Article

An Organizational Theory of International Technology Transfer

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International technology transfer plays a critical role in advancing economic and social welfare around the world. Conventional wisdom holds that strong intellectual property rights—primarily patents—promote the transfer of technologies between countries. An important counternarrative, however, contends that weakening patents promotes important forms of technology transfer. This Article challenges the centrality of both perspectives by arguing that neither strengthening nor weakening patents is sufficient to transfer many technologies. This Article disaggregates international technology transfer into its constituent activities, focusing on the important processes by which technical knowledge itself moves between countries. In theory, patents play an important role in the international transfer of technical knowledge because, among other functions, they require inventors to disclose their inventions. In practice, however, such disclosure is often inadequate. This Article argues that multinational organizational structures play an important and

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underappreciated role in transferring technical knowledge between countries, even for inventions that are ostensibly disclosed in patents.

In so doing, this Article offers a new gloss on the knowledge-based theory of the firm. In pertinent part, the knowledge-based theory of the firm emphasizes the advantages of transferring tacit knowledge—personal, experiential knowledge that is not amenable to codification (and not disclosed in patents)—within firms as opposed to between separate firms. This Article extends this theory in two ways to articulate a novel knowledge-based theory of "bounded entities." First, it argues that firms (and organizations more broadly) provide a hospitable environment for transferring not only tacit knowledge but also trade secrets—secret, technical information that may or may not be codified. Second, it argues that the knowledge-transfer advantages of organizations extend beyond classic, integrated firms to a broader class of "bounded entities." Such entities, which span integrated and quasi-integrated organizational forms, facilitate the transfer of tacit knowledge and trade secrets.

Drawing on this novel theory, this Article argues that "multinational bounded entities"—which include multinational firms, foreign-domestic joint ventures, and "thick" cross-border contractual relationships—greatly facilitate the transfer of technical knowledge abroad. They do so even for inventions that have been publicly disclosed in patents and even when innovators would ordinarily assert intellectual property rights to limit such transfer. Illustrating these dynamics, this Article explores the role of multinational bounded entities in the global manufacturing of patented COVID-19 vaccines and "forced technology transfer" in the U.S.-China trade war. Going further, this Article synthesizes the roles of patents and organizations in international technology transfer, arguing that the strength of patent protection and the nature of technology to be transferred help determine the most effective transfer channels. It then provides prescriptions for improving international technology transfer through patent-based channels and multinational bounded entities.

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> In our view, the central competitive dimension of what firms know how to do is to create and transfer knowledge efficiently within an organizational context.[1]

INTRODUCTION

How do technologies move from one country to another? This is a critical question given the crucial role of international technology transfer in advancing economic and social welfare around the world. This question is particularly urgent for developing countries, which rely substantially on adopting foreign technologies to improve productivity and standards of living.[2] Conventional wisdom holds that strong intellectual property (IP) rights promote international technology transfer. In particular, commentators contend that strong patents—which confer exclusive rights to technologies—encourage technological exports, cross-border licensing, and foreign direct investment (FDI).[3] A vocal counternarrative, however, argues that weakening patents increases access to foreign technologies.[4] For instance, developing countries have weakened patents on AIDS drugs from developed countries to increase access to these essential technologies.[5]

This Article challenges the dominance of these perspectives. It argues that neither strengthening nor weakening patents is sufficient to transfer many technologies. Rather, this Article contends that multinational organizational structures play an important and underappreciated role in transferring technologies and technical knowledge between countries. Understanding the mechanics of such transfer, moreover, can lead to more effective

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1. Bruce Kogut & Udo Zander, *Knowledge of the Firm, Combinative Capabilities, and the Replication of Technology*, 3 ORG. SCI. 383, 384 (1992) [hereinafter Kogut & Zander, *Combinative Capabilities*].

2. *See* Harrie Vredenburg & Percy Garcia, *Technology Transfer in International Business: The Role of the Multinational Corporation in Building Capacity in Developing Countries*, 7 INT'L J. BUS. STRATEGY 141, 144 (2007); U.N. Conference on Trade & Development, *Foreign Direct Investment, the Transfer and Diffusion of Technology, and Sustainable Development*, U.N. Doc. TD/B/C.II/EM.2/2 (Dec. 8, 2010) [hereinafter UNCTAD]. This Article uses the terms "developed" and "developing" countries as descriptive terms consistent with their common usage in the legal and economics literatures. It acknowledges that these terms have been controversial, and this Article implies no normative connotation other than to refer to aggregate levels of economic development.

