9 *SDG9, industry, innovation and infrastructure: technology and knowledge transfer as means to generate co-benefits between health and industrial Sustainable Development Goals*

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9.1 Introduction

Ensuring universal health coverage requires a stable, affordable supply of drugs and vaccines. The current COVID-19 pandemic has exacerbated the need for low- and middle-income countries (LMICs) to strengthen (or build) their own health industrial capabilities that would allow them to gain a steady supply of vaccines and achieve faster immunization coverage. This chapter explores the links between Sustainable Development Goal 3 (SDG3) (specifically Targets 3.3, 3.8 and 3b, which address the need to fight communicable diseases, achieve universal health coverage, and invest in research and development of vaccines and medicines, respectively) and SDG9, which calls for the development of industry, innovation and infrastructure in LMICs. It argues that initiatives such as technology transfer and local production of pharmaceuticals in LMICs can be a means to promote industrial and innovation goals (for example, skills development and manufactory capacity-building), while meeting health needs.

The first parts of this chapter revisit the international commitments to align health and industrial goals and identify their causal pathways and limitations. Sections 9.4 and 9.5 present two case studies: 1) Brazil's technology transfer strategy for the human papillomavirus (HPV) vaccine through a public–private partnership between Merck Sharp & Dohme (MSD) and the Butantan Institute, a local, state-owned

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laboratory, and 2) the implementation of the *Sociedade Moçambicana de Medicamentos* (SMM, or Mozambican Pharmaceutical Ltd), a Brazil–Mozambique South–South cooperation (SSC) project for the implementation of an antiretroviral and other essential medications factory in this sub-Saharan African country.

Brazil has been known for integrating health and industrial policy through initiatives that foster technological development of local pharmaceutical companies through public–private partnerships (termed productive development partnerships, PDPs) (Flynn, 2015; Shadlen & Fonseca, 2013), and as such, the country merits attention. Brazil's successful domestic experience has also inspired the development of pharmaceutical technology and capacity-building in sub-Saharan Africa (Mackintosh et al., 2016).

Both cases illustrate the intersectoral initiatives between health and industrial policies in Brazil and Mozambique and how they have led to increased health benefits – such as sustainable and affordable access to the HPV vaccine in Brazil and essential medications in Mozambique – but also the industrial and technological co-benefits – such as the modernization of local state-owned laboratories and enhancement of technological and human capacity in both countries. Additionally, the cases illustrate co-benefits concerning other SDGs related to gender (SDG5 and SDG10), as well as cross-sector and cross-country collaboration.

The two case studies have significant variations between them, namely the fact that Brazil is an upper-middle-income country and Mozambique a low-income country. As such, these cases allow us to explore the dynamic interaction and co-benefits between SDG3 and SDG9 in different contexts and to study the complexities and difficulties as functions of these contexts. Although the two case studies can help elucidate the co-benefits between health policy and measures to promote scientific and technological development, further research is still needed to better understand which channels, governance arrangements, and mechanisms can promote effective coordination between the two sectors. Our analysis does not intend to be exhaustive in the possibilities and avenues for promoting co-benefits between SDG3 and SDG9. Also, although we focus primarily on the health care aspect of SDG3, the analyses presented in our chapter can stimulate investigation into other elements of public health, for instance, disease prevention (for example, the production of diagnostic test kits).

9.2 Background

This section briefly characterizes SDG9, its relevance to SDG3, and why it matters for co-benefits. SDG9 relates to three core aspects of sustainable development: infrastructure, industrialization and innovation. According to the first SDG progress report,

> Infrastructure provides the basic physical systems and structures essential to the operation of a society or enterprise. Industrialization drives economic growth, creates job opportunities and thereby reduces income poverty. Innovation advances the technological capabilities of industrial sectors and prompts the development of new skills. (United Nations Economic and Social Council, 2016, p. 13)

SDG9 has eight targets, which refer to "outcome targets" (such as upgrade all industries and infrastructures for sustainability, enhance research and upgrade industrial technologies) and "means of achieving targets" (such as facilitate sustainable infrastructure development for LMICs, and support domestic technology development and industrial diversification). The case of pharmaceutical technology transfer speaks well to these SDG9 targets as it requires building new infrastructure, it relates to a global industrial sector, and it is also innovative as it means gaining knowledge. Other areas of investigation would be medical technologies and devices, such as the surge of wearables to monitor people's health.

