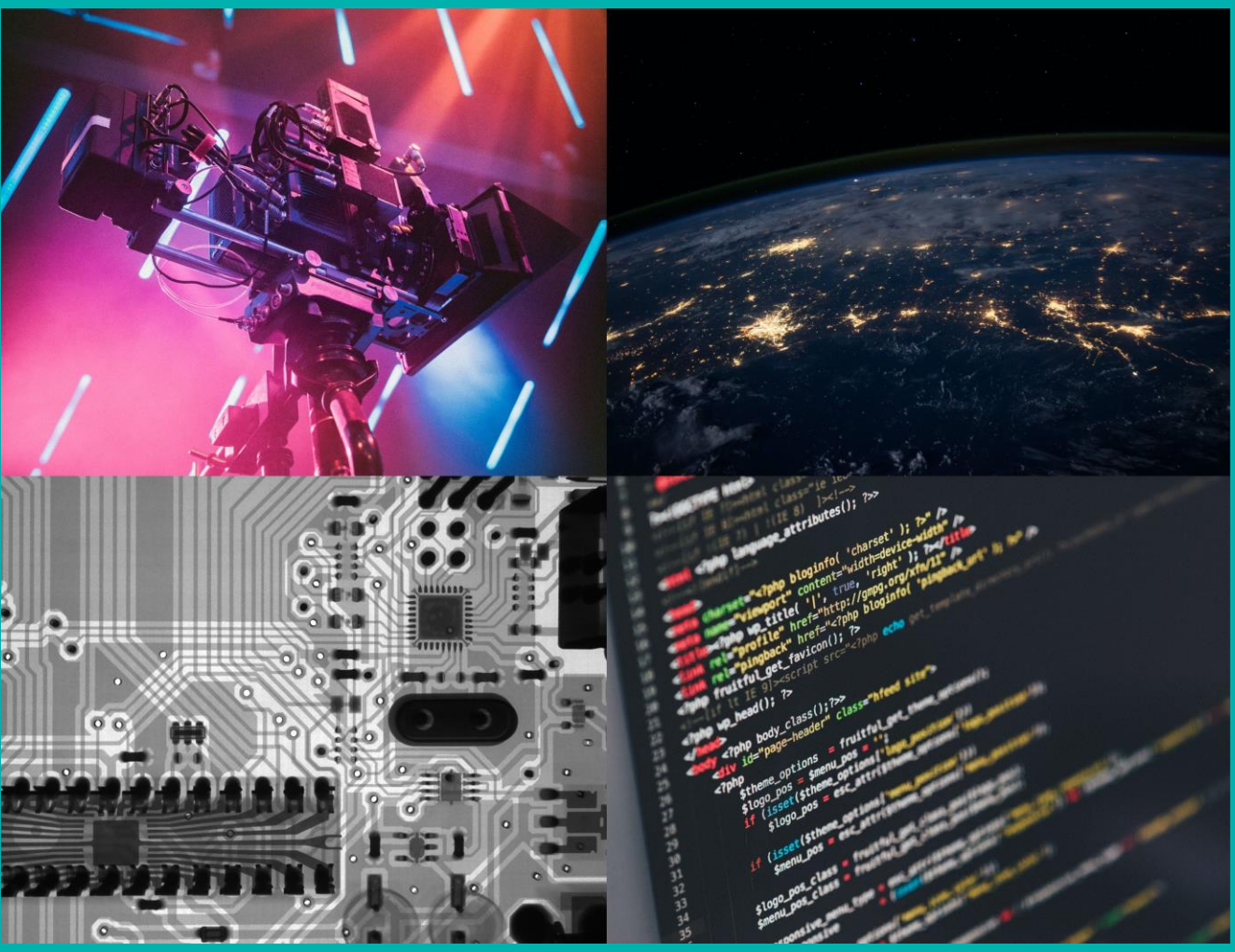

Working Paper

Co-innovation for Low Carbon Technologies: The Case of Japan-India Collaboration

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Key Messages

- The conventional model of technology transfer often focuses on the sale of finished products from developed country (source country) to developing country (recipient country).
- This conventional model risks undermining the dynamic learning process needed to adapt and create market share for low-carbon technologies in developing economies.
- Co-innovation offers access to advanced technology and manufacturing within the recipient country while helping the source country access to fast-growing market.
- Co-innovation can supplement the static, one-way, conventional technology transfer model and help enhance the speed and scope of technological collaboration between Japan and India.