3. *See infra* Part I.A.

4. *See infra* Part I.B.

5. *See infra* Part I.B.

use of patents and organizational connections to transfer technologies abroad.

Consider, for example, the challenge of transferring patented COVID-19 vaccine technology to foreign countries. The newest generation of mRNA COVID-19 vaccines, distributed by Moderna and Pfizer, have been patented throughout the world.[6] A wide literature suggests that such patents should promote technology transfer to foreign countries.[7] However, vaccine access remains grossly unequal between developed and developing countries.[8] Particularly striking, developing countries have almost no access to mRNA vaccines.[9] To increase access, the World Trade Organization (WTO) adopted a temporary waiver of international obligations governing the enforcement of patents on COVID-19 vaccines for most developing countries.[10] While this

6. *See* Sharon LaFraniere et al., *Politics, Science and the Remarkable Race for a Coronavirus Vaccine*, N.Y. TIMES (Nov. 30, 2020), https://www.nytimes.com/2020/11/21/us/politics/coronavirus-vaccine.html [https://perma.cc/4DVT-9QUA]; Cecilia Martin & Drew Lowery, *mRNA Vaccines: Intellectual Property Landscape*, 19 NATURE REVS. DRUG DISCOVERY 578, 578 (2020); Mario Gaviria & Burcu Kilic, *A Network Analysis of COVID-19 mRNA Vaccine Patents*, 39 NATURE BIOTECH. 546, 546–48 (2021).

7. *See infra* Part I.A.

8. As of August 23, 2023, 72.89% of people in high-income countries had received at least one dose, while only 35.85% of people in the lowest income countries had received one dose. Data Futures Platform, *Global Dashboard for Vaccine Equity*, U.N. DEV. PROGRAMME, https://data.undp.org/vaccine-equity [https://perma.cc/DBM9-ZVE3]. Patents have garnered criticism for limiting access. *See, e.g.*, Achal Prabhala et al., *Want Vaccines Fast? Suspend Intellectual Property Rights*, N.Y. TIMES (Dec. 7, 2020), https://www.nytimes.com/2020/12/07/opinion/covid-vaccines-patents.html [https://perma.cc/8VX4-MRCY]; Walden Bello, Opinion, *The West Has Been Hoarding More than Vaccines*, N.Y. TIMES (May 3, 2021), https://www.nytimes.com/2021/05/03/opinion/covid-biden-wto-vaccine.html [https://perma.cc/8A2T-DAVG]; Matthew Kavanagh & Madhavi Sunder, Opinion, *Poor Countries May Not Be Vaccinated Until 2024. Here's How to Prevent That*, WASH. POST (Mar. 10, 2021), https://www.washingtonpost.com/opinions/2021/03/10/dont-let-intellectual-property-rights-get-way-global-vaccination [https://perma.cc/6KTB-NVXR].

9. Achal Prabhala, Opinion, *Monopolies Are Getting in the Way of mRNA Vaccines*, SCI. AM. (July 11, 2022), https://www.scientificamerican.com/article/monopolies-are-getting-in-the-way-of-mrna-vaccines [https://perma.cc/9SMX-D82Z].

10. *See* World Trade Organization, Draft Ministerial Decision on the TRIPS Agreement, WTO Doc. WT/MIN(22)/W/15/Rev.1 (2022) [hereinafter TRIPS Draft Ministerial Decision], https://docs.wto.org/dol2fe/Pages/SS/directdoc.aspx?filename=q:/WT/MIN22/W15R1.pdf&Open=True [https://perma.cc/H39M

waiver aims to increase generic manufacturing of COVID-19 vaccines, weakening patents alone is unlikely to do so.[11] Vaccine developers like Moderna and Pfizer contend that even if countries did not enforce patents, third-party manufacturers could not make mRNA vaccines in industrial quantities.[12] Although vaccine developers have ostensibly disclosed their technologies in patents, they retain tacit knowledge—personal, experiential knowledge that is difficult to codify—and trade secrets—secret, technical information that may or may not be codified—that are critical for manufacturing patented vaccines.[13] Vaccine patentees contend that they can only transfer such private technical knowledge through direct interactions with vaccine manufacturers.[14] In this context, neither strengthening nor weakening patents is enough. Organizational linkages between vaccine

