Program, Possible International Funding

Finally, developing countries might establish their own internal grant programs to subsidize industrial R&D collaboration between their own firms and firms from the developed world. The programs would be implemented in and by the developing nations themselves. International development aid funding might be made available to finance these efforts. A program designed by developing nations themselves will allow them to fashion the program in a way that serves their own national interests. This model casts developing nations in an active role in stimulating their own economic growth and is thus well in line with the Paris/Accra principles mentioned above. In the absence of a Northern implementing partner, however, it might be difficult for developing nations to effectively advertise the program to firms in developed countries. Southern nations may also lack the knowhow needed to tailor the programs in a manner that will attract firms from abroad. Moreover, programs administered in the South might be vulnerable to mismanagement of funds, a prominent concern in some developing countries.

## Other Key Design Considerations

Choosing a basic program structure is just the beginning. A myriad of factors will impact on the success or failure of any of the above models. Budget size is one obvious example. But while an adequate budget is crucial to the success of any program, large budgets are no substitute for a well-designed program. To be successful in the North-South context, CIRD programs must consider their context and help to mitigate the central challenges to collaboration. A brief discussion of some of the key design-related questions is set forth below:

1. *Should the program seek to build* **one-on-one collaborations or consortia of multiple companies***?* Most existing CIRD models focus on one-on-one collaborations between firms. It might be argued that the challenges to cross-border collaboration are weighty enough and a multi-party approach would become unwieldy. This argument has definite merit. Yet, given the particular stage of R&D development in some developing countries, a consortium approach might have more promise. Regional clusters of firms (especially small companies) might prove more attractive partners to Northern firms with concerns about the capabilities of any one partner. In some instances, no single Southern firm will have the requisite aptitude and a multi-party approach may be the only practicable solution. Clusters also provide an opportunity for local firms to collaborate and close-knit relationships between Southern companies can prove constructive in facilitating future economic development.

2. *How can the program help potential applicants* ***find partners****?* Matchmaking efforts are essential to the success of most CIRD initiatives. Most firms in the developed world lack

strong networks of contacts in the South and vice versa. Governments can engage in a variety of efforts to help firms find potential partners including: (i) matchmaking facilitated by CIRD implementation agencies and/or consular offices overseas (such as those currently conducted by bilateral CIRD funds and implementing agencies[9]), (ii) online databases and networking events (such as those initiated by the European Enterprise Network in the North-North context), (iii) industry-specific trade shows and networking events (preferably without entry fees), regional and national road shows, technology days, advertising, and online forums. In this last category, "Innocentive" is an interesting model that might be considered. Innocentive is an online forum launched by Eli Lilly Pharmaceuticals which uses crowdsourcing to link corporations with research-related challenges with R&D professionals and partners who might solve them[10].

3. *How should the program define its* ***target audience****?* Defining aims and a particular target audience is an important part of building a focused and effective CIRD program model. Many have rightly argued that small-to-medium enterprises (SMEs) are important vehicles for economic growth and funding programs should focus on building SMEs in the South (Juma and Yee-Cheong, 2005). Still, a CIRD program should not feel complacent in defining its target audience as 'SMEs' for several reasons. First, the term 'SMEs' is exceedingly broad and might include a firm with as few as 1 and as many as 1200 employees[11]. Second, firm size must be taken in context. A 50-employee company in a small island state likely has an entirely different market role than in a vast country such as China or India. Third, very small companies might not be the best partners to drive economic growth in the CIRD context because they most likely lack the resources to effect the sales of the eventual product and other essential skills. After considering these trade-offs and deciding upon a target audience, governments should endeavor to actively involve representatives from that audience in the program design process by soliciting feedback prior to program launch.

A program should also contemplate which stage(s) of R&D will be eligible for funding. Early stage R&D collaboration might be better at building S&T capacity but a program with that model might be ill-suited for poorer countries without a well-established S&T infrastructure. If a centralized agency model is adopted, this may mean that firms in IDCs (and large enterprises in other Southern countries) will be the most frequent recipients of grants. This trade-off is considerable.

4. *Should the program be limited to* ***certain industrial sectors****?* A CIRD program might define particular thematic areas. Several pan-European programs have adopted this approach[12].

9 In Israel, these efforts are facilitated with a small measure of success by MATIMOP and through bilateral funds such as BIRD (US-Israel), CIRDF (Canada-Israel), and KORIL (South Korea-Israel).