Abstract

Enhanced collaboration with countries with advanced technologies is essential to closing greenhouse gas (GHG) mitigation gaps in developing countries' energy consuming and producing sectors. However, traditional models of technology transfer tend to focus on the sale of expensive technologies to developing countries, often subsidised through aid or grant programmes. These models also limit the recipient country's involvement in the conceptualisation, manufacturing and scaling of those technologies. The high costs and lack of involvement can, in turn, generate end products that are poorly suited to local conditions while dampening incentives to promote the sale and purchase of those technologies. This paper argues that this conventional model is too static and not sustainable given fast-growing low carbon technology demands. To build a more dynamic and sustainable model, technology donor (source) and recipient (host) countries need to partner together from conceptualisation to production to scaling up. This paper examines the potential of co-innovation — a collaborative and iterative approach to jointly innovating, manufacturing and scaling up — to support Japan-India technology collaboration. The paper contends both developed and developing countries can be better off if they pool knowledge and resources with a view toward bringing faster and more efficient solutions to closing the mitigation gap.

> Co-innovation is a collaborative and iterative approach to jointly innovate, manufacture and scale up technologies

Introduction

Developing countries are increasingly turning to foreign manufacturers to meet sharply escalating demands for low-carbon technologies. The conventional approach to transferring these technologies is nonetheless often limited to the one-way flow of finished, high-end products. However, this conventional view often overlooks multiple challenges when adapting technologies from a developed to a developing country. These include a lack of continuous support, inadequate capacity for operations, and a poor fit with local conditions. There is an urgent need for an alternative approach to technology collaboration where both donors as well as recipients benefit from mutual engagement. The uptake of an alternative approach has become even more pressing as countries consider greening their COVID-19 recoveries.

The main purpose of this paper is to present the core design features of an alternative approach. The paper focuses on the concept of co-innovation. Co-innovation refers to a dynamic and iterative process where both domestic and external partners jointly participate in the ideation of concepts, test the feasibility of those concepts, translate the concepts into demonstration projects, and adjust demonstration projects to local conditions with a view to reaching a marketable and scalable end product. The paper contends that efforts to facilitate co-innovation will help overcome many of the barriers to technology transfer and widen opportunities for exchange of knowledge. To make the design features of co-innovation more concrete, the paper presents examples from Japan's efforts to promote low-carbon technology in India.

Literature Review: Why co-innovation instead of technology transfer

The section outlines how literature has looked at technology transfer and its limitations, and then discusses how co-innovation can help overcome several of the main limitations.

Existing model of technology transfer

Although technology transfer has long been regarded as crucial for climate change mitigation in developing countries, there is no commonly agreed definition of the term. Most definitions concentrate on the flow of knowledge, expertise, equipment and so on, from one stakeholder to another. These flows can move in either a vertical and horizontal direction; the former refers to the transfer of technology across production phases (from research and development to commercialisation), while the latter concerns the diffusion of that technology across geographic space (Schnepp, Glinow, & Bhambri, 1990). In either case, the transfer is typically one-way from suppliers in developed countries to recipients in developing countries (Bell, 1990).

The transfer of the technology can also occur via different channels, including joint ventures, the trade of goods, foreign direct investment (FDI), mergers and acquisitions, and patent licencing (Hayashi D. ,

2018). While the most effective of these channels is typically a joint venture, there are still many barriers to making even that more dynamic model work well. On the investor side, for example, inadequate protections on intellectual property is a frequently cited challenge. The lack of protections may discourage companies from sharing product and manufacturing knowledge for fear that they will lose on the investments that went into researching and developing products.