-TW5Z]. As discussed further below, this decision temporarily waived certain provisions of the Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS Agreement), an international agreement establishing minimum requirements for intellectual property protection for most countries around the world. Agreement on Trade-Related Aspects of Intellectual Property Rights, Apr. 15, 1994, Marrakesh Agreement Establishing the World Trade Organization, Annex 1C, 1869 U.N.T.S. 299, 33 I.L.M. 1197 [hereinafter TRIPS Agreement]. In pertinent part, the waiver permits most developing countries to use patented inventions necessary to produce and supply COVID-19 vaccines without the authorization of the patentee. The waiver also modifies TRIPS obligations governing compensation of patentees for such unauthorized use. *See* TRIPS Draft Ministerial Decision, *supra*.

11. *See, e.g.*, Eric Martin & Susan Decker, *U.S. Weighs Global Vaccine-Expansion Move Opposed by Drugmakers*, BLOOMBERG L. NEWS (Apr. 22, 2021), https://www.bloomberg.com/news/articles/2021-04-21/u-s-weighs-global-vaccine-expansion-move-opposed-by-drugmakers [https://perma.cc/53TM-7876] ("Business groups say the waiver plan is ineffective. They argue that few countries have the capacity to produce more vaccines even if they knew the formulas."); Christopher Rowland et al., *Drug Companies Defend Vaccine Monopolies in Face of Global Outcry*, WASH. POST. (Mar. 20, 2021), https://www.washingtonpost.com/business/2021/03/20/covid-vaccine-global-shortages [https://perma.cc/BZP6-PUUL] ("Step-by-step manufacturing instructions are just as important as intellectual property rights because vaccines require a complex process to produce.").

12. *See* Rowland et al., *supra* note 11; Ian Lopez, *Vaccine IP Enforcement Takes Stage in Global Immunization Fight*, BLOOMBERG L. NEWS (Apr. 27, 2021), https://news.bloomberglaw.com/health-law-and-business/vaccine-ip-enforcement-takes-stage-in-global-immunization-fight [https://perma.cc/W69F-X3WK].

13. *See infra* Parts II.B (discussing tacit knowledge) and III.A (discussing trade secrets).

14. Lopez, *supra* note 12.

developers and foreign manufacturers are necessary to transfer patented vaccine technology.

In some contexts, organizational connections promote international technology transfer even when innovators would ordinarily assert intellectual property rights to limit such transfer. This dynamic is evident in the longstanding U.S.-China trade war.[15] The United States has repeatedly accused China of engaging in "forced technology transfer."[16] This rather amorphous term encompasses several policies by which China allegedly compels foreign firms to transfer IP and technical know-how to Chinese counterparts.[17] One of these policies requires foreign companies to form joint ventures with Chinese firms to enter certain Chinese markets.[18] Among other effects, the organizational meshing inherent in foreign-domestic joint ventures facilitates the transfer of tacit knowledge and trade secrets from U.S. companies to Chinese partners. Foreign firms doing business in China often protect their technologies with IP rights to limit or

15. *See, e.g.*, Julia Ya Qin, *Forced Technology Transfer and the US–China Trade War: Implications for International Economic Law*, 22 J. INT'L ECON. L. 743, 743 (2019) (asserting that China's practices designed to force technology transfer precipitated the U.S.-China trade war); Alan O. Sykes, *The Law and Economics of "Forced" Technology Transfer and Its Implications for Trade and Investment Policy (and the U.S.–China Trade War)*, 13 J. LEGAL ANALYSIS 127, 128 (2021) (noting the centrality of "forced technology transfer" to the trade dispute between the United States and China).

16. *See generally* Peter K. Yu, *The U.S.-China Forced Technology Transfer Dispute*, 52 SETON HALL L. REV. 1003 (2022) (describing American concerns over the lack of protection of intellectual property rights in China).

17. *See* Jyh-An Lee, *Forced Technology Transfer in the Case of China*, 26 B.U. J. SCI. & TECH. L. 324, 327 (2020) [hereinafter Lee, *Forced*] ("The U.S. accused China of unfairly forcing 'the transfer of foreign technologies and IP to Chinese competitors, often in exchange for access to the vast Chinese market.'" (quoting WHITE HOUSE OFF. OF TRADE & MFG. POL'Y, HOW CHINA'S ECONOMIC AGGRESSION THREATENS THE TECHNOLOGIES AND INTELLECTUAL PROPERTY OF THE UNITED STATES AND THE WORLD 5 (June 2018) [hereinafter ECONOMIC AGGRESSION], https://trumpwhitehouse.archives.gov/wp-content/uploads/2018/06FINAL-China-Technology-Report-6.18.18-PDF.pdf [https://perma.cc/9GWQ-W288])).