10 See www.innocentive.com

11 See US Small Business Administration. "What is a Small Business?" http://www.sba.gov/category/navigation-structure/contracting/contracting-officials/size-standards.

12 One example of an industry-specific program is the EUREKA Prometheus Project (PROgraMme for a European Traffic of Highest Efficiency and Unprecedented Safety), a Pan-European R&D consortium to advance the development of driverless cars). http://en.wikipedia.org/wiki/EUREKA_Prometheus_Project. Accessed 26 February 2012. See also JESSI (Joint European Submicron Silicon Initiative), a 3.8 billion Euro multilateral initiative wherein a publicly subsidized consortium of European companies collaborated to help gain ground lost to Asian and US competitors in the field of microchips. http://www.eurekanetwork.org/project/-/id/127. Accessed 26 February 2012. Europe's cross-border industrial R&D programs implemented through EUREKA represent a middle ground; calls for proposals are limited to broadly defined research areas.

Focusing on particular sectors allows Southern countries to build a critical mass of activity in one industry, facilitating both network and knowledge spillovers. By defining particular industries, Southern countries also take an active role in shaping their own futures, in line with the Paris/ Accra principles[13].

Industry-specific programs have certain key drawbacks. It is possible that the best opportunities for collaboration (or the greatest market failures) are not in the fields prioritized by government. Implementation agencies are unlikely to have a nuanced understanding of these opportunities. Moreover, governments may not be able to anticipate the fields that will have the greater positive impact on their economies. For instance, few anticipated how cellular phones would transform African markets (Clean Energy Group, 2011).

5. *How can the program help* **raise awareness about opportunities** *and* **build trust***?* Awareness of collaborative opportunities begins with an awareness of market needs and potential. Northern countries can help raise awareness through seminars and lectures for local firms through trade associations and export agencies. Facilitated workshops also offer interesting prospects for identifying untapped market opportunities. One promising workshop model is the "sandpit" model. A sandpit is a multi-day interactive workshop involving a team of expert mentors and a multidisciplinary group of stakeholders, some active researchers and some potential end-users of research outcomes. The aim of the workshop is to inspire innovative approaches to address particular challenges[14].

Trust is difficult to engineer. Still, countries can take a variety of measures to help facilitate confidence in cross-border efforts. Government-run companies can send a strong message by entering into collaborative R&D relationships with counterparts in the developing world. CIRD programs should also tap into the diaspora communities of former nationals of each country living within the borders of the other. Diaspora communities can play an important bridging role in the establishment of CIRD relationships. (Matlin and Abegaz, 2011).

6. *Should the program actively encourage the involvement of* ***other stakeholders*** *and if so, how?* End-consumers, research institutions and the financial sector have an important stake in the outcome of the collaborative process. CIRD program administrators should consider involving these stakeholders in these programs. Financial sector representatives and academics are currently involved in the application review process of bilateral CIRD programs in many countries including: France, Finland, Israel and Norway[15].

In addition to these design consideration, an effective model should also seek to find ways of complementing other national and international programs and aid initiatives so as to maximize synergies and create a holistic solution for local enterprises.

13 One might be tempted to define research areas that are of particular importance to the public good (e.g. health, agriculture, water). However, caution should be taken when adopting such an approach. If, as has been advanced in this paper, the aim of North-South CIRD programs is fostering economic growth, then the focus should not be on advancing a specific research agenda. Technologies in many high priority research areas are likely to have low rates of private return (WHO, 2010). A program serving multiple agendas is less likely to be optimally successful in achieving any of its aims.

14 This model was first developed by the Engineering and Physical Science Research Council in the United Kingdom as part of its "Ideas Factory approach". The model has since been replicated in a number of different countries.

15 Information based on conversations with representatives from CIRD implementing agencies in Western Europe and Israel. September-October, 2011.

## Conclusion

International development aid has done much to promote economic growth in developing countries. Although public sources of financing are critical, alone they are not sufficient; the private sector must help bridge the gap. North-South collaboration in industrial R&D represents a promising vehicle to promote economic growth in the developing world. Such collaboration allows Southern firms to develop technological and business skills and contacts and participate more actively in international trade. Because of the obstacles to CIRD, outside intervention will be needed to stimulate North-South collaboration of this type. This paper has provided a rapid assessment of opportunities and design considerations for a model to promote CIRD. It is our hope that this assessment will provide the platform for the design of sustainable programs – programs that can benefit the developed and the developing world, together as one global community.

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