Although inventor side concerns are important, they pale in comparison to the impediments developing countries face. These barriers include concerns that the technology transfer process has not supplemented the development of supportive "indigenous technologies." These complementary technologies are often needed to support the adoption and operation of advanced leapfrogging technologies (Khosla, Sagar, & Mathur, 2017). A related set of challenges is that end product technologies may be ill-suited for local contexts. A final set of constraints involve the lack of technological know-how and capacity in manufacturing products and machinery in the developing countries. The next section will demonstrate how the more dynamic process of co-innovation — with its emphasis on learning and benefitting a wider range of stakeholders — could help overcome these barriers.

Key terms and concepts

As the term co-innovation is relatively new, it has thus far received modest attention in pertinent environmental and climate policy literature. Rather, most studies use the term when discussing information technologies as opposed to environmentally sustainable technologies. There has nonetheless been some useful work on the definition of co-innovation. For example, some studies suggest co-innovation is the 'shared work of generating innovative and exceptional design conducted by various actors from firms, customers, and collaborating partners' (Saragih & Tan, 2018). Arguably the most noteworthy part of this definition is that there exists an innovation process that is not limited to engaging the usual suspects of firms and academia who have been traditionally the lead actors in innovation. Instead a much larger web of stakeholders who are offered access to an innovation platform and an opportunity to engage with the external actors can meaningfully participate in this process (Lee, Olson, & Trimi, 2012).

Although the term "co-innovation" itself is still relatively new, similar concepts of "co-creation" and "co-development" are used more commonly and have important implications for actors as well as the outcomes of the innovation process. For example, when Ramaswamy and Gouillart (Ramaswamy & Gouillart, 2010) discuss co-creation they highlight "the practice of development systems, products, or services through collaboration with customers, managers, employees, and other company stakeholders [in an effort to create value]." A key takeaway from this passage is that the creation of value is not limited to the product itself but extends to the development of socio-economic and human capital of the participating stakeholders. Hence the innovation process also brings benefits to the aforementioned

broader range of stakeholders. These stakeholders are giving as well as getting returns from participation in the innovation process.

Technology transfer from Japan to India: opportunities, limitations, challenges

Japan has been a longstanding leader in official development assistant (ODA), foreign direct investment (FDI), transferring technology and collaboration to India. This leadership is evident in survey data from the Reserve Bank of India (RBI) that showed during 2012-13 and 2013-14 about one fourth of foreign technology collaboration (FTC) with Indian companies came from Japan. The same study demonstrated the transfer of "know-how" was also increasing sharply over the same juncture (PTI, 2015). In terms of sectoral focus, the transport sector has been the area with the highest levels of cooperation. Between 1997 and 2007, the transport sector registered the highest levels of technical collaboration (Nataraj, Sahoo, & Dash, 2013). Moreover, cooperation on transport is likely to continue to bring India and Japan together as the leading institutions for the innovation in electric vehicles are Japanese companies, and India is supporting a transition to these vehicles.

In the environment and climate policy areas, Japan has made considerable efforts to transfer low-carbon technologies in and beyond Asia. However, similar to technology transfer more generally, several challenges have limited the scope and the speed of that cooperation. First, the initial cost as well as the operation and maintenance costs for some highly sought low-carbon technologies can be prohibitively high. These high costs can serve as disincentives to purchase technology — even if they can be offset by climate finance or official development assistance (ODA). Second and partially related to the first issue, there have been a limited number of demonstration projects that qualify for climate finance or other forms of assistance between India and Japan in recent years. To facilitate the transfer of Japanese technologies to developing country partners, Japan has created the Joint Crediting Mechanism (JCM) as a bilateral offset crediting mechanism. However, since India is a non-signatory to Japan's JCM programme, it has not become a viable channel to support the transfer of technologies to India. Moreover, JCM is designed to chiefly facilitate the transfer of technologies from Japan to partner countries rather than involving partner countries in the early conceptualisation and production phases of the transfer.