18. Qin, *supra* note 15, at 747 ("[T]he transfer of technology may be compelled by foreign ownership restrictions in different ways. One is via mandatory JV [joint venture] requirements."); Sykes, *supra* note 15, at 129 ("[T]he key problem in China stems from legal requirements that condition permission to invest in the formation of joint ventures with Chinese partners . . . ."); Bernard M. Hoekman et al., *Transfer of Technology to Developing Countries: Unilateral and Multilateral Policy Options*, 33 WORLD DEV. 1587, 1591 (2005) ("For example, the Chinese policy has encouraged joint ventures more than inward FDI.").

control technology transfer. However, China's controversial policy circumvents those rights by establishing direct organizational connections between foreign innovators and Chinese firms, thereby accelerating international technology transfer.[19]

This Article challenges the perceived centrality of patents to international technology transfer. In so doing, it deconstructs the concept of technology transfer itself. "International technology transfer" is a rather broad term that can encompass at least three distinct but related activities: exporting technological goods, licensing rights to practice technologies to entities in foreign countries, and transmitting technical knowledge abroad. Patents bear most directly on the first two activities, though as we shall see, they also impact the transfer of technical knowledge.[20] This Article focuses on this third activity by examining processes by which technical *knowledge* itself moves between countries. It argues that multinational organizational structures fill substantial gaps left by patents in transferring important forms of technical knowledge abroad. Indeed, an enormous amount (perhaps the majority) of international technology transfer takes place in organizational contexts outside of the formal patent system.[21]

In advancing this argument, this Article mobilizes economic insights from an underutilized source: the knowledge-based theory of the firm. In so doing, it fills an important gap in the literature. Despite robust scholarship on international technology transfer[22] and the knowledge-based theory of the firm,[23] legal

19. Lee, *Forced*, *supra* note 17, at 331 (noting that China's most well-known policy for forcing technology transfer is restricting foreign ownership of companies operating in China).

20. Ashish Arora, *Licensing Tacit Knowledge: Intellectual Property Rights and the Market for Know-How*, 4 ECON. INNOVATION & NEW TECH. 41, 42 (1995) [hereinafter Arora, *Licensing*] (arguing that strong patent protection can facilitate the transfer of unpatented technical knowledge).

21. *See infra* notes 212–17 and accompanying text.

22. Examples are too numerous to mention, but they include Margaret Chon, *Intellectual Property and the Development Divide*, 27 CARDOZO L. REV. 2821 (2006) [hereinafter Chon, *Development*]; Keith E. Maskus, *Using the International Trading System to Foster Technology Transfer for Economic Development*, 2005 MICH. ST. L. REV. 219; and Joshua D. Sarnoff, *The Patent System and Climate Change*, 16 VA. J.L. & TECH. 301 (2011).

23. Prominent examples include Érica Gorga & Michael Halberstam, *Knowledge Inputs, Legal Institutions and Firm Structure: Towards a*

scholars have curiously overlooked how these concepts intersect. In broad strokes, the knowledge-based theory of the firm recognizes that transferring technical knowledge within a firm is more efficient than transferring such knowledge between separate entities.[24] Firms are particularly adept at transferring tacit knowledge, which comprises personal, experiential knowledge residing in the minds of inventors that is inherently difficult to communicate. Transferring tacit knowledge often requires direct interpersonal interactions between technology generators and adopters. Firms are well suited to facilitate the shared context and repeat interactions necessary to transfer such knowledge. The aptly named knowledge-based theory of the multinational firm extends this insight to the international arena.[25] It posits that multinational firms enjoy significant efficiencies in transferring tacit knowledge abroad, such as to foreign subsidiaries. Whether in the domestic or international context, it is easier to transfer tacit knowledge within one organization than between two separate ones.