SDG9 is usually discussed in relation to environmental issues (Kynčlová, Upadhyaya & Nice, 2020). However, there are important synergies between SDG3 and SDG9, particularly Target 3b, which relates to the research and development of vaccines and medicines for the communicable and non-communicable diseases that primarily affect LMICs, as we shall see now.

One of the important societal challenges of our time is securing steady and affordable access to, and stimulating the development of, innovative health technologies in LMICs. In the early 2000s, the linkages between intellectual property regulation and access to biomedical technologies in LMICs became more evident and revealed the need for a new way of thinking about research and development (R&D) policies to respond to societal needs and demands. It was in this context, in 2008, that the World Health Assembly launched the Global Strategy and

Plan of Action on Public Health, Innovation and Intellectual Property (GSPA-PHI) (World Health Assembly, 2008). This plan represented not just a framework for action but also a fundamental paradigm shift for global R&D by focusing on priority diseases in LMICs (Nunn, Fonseca & Gruskin, 2009). For the first time, there was a global commitment to creating, and consensus on the need for, new mechanisms to incentivize R&D and the capacity to generate health innovations in LMICs. Today, although the linkages between health systems, innovation and health industry policies have become more visible (Natera, Tomassini & Vera-Cruz, 2019; Proksch et al., 2019), there is still a great need to explore the governance arrangements that connect these policies and their co-benefits.

Local pharmaceutical production and technology transfer were identified as means of bridging gaps in access to medicines and contributing to local economies in LMICs (Mackintosh et al., 2016; Russo & Banda, 2015; Shadlen & Fonseca, 2013). Throughout the years, the World Health Organization has developed an initiative to assist LMICs in strengthening their capacity to produce medicines (WHO, 2011). It also became clear that the limitations of the GSPA-PHI in promoting such initiatives as its goals were too broad for effective implementation (WHO, 2018).

The COVID-19 pandemic renewed the interest in technology transfer and local production of pharmaceuticals because of the need to scale up vaccine production to secure a stable supply and the challenges of ensuring equitable access to COVID-19 vaccines. In June 2021, the WHO organized the first World Local Production Forum (WLPF). The Forum aimed to call "Member States' attention in aligning the production of health products as essential long-term infrastructure akin to food, water and energy as safeguards to protect national, regional and global security" (WHO, 2021b). Therefore, the WHO recognizes that increasing investment in industrial development alone is not sufficient. It is the dynamic interaction of both realms, R&D and health systems, that matters (Santiago, 2020). Such intersectoral action cannot be built quickly during the pandemic era. It requires long-term investments to build partnerships and business linkages and develop knowledge in strategic sectors for national security – knowledge that can be applied during public health emergencies.

For instance, bridging health and industrial goals requires patent licences, strengthening the regulatory system, and building an ecosystem

for local production, among other factors (WHO, 2021b). An ecosystem for local pharmaceutical production includes engagement of the trade, finance and judicial sectors of governments (WHO, 2021a). For instance, low access to capital is a key limiting factor for local manufacturers in LMICs; this requires long-term financial support from development banks and other financial institutions. According to the WHO, these elements would hopefully stimulate the development and sustainability of vibrant health product manufacturing industries in LMICs.

9.3 Causal pathways between health action and SDG9 co-benefits

There are actions that have the potential to build co-benefits between the health care sector and industry. One is the notion of PDPs. Initiatives such as the Drugs for Neglected Diseases initiative (DNDi) – which aimed at conducting and coordinating R&D for new drugs, diagnostics or vaccines – address pressing health needs in resource-limited settings. By doing so, since the early 2000s, DNDi has contributed to building innovation ecosystems in LMICs and invested in improving health infrastructure through clinic and laboratory renovations, the provision of essential equipment and supplies, and the continuous training of health personnel, with almost 5,000 people trained since 2010 in the Lead Optimization Latin America project[1] alone (Drugs for Neglected Diseases initiative, 2019).