For many of the above reasons, collaboration between Japan and India has followed the conventional technology transfer process whereby Japan remains the provider and India is recipient of technology. Thus the desirable expansion of participation of Indian stakeholders in the process of innovation, product development, installation and application has not materialised. As a result, the transfer and adoption of low-carbon technologies in India has not matched local context. In a similar vein, India has not undergone a "technology transformation" or "naturalisation" process that could deepen and spread support for that technology. That transformative process adjusts the enabling environment in the

recipient country by acquiring some of the key traits of that technology or embracing other supportive reforms needed for that technology to gain market share (Hayashi T. , 1984).

Japan's Perspective on Co-innovation

The challenges outlined in the previous section are notable because Japan has been an advocate for "co-innovation" or similar themes in important policy statements. In international climate policy, Japan has repeatedly underlined the need to create a broader enabling environment for low-carbon technological development, especially in developing countries. For example, Japan's Ministry of the Environment (MOEJ) has argued that deep emission cuts can be achieved when 'innovation developed through collaboration between Japan and the partner country creates markets for decarbonized products, services, and technologies that are suited to the partner country and that bring about major transformations in socioeconomic systems and lifestyles' (MoEJ, 2018).

Japan has also initiated concrete programmes that are consistent with the advocacy in the above policy statements. The Partnership to Strengthen Transparency for co-Innovation (PaSTI) (MoEJ, 2018a), for example, promotes engagement with non-state actors in partnering countries, enhancing capacities and institutional structures and strengthening collaboration at the national, regional and subnational levels. The Japanese government's long-standing support for co-benefits — actions that achieve both local development and global climate benefits — also has potential to facilitate a collaborative process of learning and adjustments to local contexts. While these programmes have helped to strengthen partnerships, they also underline the need to further specify how co-innovation could be more formally operationalised. The operationalisation will require creating an ecosystem of legal, institutional and market facilities that predictably pattern interactions within and across stakeholders in supplier and recipient countries.

Low Carbon Technologies in India

Operationalising co-innovation is critical because it would help meet fast-growing low-carbon technology needs in India. Simply stated, India's demands for low-carbon technologies are significant and growing. India's Biennial Update Report makes this point clear by stating that the 'the transfer and grounding of appropriate technologies and know-how is key to enhancing adaptation and mitigation measures (MoEFCC, 2018)'. The report also presents an array of technologies that are critical to meet national climate and energy goals — especially, in the transport, industry, power and building sectors. Finally, the report notes that 'learning from the collective wisdom of innovators elsewhere, India can complement its own efforts and fast-track the development of environmental friendly technologies appropriate to its national circumstances and requirements (MoEFCC, 2018)'.

Another rationale for operationalising this concept involves the market share Japan is losing as well as the undesirable effects for India of leaning too heavily on a single country for technologies. At the risk of

exaggeration, India has almost limitless potential for harvesting solar energy. Much of that potential is currently being met by technologies manufactured by foreign companies. In the renewable energy industry, India imports almost 85% of the solar panels required to meet domestic demands. Though domestic manufacturers have previously been involved in the solar equipment production, the high influx of cheap equipment from China has turned many domestic manufacturers into retail outlets for Chinese goods. This has adversely affected domestic industry production; it has also led to some legally questionable behaviour such as China re-routing solar products through other countries with which India has Free Trade Agreements (FTA) to circumvent anti-dumping and countervailing duties.' This example serves to underscore that dependency on overseas technology in the form of finished products is not necessarily good for India or Japan.