This Article extends this theory in two respects to articulate a novel knowledge-based theory of "bounded entities." First, it argues that firms (and organizations more generally) enjoy efficiencies in transferring not only tacit knowledge but also trade secrets, which encompass technical and business information that innovators deliberately keep secret.[26] Trade secrets may be critical to practicing new technologies, including patented technologies. While certain forms of tacit knowledge may qualify as trade secrets, trade secrets also include codified, confidential information. Unlike tacit knowledge, such codified trade secrets are readily appropriable by third parties exposed to them.[27] Transferring such trade secrets to an external party creates a risk of misappropriation, as the external party may use or disclose them in an unauthorized manner. Transferring trade

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Knowledge-Based Theory of the Firm, 101 NW. U. L. REV. 1123 (2007); Kogut & Zander, *Combinative Capabilities*, *supra* note 1; Jack A. Nickerson & Todd R. Zenger, *A Knowledge-Based Theory of the Firm—The Problem-Solving Perspective*, 15 ORG. SCI. 617 (2004).

24. *See infra* Part II.C.

25. *See infra* Part II.D.

26. *See infra* Part III.A.

27. *See* Kogut & Zander, *Combinative Capabilities*, *supra* note 1, at 384 ("[T]he codification and simplification of knowledge also induces the likelihood of imitation.").

secrets within an organization, however, reduces such misappropriation risk. In essence, the "bounded" nature of organizations prevents the leakage of confidential information, thus promoting the (internal) transfer of trade secrets.

Second, the knowledge-based theory of bounded entities posits that the advantages of firms in transferring tacit knowledge and trade secrets are not limited to classic, integrated firms. Rather, they extend to a broader range of integrated and quasi-integrated organizational forms.[28] This Article coins the term "bounded entities" to refer to these organizational complexes. They include integrated firms, joint ventures, and even "thick" contractual relationships between long-term partners.[29] Bounded entities solve two problems with transferring two kinds of knowledge. The integrated nature of bounded entities facilitates the transfer of tacit knowledge, which is intrinsically difficult to convey and often requires direct interpersonal interaction.[30] The "closed" nature of bounded entities facilitates the transfer of trade secrets, which may be easily appropriated and thus risky to convey to arm's-length, external parties. Put differently, bounded entities represent modular systems that facilitate intensive internal knowledge-sharing while limiting knowledge exposure to outside parties.[31]

This Article then extends this novel theory to international technology transfer by articulating a knowledge-based theory of multinational bounded entities.[32] It argues that wholly owned

28. *See infra* Part III.B.

29. The "bounded" nature of these organizational complexes suggests some degree of integration; an integrated firm is bounded by its corporate boundaries, and even long-term partners can be contractually bound in such a way that they resemble a unified organization.

30. *Cf.* Arora, *Licensing*, *supra* note 20, at 41 (asking whether arm's-length contracts can transfer knowledge when efficient technology transfer requires sharing uncodified information); *see also* Valeria Aman, *Transfer of Knowledge Through International Scientific Mobility: Introduction of a Network-Based Bibliometric Approach to Study Different Knowledge Types*, 1 QUANTITATIVE SCI. STUD. 565, 566 (2020) ("[P]ersonal contacts between scientists are essential to transfer tacit knowledge.").

31. *See* Herbert A. Simon, *The Architecture of Complexity*, 106 PROC. AM. PHIL. SOC'Y 467, 473–74 (1962) (noting that in hierarchical systems, interactions will be greater within subsystems than between subsystems); Henry E. Smith, *Intellectual Property as Property: Delineating Entitlements in Information*, 116 YALE L.J. 1742, 1761–66 (2007) (discussing "information-hiding" in modular systems, which allows components to interact in only specified ways).

32. *See infra* Part IV.A.

foreign subsidiaries, foreign-domestic joint ventures, and thick cross-border contractual relationships constitute multinational bounded entities that facilitate the international transfer of tacit knowledge and trade secrets. Notably, multinational bounded entities facilitate international knowledge transfer even for technologies that are ostensibly disclosed by patents and even when innovators would ordinarily assert intellectual property rights to limit such transfer. This Article illustrates these phenomena through case studies of the two most important international technology transfer controversies of recent times: the challenge of global manufacturing of COVID-19 vaccines and the conflict over "forced technology transfer" in the U.S.-China trade war.[33]

In exploring the importance of multinational bounded entities to technology transfer, this Article does not disclaim the significance of patents. Rather, this Article shows how patents and bounded entities provide different and sometimes complementary avenues for firms to transfer technologies abroad.[34] It shows how the strength of patent protection and the nature of technical knowledge to be transferred affect whether firms transfer technologies via patents, multinational bounded entities, both, or neither. For example, where patents are strong and the knowledge necessary to practice an invention is fully disclosed, patents may substitute for bounded entities in transferring technologies. However, where patents are strong but the knowledge necessary to practice a patented technology is tacit or protected by trade secrets, patents and bounded entities often function as complements. For instance, for cutting-edge, patented technologies with a high tacit dimension, patents may not disclose all technical knowledge necessary to practice such inventions. As such, an innovator may combine patenting the technology with forming an organizational connection to a foreign entity to transfer such tacit knowledge.