Although our analysis focuses primarily on the LMICs context, experiences in industrialized nations illustrate the potential for generalizing our rationale of co-benefits between SDG3 and SDG9. For instance, promising actions are mission-driven innovation policies, which have been encouraged mainly by the European Commission (EU) (Directorate-General for Research and Innovation, 2003; Kok, 2004).[2] For instance, the EU Horizon 2020 research and innovation programme (2014–2020) aimed to combine solutions to broad societal challenges as drivers of economic growth and industrial leadership. As part of

[1] A project to foster studies on two neglected diseases, leishmaniasis and Chagas, in collaboration with my Latin American academic partners.

[2] As defined by Rozenkopf, Sjatil and Stern (2019), a mission – a concrete, ambitious goal – has the power to unite different stakeholders to collaborate at scale and provide a bold and inspirational space to answer innovation challenges.

this framework, the Innovative Medicine Initiative, a public–private partnership between the EU and the pharmaceutical industry, supported several projects, including measures to combat infectious diseases such as Ebola (Laverty & Meulien, 2019). Investments included developing and testing a new vaccine against Ebola and community engagement to educate and assist in vaccine uptake in affected areas.

Considering the strength of the evidence, previous studies point to different directions in relation to the effectiveness of such public–private partnerships. In the case of PDPs and mission-driven innovation, despite the enormous literature on the management of these programmes, we still need a better understanding of how to implement them effectively (Uyarra et al., 2020). When it comes to defining the mission and using strategic purchasing in the public sector, we cannot ignore that asymmetries in information, market power, political power and financial power can hinder the effective implementation of these public–private partnerships (Corporate Europe Observatory, 2020; Greer, Klasa & van Ginneken, 2020). Particularly in the health sector, with the introduction of new medical treatments, policymakers and regulators must decide on medicines whose effectiveness is low or even controversial, as in the case of Aducanumab (Salinas, 2021). Scholars have proposed different scenarios in which public purchasing can promote economic development and structural change (Uyarra et al., 2020) and methodologies as to remedy this limitation (Héder, 2017).

Although stimulating drug production in LMICs could bring potential cost savings, as some locally produced pharmaceuticals are less expensive than their imported versions, there is no consensus about this dilemma (Chaves et al., 2015; Kaplan, 2011). The tension between two objectives cannot be ignored: access to medicines depends not just on procuring at the lowest price, but also on having a stable supply of vaccine and drugs (Shadlen & Fonseca, 2013). Kaplan (2011) found some evidence that investments in local pharmaceutical production increased the innovative capacity of local firms, particularly in Southeast Asian countries, and other modest innovation experiences in sub-Saharan Africa. In the case of antiretroviral drug production, clearly the local production of medicines increased the export capacity of India and South Africa, but there was little evidence that local production increased the quality standards for the product or the reliability of supply in LMICs.

Finally, considering the alliance between these two realms – health care and industry – we cannot ignore the challenges of coordination.

Brazil is a successful case in which government commitments in health, which often translate into public procurement for essential health supplies, revealed weaknesses and deficiencies in manufacturing of pharmaceutical products and incentivized industrial development in sectors where demand is strong (Flynn, 2014; Nunn, 2008; Shadlen & Fonseca, 2013). However, the case of India is illustrative as the country is known worldwide for its impressive drug industry, which has contributed to increasing access to medicines in several LMICs but has so far failed to provide essential medicines regularly to its own people (Chaudhuri, 2007). China, a giant producer of active pharmaceutical ingredients, also failed to provide satisfactory pharmaceutical care in its national health system but has recently begun applying strategies to remedy this situation (Abbott, 2017). During the COVID-19 pandemic, despite the vaccine development capacity of China, India and Russia, all three struggled to achieve high immunization rates quickly (Safi, Merz & Davidson, 2021). All these examples suggest we still need to better understand which channels, governance arrangements, and mechanisms can promote effective coordination between health care and industrial capabilities. Such challenges are not easy to overcome and will require continuous debates in forums such as the WLPF.

Co-benefits between SDG3 and SDG9 should produce spillover effects on other SDGs as well. For instance, the policies discussed so far have clear implications for SDG17 (global partnership for sustainable development), which promotes public–private partnerships, multilateral cooperation, and science, technology and innovation capacity-building mechanisms. Over the past two decades, vaccine R&D has been transformed by public–private partnerships such as DNDi and GAVI (a global partnership that provides vaccines to low-income countries), combining the strengths of both sides to develop, finance and deliver affordable vaccines to children in LMIC.