Trying to manage the above issues by competing on renewable energy with China might not be feasible or prudent for Japan. However, as noted previously, there are several areas that Japan could target to gain ground. These begin with growing demand for both passenger and public transport electric vehicles. Japan has potential to tap this market if vehicle exports could be packaged with high quality and dependable battery storage, charging facilities and vehicular designs that suit the needs of Indian consumers. Another need for Indian industries are energy efficient technologies. These technologies account for a significant share of fossil fuel consumption and India has made continuous efforts to promote energy efficiency in the industrial sector. Such technologies are crucial for not only heavy industries but also small and medium sized enterprises. A final area where more cooperation could pay dividends are air pollution abatement technologies. Increasing concentrations of particulate matter (PM2.5) and other toxic pollutants are leading to significant rise in the number of respiratory illnesses, hospital admissions, health expenditures and losses in labour productivity in India. Cleaner technologies could deliver multiple benefits for India. Costs and context appropriateness are concerns for each of these potential areas of collaboration, but they could be relaxed with a well-defined strategy to bring down costs and tailor technologies to user needs.

India-Japan Experience in Co-innovation: Lessons from Maruti Udyog Limited

Collaboration with Japan is particularly important for India. This is partially because of the remarkable progress Japan has made with energy efficiency and energy conservation. That progress offers useful examples and sources of inspiration for India (and other countries) that is behind the learning curve in areas of technological need. There is also a shared sentiment that both India and Japan do not only have commercial interests but also strategic gains in deepening that collaboration. For example, the two countries have ‘underlined the need to intensify cooperation in high technology, space, clean energy and energy sector development, infrastructure and smart cities, bio-technology, pharmaceuticals, ICT, as well as education and skills development to strengthen and deepen their Special Strategic and Global Partnership’ Invalid source specified..

Importantly, the opportunities for enhanced collaboration are not limited to words on paper. There have been concrete examples of both Japan and India benefiting from collaboration. One of the most illuminating is the formation of Maruti Udyog Limited, a joint venture created by the government of India and Japan's Suzuki Automotive manufacturer. That venture is currently called Maruti Suzuki India Limited (MSIL) and occupies an impressive 53% of market share of the passenger car segment in India. Further illustrating the success of this partnership, MSIL is known today for producing the most affordable passenger cars in low- to high-cost segments and has become the preferred brand among Indian vehicle manufacturers. The obvious question is how did this initiative become so successful?

Several elements coalesced to make that success possible. First, the car manufacturing operation was jointly set up by the Indian government and Japan's Suzuki Motor Corporation to meet growing demands for private vehicles in India following a series of market liberalising reforms in the 1990s. The increase in sales then helped to lower costs. Second, growing sales allowed the joint venture to offer continuous post-sales support by creating service centres to install new parts and offering used car sales, driving schools, and other auxiliary services. Last but not least, MSIL is now expanding its technology and product offerings to meet new demands for compressed natural gas (CNG) powered, auto gear shifting vehicles and smart hybrid vehicles (Mobility and Automobile Innovation Lab, 2019).

Co-innovation: Role in Economic Recovery and Rebuilding

As countries are focusing on economic recovery in the post-COVID period, two points have come clearly into focus. First, demand for newer technologies that can support economic recovery are expanding quickly. While developing countries cannot depend on expensive advanced technology or equipment, they also recognise developing technologies domestically can be time-consuming and, hence, may need to look to foreign markets. Second, demands for clean energy technologies in developing countries are likely to continue to grow as countries push for greater 'self-sufficiency' and 'strengthening local economies'. Advanced technology can play a critical role in addressing both points as part of COVID-19 recoveries.

In India, bearing in mind the above two points as governments prepare fiscal stimulus packages can widen opportunities for collaboration on priority technologies and machinery. India's fiscal stimulus has been estimated at 20 trillion Indian Rupees (270 billion USD); significant shares of those resources are slated to flow to the coal sector and MSMEs. Although the contributions to sustainability of investing in coal can be disputed, MSMEs could be a particularly attractive target for cleaner technologies. According to the sixth Economic Census (2013), for example, roughly 60 million MSME establishments are in operation with approximately 60%set up in rural areas. Moreover, according to government estimates, MSME also contributed to roughly 28% of the total GDP in 2015-16 (Ministry of Micro, Small and Medium Enterprises, 2018); this underlines that investments in these industries can deliver benefits beyond the immediate improvements in the technology. Key MSME sectors, including rural industrialisation, agriculture and several cottage industries such as leather, could arguably reap a wide

range of benefits from energy savings and cleaner production methods. Yet here again it will be critical to enable a mutually beneficial process of shared learning as embodied by co-innovation rather than linear technology transfer.