Turning to normative analysis, this Article argues that the widespread use of multinational bounded entities to transfer technologies abroad reflects the significant limitations of technology transfer between arm's-length parties.[35] Specifically, it reveals the inability of patents alone to transfer critical technical knowledge between separate parties. Within this context,

33. *See infra* Part IV.B.
34. *See infra* Part V.
35. *See infra* Part VI.A.

bounded entities represent a valuable (though costly) alternative or supplement to the patent system. Some might question if bounded entities meaningfully transfer technical knowledge to other countries if that knowledge remains locked in a transnational organizational silo. This Article argues, however, that despite their "closed" nature, bounded entities ultimately contribute to beneficial information spillovers in receiving countries. It further argues that countries may have reason to accelerate such spillovers in cases of national urgency.

Drawing on its analyses, this Article proposes two sets of policy prescriptions to improve international technology transfer.[36] It first argues for shoring up the disclosure requirements of patentability to increase the dissemination of tacit knowledge and trade secrets for practicing patented inventions. This reform would lessen the need for innovators to use multinational bounded entities to transfer technical knowledge across borders. In so doing, this reform would increase the efficiency of patent-based transfers, both voluntary and involuntary (such as through compulsory licenses). In some cases, however, bounded entities will remain necessary or preferred conduits for transferring tacit knowledge and trade secrets. Accordingly, this Article next proposes strengthening the effectiveness of multinational bounded entities through public funding and dedicated knowledge-sharing infrastructure. It particularly warns that the current preoccupation with strengthening or weakening patents distracts from the need to invest in the "absorptive capacity" of transferee countries, particularly developing countries.[37] Basic investments in scientific, educational, and health infrastructure will improve developing countries' ability to absorb transferred technology and ultimately pursue endogenous innovation.

This study of multinational bounded entities holds important theoretical implications for the roles of patents and organizations in technology transfer. A robust literature argues

36. *See infra* Part VI.B.

37. Wesley M. Cohen & Daniel A. Levinthal, *Absorptive Capacity: A New Perspective on Learning and Innovation*, 35 ADMIN. SCI. Q. 128, 128 (1990) (defining "absorptive capacity" as "the ability of a firm to recognize the value of new, external information, assimilate it, and apply it to commercial ends").

that patents promote technology transfer.[38] They primarily do so by reducing appropriation risk: by protecting against unauthorized copying, patents encourage innovators to market and transfer their technologies to external entities. However, even where patents are strong, parties may still pursue organizational strategies—including establishing bounded entities—to transfer tacit knowledge and prevent the leakage of trade secrets. Patents alone are primarily effective for transferring technologies that innovators are willing and able to fully disclose, such as older, less sophisticated inventions. For many novel, cutting-edge technologies that require significant private knowledge to practice, organizational linkages play an important and underappreciated role in effectuating transfer.

This Article makes several novel contributions. It challenges the dominance of the patent-based model of technology transfer by highlighting the role of organizations in moving tacit knowledge and trade secrets between countries. It mines an underutilized resource—the knowledge-based theory of the firm—to offer new insights into international technology transfer. It builds upon the knowledge-based theory of the firm to introduce an original knowledge-based theory of bounded entities, which provides a fuller account of the advantages of organizations in transmitting technical knowledge. Finally, this Article provides novel proposals to improve technology transfer and helps shift policy attention toward capacity building as a necessary predicate for international technology transfer, which has broad ramifications for global development.