Fig. 9.1 depicts some of the causal pathways between health systems and industrial, innovation and infrastructure actions. Specifically, it illustrates these pathways in the initiative to stimulate local production of pharmaceuticals, diagnostics and vaccines in LMICs. Between the two extremes – health and industrial goals – there are several intersectoral actions ("enabling ecosystems"), such as strengthening the regulatory capacity that is necessary to assess good manufacturing practices. There is a need to promote partnerships such as South–South cooperation or technology transfer, continuous training of human resources, and

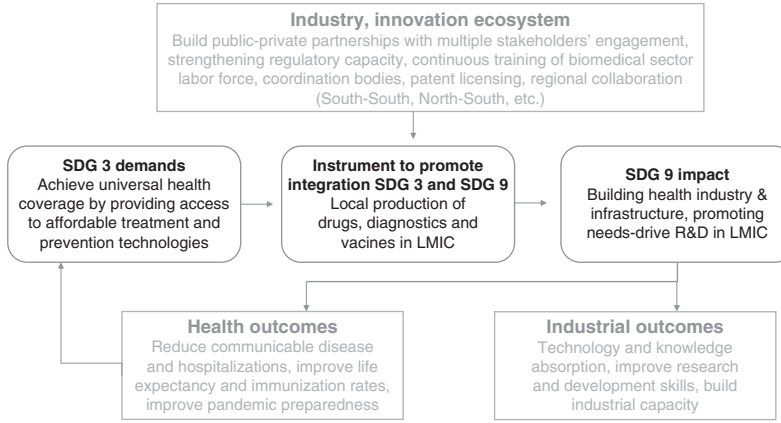

Fig. 9.1 Mapping causal pathways between health programmes and co-benefits

absorption of new knowledge and technology for drug and vaccine production. Achieving SDG9 goals will produce industrial outcomes such as technology absorption, but also health benefits such as the reduction of communicable disease transmission because of increased access to vaccines (as in the case of hepatitis B), improvement of pandemic preparedness, and eventually improvement of population health outcomes (for example, reduced hospitalizations and increased life expectancy and immunization rates).

9.4 Case study 1: HPV vaccine technology transfer in Brazil

This section discusses Brazil's technology transfer strategy for the HPV vaccine. HPV is one of the most common sexually transmitted infections, and a small percentage of infections, depending on the viral type, can progress to cervical cancer. Cervical cancer is the fourth most common cancer in women, with 85% of new cases occurring in LMIC, and 87% of deaths from cervical cancer occurring in less-developed regions (Ferlay et al., 2015). Brazil introduced HPV vaccination into the National Immunization Programme (PNI) in 2014, after the approval of the National Commission of Technology Incorporation (Conitec) (Domingues, Maranhão & Soares Pinto, 2015). In 2012, the Ministry of Health encouraged the transfer of HPV vaccine technology from Merck Sharp & Dohme (MSD) to a local, state-owned laboratory, the

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Butantan Institute, as a way of maintaining a stable, affordable supply of vaccines (Baker et al., 2015).[3] Promoting access to HPV vaccination and technology transfer relates directly to SDG3.3 (fight communicable disease), 3.8 (achieve universal health care coverage), and 3b (support research, development and universal access to affordable vaccines). It also creates relevant co-benefits relating to SDG9 (industry, innovation and infrastructure) and SDG5 (gender equality).

The transfer of HPV vaccine technology is part of Brazil's strategy to use the purchasing power of the health system to stimulate transfer of knowledge and technology around drug and vaccine production to local firms (public and private) (Varrichio, 2017). In 2012, the Ministry of Health opened a call for partners interested in transferring HPV vaccine technology to a public laboratory. Two consortia submitted a proposal: GlaxoSmithKlein and Biomanguinhos, with a bivalent (protects against two virus types) HPV vaccine, and MSD and Butantan, with a quadrivalent (against four virus types) HPV vaccine. After deliberation by the Management Commission, which included representatives of the National Health Surveillance Agency as well as the Ministries of Health, of Industry and Trade, and of Science and Technology, the Ministry of Health approved the MSD/Butantan consortium, arguing that a quadrivalent vaccine was a better technology. In addition, the agreement with Butantan included access to the nonavalent (against nine types) portfolio which was then under research (Gadelha, 2018). A total of US$452.5 million would be invested in purchasing the vaccine over a five-year period, starting in 2014, while the technology was being transferred (Marchesini, 2013).