Operationalising Co-innovation

'Co-innovation' can be a powerful catalyst for technology change. While climate change is recognised as an immense challenge, co-innovation is still a relatively new area of research that can help meet this challenge. In shedding fresh light on this area, it is important to detail the institutional, policy, legal, and market frameworks that enable an advanced source country to collaborate with a developing recipient country. Strengthening interactions between governments and business can be both commercially and strategically valuable; it could also deepen and reveal often latent knowledge on what can make technology collaboration work in a developing country context. While the paper specifically looks at co-innovation as a means to narrow technology gaps, this model has more general applications to other areas where developing and developed countries collaborate. In terms of India-Japan bilateral cooperation specifically, co-innovation can be seen as a process that moves from ideation and innovation to develop technology-based solutions to address critical national as well as global challenges.

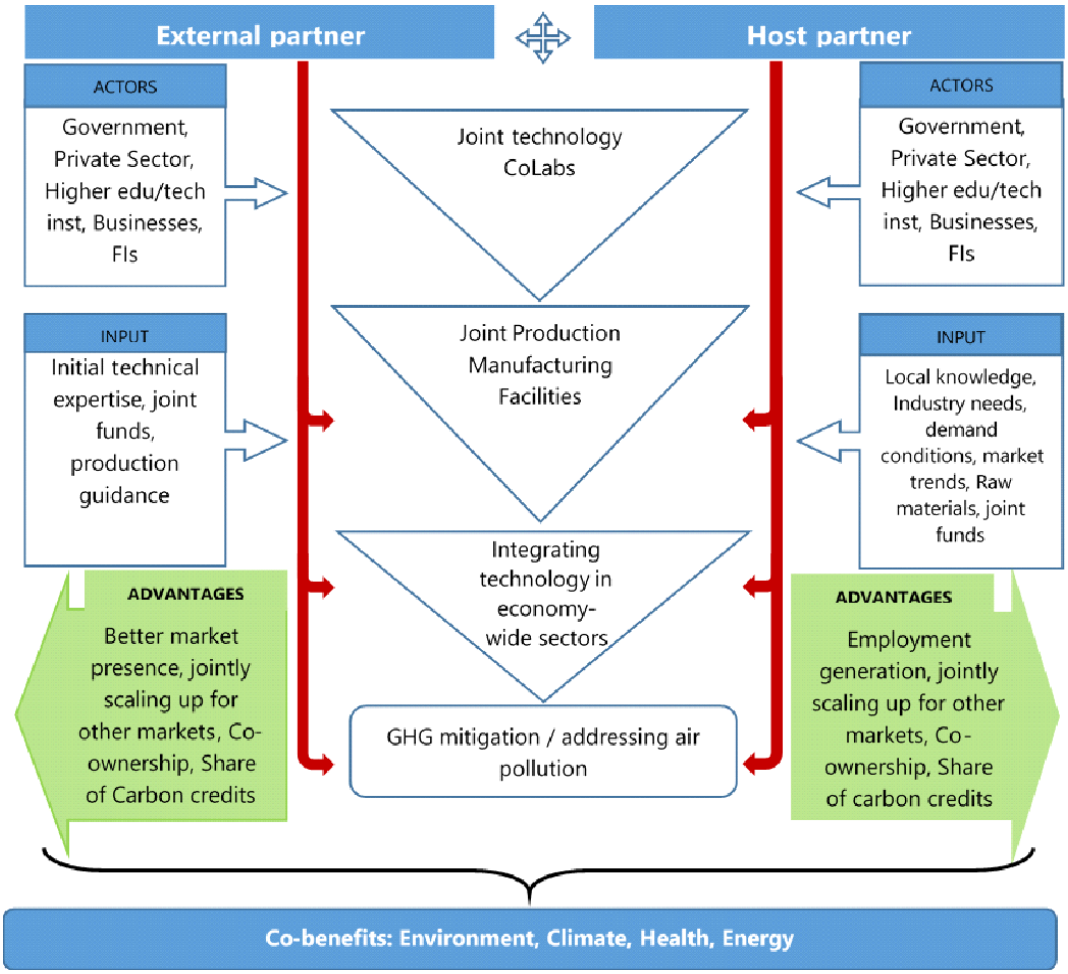
It is widely recognised that low-carbon technologies can help meet climate mitigation and clean energy targets while combating air pollution. Unlike the conventional model of technology transfer, where technologies from one country to another through often temporary, profit-motivated business-to-business (B2B) interactions, the public goods nature of low-carbon technologies arguably demands a more sustainable approach. Sustainable should, however, not be confused with static. Climate mitigation and air pollution are dynamic and evolving issues that move quickly with economic activities, emissions trends etc. Hence, it is important to continuously integrate contextual concerns when adapting technological solutions to local and wider environments. Co-innovation can do just that, helping meet desired context-appropriate targets while making solutions economically viable and environmentally sustainable.