The technology transfer arrangement proceeded in reverse, from the final to the early stages of the production process. Between 2014 and 2016, Butantan was responsible for importing vaccines from MSD and distributing them to the Ministry of Health. In 2016, Butantan proceeded to fill and finish the product, certify quality control, and package the medicine for distribution (Albuquerque, 2016). Although the Ministry of Health and the government of São Paulo agreed to invest R$300 million (US$54.4 million) to build a new factory for Butantan, which would allow the full transfer of the HPV technology (Marchesini, 2013), the project is yet to be finished.

[3] Vaccine efficacy can be accessed here: https://www.merckvaccines.com/gardasil9/efficacy/#Demo27to45 (accessed 15 November 2021).

The governance structure of the HPV agreement specified Ministry of Health involvement primarily in coordination, monitoring and evaluation of the partnership, guiding technology transfer protocols, and financing. The CGU (Office of the Comptroller General) and the TCU (Federal Court of Accounts) audit the PDP contracts (including the HPV vaccine technology transfer) and set parameters for them (Table 9.1). However, the partnership stalled owing to low access to the capital needed to build the new factory (the final step to conclude knowledge transfer). It illustrates, therefore, the challenges of securing governments' long-term commitment to local drug production and the crucial relevance of access to credit for the sustainability of technology transfer projects.

The HPV vaccine technology transfer produced important co-benefits in terms of industry, innovation and infrastructure. These benefits correspond particularly to SDG Targets 9.2 (promote inclusive and sustainable industrialization) and 9.5 (enhance research and upgrade

Table 9.1 *Governance actions and intersectoral structures of the HPV vaccine technology transfer*

			Governance actions								
			Goals and targets	Evidence support	Policy guidance	Implementation and management	Coordination	Advocacy	Monitoring and evaluation	Financial support	Legal mandate
Tools	Plan	**Plan (agreement)**	x			x	x		X	X	x
	Indicators and targets	**Indicators**									
		Targets									
	Budgeting	**Pooled budget**									
		Shared objectives	x		x			x	x		
		Coordinated budgeting	x			x				x	x

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Table 9.1 *(Cont.)*

			Governance actions						
Tools	Organization	Ministry of Health	x		x	x	x	x	x
		CONITEC		x					
		Ministerial linkages (Industry and Trade, Science and Technology, ANVISA)					x		
		Butantan (State-owned laboratory)		x					
		Regional government (Sao Paulo)				x			
		MSD		x					
	Accountability	Transparent data	x						
		Regular reporting	x				x		
		Independent agency/ evaluators: TCU and CGU	x	x	x				x
		Support for civil society							
		Legal rights							

industrial technologies). According to a representative of the Ministry of Health who participated in the HPV agreement, the technology transfer would not only allow sustainable, affordable access to the HPV vaccine, but would also modernize Butantan's technological capacity, which was then dedicated to an outdated product portfolio (Gadelha, 2018). In terms of industrial and innovation goals, the technology transfer of the HPV vaccine brought important gains to Butantan. First, it allowed Butantan to make use of the Virus-like Particle (VLP) vaccine platform (Kallil, 2018). In possession of technology that uses VLPs – molecules

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that mimic viruses but are not infectious – Butantan would be able to conduct research in new directions. Noteworthily, after almost ten years of agreement, the factory was not built, causing delays to Butantan's full assimilation of the technology. Second, in terms of quality and process control, Butantan has undergone notable advancement in its infrastructure as part of this agreement, an improvement reflected in the manufacturing of other products as well. For instance, it has enhanced quality control processes in production of the influenza vaccine (Rocca, 2018). For MSD, besides gaining access to the Brazilian market, the partnership was important in that it certified an additional outsource supply, which is significant considering that production is a major bottleneck in the vaccine supply chain (Lesser, 2014).

Besides the co-benefits in industry and innovation, the technology transfer of the HPV vaccine and vaccination also produced spillover effects on gender equality, particularly in ensuring access to sexual and reproductive health (SDG Target 5.6) (Portnoy et al., 2020). Therefore, as younger females have higher rates of vaccination in Brazil (Wendland et al., 2021), it can evidence their access to sexual and reproductive health care. The technology transfer of the HPV vaccine was also an important instrument to stimulate public–private partnerships in the health sector (SDG Target 17.17, encourage effective public–private partnerships).

The HPV vaccine technology transfer took place in a context of expansion of health industry policies in Brazil (Shadlen & Fonseca, 2013). Although public laboratories such as Butantan and Biomanguinhos had engaged in technology transfer of vaccines in the past, in 2011 the Ministry of Health began an ambitious project, known as PDP, to foster technological development of local pharmaceutical companies. The legal architecture and protocols of PDPs paved the way for the transfer of HPV vaccine technology. Given the strategic relevance of the HPV vaccine to the public health system and its technological gains to Brazil and Butantan, the political importance of this project can be defined as high. The political conflict, in contrast, is defined as low, as there was collaboration between the government of São Paulo and the Ministry of Health, as well as a voluntary patent licence awarded to Butantan. The latter is usually a key source of contention in the pharmaceutical sector. By promoting an agreement with Butantan, MSD has gained market access to Brazil's public health system and certified a new outsource supplier (Table 9.2).

Table 9.2 *Political importance and conflict: the context of policymaking and implementation of HPV technology transfer*

		Conflict	
		Low	**High**
Political importance	High	x	
	Low		

9.5 Case study 2: the Mozambican Pharmaceutical Ltd: a South–South cooperation project

In 2003, the governments of Brazil (henceforth GoB) and Mozambique (GoM) signed a South–South cooperation (SSC) agreement for the installation of the *Sociedade Moçambicana de Medicamentos* (SMM, or Mozambican Pharmaceutical Ltd), a pharmaceutical laboratory for the production of antiretroviral (ARV) and other medications. Based on Brazil's successful domestic production of ARV generics to fight the HIV/AIDS epidemics, the SMM would also help foster Mozambique's – and sub-Saharan Africa's – first state-owned pharmaceutical industry. Local production of medicine through capacity-building courses and technology transfer from Brazil is directly related to – and could potentially produce – the SDG Targets 3.3 (fight communicable disease), 3.8 (increase access to quality and affordable essential medicines), 3b (support the research and development of vaccines and medicines), and 3c (increase health financing and the recruitment, development, training and retention of the health workforce in developing countries). It could also produce co-benefits related to SDG9 (promotion of industrialization, innovation and infrastructure) and SDG17 (partnerships for the goal), particularly 17.6 (enhance SSC for access to science, technology and innovation, and enhance knowledge sharing on mutually agreed terms) and 17.9 (through SSC, enhance international support for implementing effective and targeted capacity-building in developing countries). The implementation of the SMM unfolded in a low-income setting highly dependent on Indian generics. As such, this study may help illustrate how to increase access to medicines through domestic production in similar contexts in sub-Saharan Africa.

It can be argued that the implementation of the SMM went through three phases (Achcar, 2022). The initial phase was characterized by a

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common understanding among stakeholders of the importance of the factory in public health policies, particularly regarding the fight against HIV/AIDS, and the role of each institution in the governance of the SMM. On Brazil's side, the elaboration and implementation were carried out within the organizational structure of Brazil's SSC. The project was formally coordinated by the Brazilian Cooperation Agency (ABC) under the Ministry of Foreign Affairs (MRE), with Fiocruz[4] as the implementing agency, specifically the Institute of Drug Technology (Farmanguinhos)[5] (Table 9.3). Because ABC's capacity was low and coordination was still weak, the "true centre of gravity of Brazilian health cooperation" was the Ministry of Health, particularly Fiocruz (Abdenur & Folly, 2015).

In Mozambique, the factory belongs to a public business institution called the Institute for the Management of State Holdings (Portuguese acronym, IGEPE), and the sectorial tutelage is exercised by Mozambique's MoH (also called MISAU) (Table 9.3). IGEPE was created in 2001 to restructure state-owned enterprises and determine the sectors in which state ownership was considered necessary (Balbuena, 2014). Despite being the formal owner and financial tutor of the factory since 2009, it was not until the change in the Ministers of Health in 2010 (second phase) that IGEPE started playing a key role in the management of the factory (Achcar, 2022). Although not openly contested, this was a point of disagreement between the two governments. According to Fiocruz's health experts, the governance of the SMM should ideally model that of Brazil and Farmanguinhos. In other words, the SMM should belong to Mozambique's MoH and as such should be 100% state-owned (Achcar, 2022).