Shaping Co-innovation

Co-innovation has considerable potential as a concept; but it too must be given additional shape and substance to deliver on this potential. Identifying the key stakeholder incentives for participating in co-innovation processes is essential to making that process operational. What becomes clear from thinking about those incentives is that both developed and developing country stakeholders have much to gain from participating in this process. While the recipient country possesses a large repository of knowledge about local conditions, demand trends, political and economic dynamics, a source country maintains experience in the use of mature technologies. To give co-innovation a form that will allow it to support the transfer of climate technologies, the recipient country and source country may need to develop customised institutions and approaches to engage in co-innovation. These critical elements include

reforming policies, laws and governance arrangements that favour more conventional models of technology transfer.

Co-innovation model



Source: (Janardhanan, 2019)

Building Counterparts: Engaging with Indian States

Some of the above reforms should feature working more closely with subnational state and regional governments. How to engage with the counterparts in a recipient country is critical to strengthening technology collaboration. In India specifically, there is considerable scope to work below the national government. This is because India is not only the world's largest democracy but operates as a quasi-federal system. In this quasi-federal system, while the central government retains powers to manage issues that transcend state borders (i.e. mining, air travel), the constitution arrogates several rights and responsibilities to state governments (Ministry of Commerce and Industry, 2017). This is done to capitalise on the benefits of decentralisation and centralisation, while limiting drawbacks inherent in each. It also means that state level governments have the opportunity to work on sector specific areas of technological collaboration. Because many of the areas of technological cooperation fit this

characterisation, it may make sense to build co-innovation hubs in states that are particularly supportive of the concept.

Co-innovation: Limitations

While highlighting the importance of co-innovation, the paper does not discount potential challenges to making it work. Aligning the interests of source and recipient country, building capacity of recipient country in manufacturing and production, setting up adequate institutional mechanisms, securing financial resources, negotiating legal aspects are likely to be significant hurdles for co-innovation. This reflects on some of the barriers to co-innovation. These are aimed at highlighting these areas that are critical to policymakers, and also to present pointers for further research.

Institutional Mechanism

One of the most critical hurdles for co-innovation will be the lack of an institutional framework that guides its implementation and operation. Without institutional mechanisms that ensure both the source and recipient partners operate within a clear and credible legal and regulatory framework, co-innovation will not be a successful model. Policies related to trade, import, manufacture and marketing as well as those regulations related to the use of natural resources in a specific country need to be modified when two or more countries agree to co-innovate. The fact that direct import and sales often bring more profit to source partners than the co-innovation approach may be a point of contention when designing institutional mechanisms. Apart from creating policies specific to manufacturing and production under co-innovation, there will also be a need for newer legal machineries and institutional arrangements to handle specific issues emerging from such engagements. Legal provisions for addressing the labour issues, occupational hazards, industrial disputes and various aspects related to production and manufacturing will need to be addressed. However, institutional mechanism pertaining to co-innovation can be different in different country contexts, depending on the bilateral relations and the trade and industrial manufacturing policies.