Although in the first phase both governments agreed that the SMM should be 100% state-owned, in the second phase the GoM desired to privatize it. Without yielding financial results, the longest and most expensive Brazilian SSC project in health needed public investment that the GoM claimed not to have. The Brazilian mining giant Vale stepped in and financed the infrastructure (Russo & Oliveira, 2016). Another obstacle to the implementation of the factory was Brazil's delay in approving the funds necessary to buy the equipment for the factory. Brazil did not possess a legal framework for SSC, which made the

[4] Fiocruz is the Oswaldo Cruz Foundation, Brazil's largest public health institute.
[5] Farmanguinhos is currently the largest official pharmaceutical laboratory linked to the Ministry of Health.

Table 9.3 *Governance actions and intersectoral structures of SMM South-South collaboration*

			Governance actions								
			Goals and targets	Evidence support	Policy guidance	Implementation and management	Coordination	Advocacy	Monitoring and evaluation	Financial support	Legal mandate
Tools	Plan	Plan	x			x	x		x		x
	Indicators and targets	Indicators Targets									
	Budgeting	Pooled budget Shared objectives Coordinated budgeting									
	Organization	**In Brazil**									
		Ministry of Foreign Affairs (MRE)	x		x		x				
		Brazilian Cooperation Agency (ABC)	x		x		x		x[6]		
		Ministry of Health (MoH)			x	x					
		Fiocruz/ Farmanguinhos	x			x	x				
		Anvisa	x		x	x					x
		Private Sector (Vale)								x	
		National Congress								x[7]	x

[6] Brazilian SSC is criticized for the absence of a systematic MandE. It would be the ABC's responsibility to provide MandE, with the MoH and Fiocruz also exercising some monitoring along the way.

[7] Approval of financial support for purchasing equipment.

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Table 9.3 *(Cont.)*

		Governance actions						
		In Mozambique						
Tools	Accountability	Ministry of Health (MISAU)	x	x	x	x	x[8]	
		Regulatory Agency (DNF)		x	x			x
		IGEPE	x			x		
		Mozambique Stock Exchange (private capital)					x	
		Transparent data	x					
		Regular reporting	x					
		Independent agency/ evaluators: TCU and CGU[9] (In Brazil)	x	x	x			x
		Support for civil society						
		Legal rights						

allocation of resources into projects very difficult. It took the National Congress 20 months to approve the funds.

When the desire to privatize the SMM became clearer to Brazil, there was intense mobilization from the MRE, the MoH and, especially, Fiocruz to convince the GoM of the strategic importance of the factory not only to the health system but also to the development of a nascent national industry (Achcar, 2022), thus closely connecting it to SDG9.

[8] The financial support from MISAU would come from public purchases of drugs.
[9] Both TCU (Federal Court of Accounts) and CGU (Office of the Comptroller General) provide internal oversight of agencies such as Fiocruz, including its SSC initiatives. The TCU audits the accounts related to SSC – for example, the funds approved by the National Congress for equipment for the SMM.

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It was argued that this would promote spillover effects on different sectors of the economy owing to high technology development and transfer and the creation of high-quality employment. The argument was based on Brazil's – particularly Fiocruz's – view that integrating health policy objectives and industrial policies was crucial (Fonseca, 2018). Furthermore, throughout the project the importance of the SSC for the promotion of self-sustainability was always emphasized, reinforcing arguments related to SDG17.

Another important event reinforced the importance of today's SDG9. HIV underwent mutations and Brazil no longer had the technology to produce the most modern ARV drug. The decision, agreed upon by both sides, was to transfer the technology required for the production of essential medicines in primary health care only. This, according to Fiocruz and the MoH, was not a negative decision. Producing essential medicines would spearhead the production of other technologies (Achcar, 2022).

The third and final phase in the implementation of the SMM was characterized by a compromise between the two governments over the fate of the SMM. Rather than being 100% state-owned, the governments reached a common decision whereby 35% of the SMM's shares were to be listed in the country's stock exchange to raise capital while preserving majority state ownership. A few recent initiatives in 2020 seemed to strengthen the SMM's role in enhancing a local pharmaceutical industry, namely 1) negotiations for public–private partnerships with foreign laboratories, 2) the implementation of a health regulatory agency with the support of Brazil's health regulatory agency, Anvisa, and 3) the successful application for membership of the Southern African Generic Medicines Association (SAGMA). While the political significance of the SMM was high for Brazil's SSC foreign policy strategy, it can be classified as moderate for Mozambique. The political conflict between the two countries can be classified as moderate to low, as both governments reached an agreement in the end (Table 9.4).

9.6 Conclusion

The editors define co-benefits as the intended positive side-effects of a policy from subsidiary benefits, i.e., unintended positive side-effects. In other words, co-benefits are secondary benefits, collateral benefits or associated benefits. In this chapter, we argued that adopting initiatives

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Table 9.4 *Political importance and conflict: the context of policymaking and implementation of the SMM*

Brazil		Conflict	
		Low	Medium
Political importance	High		x
	Low		
Mozambique		Conflict	
		Low	Medium
Political importance	High		
	Medium		x
	Low		

for technology transfer and local production of vaccines and drugs can lead to a stable supply of pharmaceuticals, which, in turn, can generate capability gains for the pharmaceutical sectors. By fostering local production, countries will be encouraged to strengthen their regulatory systems, which is crucial to manufacturing practices, and ensure quality control. It will also be an opportunity to train and develop human resources, develop new skills, and promote local industrial development. Although the pathways to achieve co-benefits are relatively straightforward, the practice of transferring knowledge and gaining pharmaceutical manufacturing capabilities is more complex.

For decades, the WHO has incentivized LMICs to invest in needs-driven R&D and local drug production. The SDG Target 3b reflects the global consensus on the relevance of fostering drug manufacturing capabilities in LMICs. Despite the WHO reports, guidelines and studies, LMICs still struggle to fully accomplish these goals.

The cases of the HPV vaccine and the SMM illustrate that these projects can suffer from delays and shortages of funding, which can negatively affect the full assimilation of technology and industrial development. Both projects have produced relevant intermediate benefits, and interviewees have demonstrated a great appreciation for technology and manufacturing gains. Therefore, although technology transfer is valuable, it is easier said than done (Fonseca, Shadlen & Bastos, 2021; O'Sullivan, Rutten & Schatz, 2020).

With the renewed interest in local drug production in LMICs as a means of scaling up COVID-19 vaccine production (Fonseca, Shadlen

& Achcar, 2023; O'Sullivan, Rutten & Schatz, 2020; WHO, 2021b) and the popularity of mission-driven innovation policies (fostered mainly by the European Union) (European Commission, 2015; European Union, 2019), we will need to reflect on effective ways to implement these initiatives on the ground. The first step is to look back at the past and avoid similar mistakes. The GSPA-PHI assessment report recognized the lack of impact in its implementation and proposed focused actions (WHO, 2018). Therefore, initiatives such as the WHO's World Local Production Forum – a global platform to foster discussions about local production of pharmaceuticals, vaccines and other health products – must produce clear goals and targets.

Another vital aspect is the acknowledgement that the political economy is critical, especially in a highly politicized environment such as the biomedical sector. As the case study from Brazil shows, private–public collaboration can result in mutual benefits.

The first step of technology transfer is defining what knowledge will be transferred and why. This knowledge is typically framed as a strategic product that is crucial in life-saving terms and essential for health security. Yet, as we learned from other experiences, the concept of "strategic" cannot be taken for granted given the asymmetries in the pharmaceutical sector (Greer, Klasa & van Ginnekin, 2020). The same is true for drug regulatory capacity, which is still incipient in many countries in the Global South (Khadem Broojerdi et al., 2020). Without robust health and manufacturing surveillance, any attempt to produce drugs and vaccines in LMICs will be insufficient.

Therefore, technology transfer and local production require good governance practices, such as coordination among government departments, conducive regulatory policies, complementary supply-side measures, clearly articulated policy objectives, and careful evaluation, which are framed as "enabling ecosystems". Perhaps no other public policy requires the political ability to build coalitions with different stakeholders in such complex value chains while also building new governance capabilities in sensitive areas (for example, public budgets and patents). Doing so can be even more challenging in the context of LMICs. Not all countries have such ecosystems, and some countries only possess an informal network of players engaged in production, research and particular aspects of innovation. Technology and knowledge transfer can help foster these ecosystems and achieve the SDG9 targets.

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