Intellectual Property Concerns

One of the most important concerns could relate to intellectual property rights (IPR) of goods and products that are manufactured through co-innovation. It is important to protect the industrial property rights of both (multiple) partners involved in the co-innovation arrangement through a bilateral agreement specific to the parties involved. As co-innovation recognises the roles of partners involved, a fair share of rights need to be attributed towards their respective roles. This also points to the need for development of an IPR architecture for co-innovation.

Investor Willingness

The market in India has been sensitive to businesses owned by foreign companies. Despite the rules relating to Foreign Direct Investment (FDI) having been progressively liberalised over the past few

decades, there have been concerns related to investment from a few of its neighbours largely due to the historic perceptions of political differences. In April 2020, the Indian government further modified its FDI rules due to concerns related to Chinese businesses attempting to acquire stakes in Indian companies at significantly low valuations. As one of the changes in the rules, neighbouring countries were barred from making any investment without prior consent from the government. However, in the case of India-Japan trade ties, the latter enjoys tremendous goodwill. This also suggests that the trade, import and joint venture initiatives between the two countries will continue to grow and expand.

Conclusion

The transfer of technology from one country to another is not a new phenomenon. Hence, the objective of this paper was not to reinvent the wheel, but to examine the feasibility of technology collaboration in a manner that enhances long-term partnership and benefits multiple stakeholders under the framework of co-innovation. The paper also pointed at the benefits and drawbacks of co-innovation as a potential platform to supplement the existing models of developed-developing country technology collaboration. Apart from highlighting the concept of co-innovation in the context of India-Japan technology collaboration, the paper also highlights several critical questions and offers some useful answers.

The primary questions is, whether India can use the idea of co-innovation for low-carbon development in the long-run. As the COVID-19 pandemic has brought in an unprecedented disruption in trade, the availability of advanced technology equipment and machinery critical for climate mitigation initiatives has come into question. For India, its dependency on China for 85% of the total solar energy equipment imports has emerged as a critical challenge following the collapse of bilateral trade in the wake of the pandemic. Lack of adequate domestic capability in developing or manufacturing these equipment or machinery further challenged the domestic energy sector as well as industries. In this context, co-innovation could strengthen the country technologically, especially in meeting domestic demands for advanced technologies. This, in turn, can help the country to make much-needed progress on low-carbon development plans, especially in cutting down emissions through implementation of low-carbon measures in key emitting sectors.

Another critical question is about the feasibility of ‘co-innovation helping India to become a production and manufacturing hub’. While there are likely to be mixed responses to this question, one could argue that co-innovation will strengthen India’s capability to strengthen its manufacturing and production facilities. In addition, India’s promotion of initiatives such as *Make-in-India*, *Invest-in-India* and *Zero-effect-Zero-defect*, which are aimed at expanding the countries manufacturing sector are in tune with the concept of co-innovation. Thus, it is hoped that there will be definite advantages for India to collaborate with Japan through co-innovation. Japan’s advanced technologies and India’s favourable policies present a natural opportunity for bilateral collaboration. From a policy perspective, co-

innovation is a necessary step for India to leapfrog in enhancing self-sufficiency in the access and use of advanced technologies.

Nevertheless, co-innovation will not happen without adequate changes to institutions and laws. Convincing businesses of the advantages of co-innovation, as well as communicating the same to policymakers will be critical in promoting co-innovation. Institutional mechanisms need to be set up by both collaborating partners. These could take the form of a legal framework, financial tools, as well as measures to protect intellectual property rights — all critically important for co-innovation to become a reality. Moving forward, it will become increasingly important to communicate the benefits of co-innovation to industry in comparison to the existing technology transfer model.

[This is an ongoing work of the authors. The concept has been introduced through (Janardhanan, 2019)*. Authors thank Emma Fushimi for language editing.]*

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