This Article proceeds in six Parts. Part I examines the traditional, patent-based model of international technology transfer. It explores the dominant view that strong patents promote technology transfer and the counternarrative that weakening patents promotes access to foreign technologies. Part II challenges the dominance of the patent-based model by examining the advantages of organizations in transferring technical knowledge. It focuses on the knowledge-based theory of the firm, which posits that firms arise to economize on costs associated

38. *See, e.g.*, Arora, *Licensing*, *supra* note 20, at 42 ("[B]roader patents improve the efficiency of technology transfer, even of parts of technology that are not protected by patents."); Hoekman et al., *supra* note 18, at 1592 ("Patent protection . . . increases flows of [international technology transfer] to countries with sufficient technological capacity . . . .").

with transferring knowledge, particularly tacit knowledge. Part III builds on this analysis to articulate a novel knowledge-based theory of "bounded entities." It first posits that organizations provide a hospitable environment for transferring not only tacit knowledge (which is intrinsically difficult to transfer) but also trade secrets (which may be easy to transfer and misappropriated when exposed to external parties). It then posits that the knowledge-transfer advantages of firms extend to a broader class of bounded entities: organizational structures ranging from fully integrated firms to long-term contractual alliances.

Part IV applies these insights to international technology transfer by articulating a novel knowledge-based theory of multinational bounded entities. It explores how cross-border organizational structures transfer technical knowledge even when firms have ostensibly disclosed technologies in patents and even when firms would ordinarily assert IP rights to limit transfer. It examines these dynamics in the global manufacturing of patented COVID-19 vaccines and forced technology transfer between the United States and China. Part V considers how the strength of patent protection and the nature of knowledge to be transferred inform preferred channels of international technology transfer. Part VI normatively analyzes multinational bounded entities, and it proposes ways to improve both patent-based and organizational transfer.

I. THE PATENT-BASED MODEL OF INTERNATIONAL TECHNOLOGY TRANSFER

Nations have long granted intellectual property rights to induce the transfer of technologies and technical knowledge from abroad. During the Renaissance, Venetian authorities granted licenses—and later what could be understood as patents—to induce foreign artisans to bring their crafts to Venice.[39] Similarly, the early British patent system offered exclusive rights to foreign artisans to induce them to immigrate and train British

39. Ted Sichelman & Sean O'Connor, *Patents as Promoters of Competition: The Guild Origins of Patent Law in the Venetian Republic*, 49 SAN DIEGO L. REV. 1267, 1268–69 (2012) (detailing the Venetian practice of granting what can be understood as patents to non-guild members, especially foreigners, to engage in activities ordinarily controlled by guilds).

apprentices.[40] The aim of promoting international technology transfer also informed the Paris Convention for the Protection of Industrial Property, an 1883 agreement that eased the process by which an inventor could patent an invention in multiple countries.[41] This Part focuses on the modern international framework for intellectual property rights established by the Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS Agreement).[42] Member states adopted TRIPS with the expectation that strong patent protection would facilitate international technology transfer, particularly from developed to developing countries. However, critics have also argued that strong patent rights *inhibit* technology transfer, and they have sought to exploit flexibilities in the TRIPS regime to weaken such rights. Notably, patents—either their presence or absence—dominate debates over international technology transfer, a position that this Article will later challenge.

A. THE TRIPS AGREEMENT AND THE ROLE OF PATENTS IN PROMOTING INTERNATIONAL TECHNOLOGY TRANSFER

The modern culmination of the patent-based model of international technology transfer is the TRIPS Agreement, which entered into force in 1995. Here, some context is useful. In the decades following World War II, countries around the world held multilateral negotiations to promote free trade by reducing tariffs and other trade barriers.[43] In the 1990s, the so-called Uruguay Round of negotiations resulted in the formation of the

40. *Id*. at 1270 ("[T]he British system developed from the need to bring in existing arts and artisans from the Continent to train British apprentices . . . ."); *see also* ROBERT PATRICK MERGES & JOHN FITZGERALD DUFFY, PATENT LAW AND POLICY 7 (7th ed. 2017).

41. World Intellectual Property Organization, Paris Convention for the Protection of Industrial Property, Mar. 20, 1883, 21 U.S.T. 1583, 828 U.N.T.S. 305, https://www.wipo.int/wipolex/en/text/288514 [https://perma.cc/A6ZT-4J2L]. *See* L. Kamran Bilir et al., Do Treaties Encourage Technology Transfer? Evidence from the Paris Convention 1 (July 22, 2011) (unpublished manuscript) (on file with the *Minnesota Law Review*) (arguing that the Paris Convention's strengthening of intellectual property rights encouraged technology transfer into the United States).

42. TRIPS Agreement, *supra* note 10.

43. IAN F. FERGUSSON, CONG. RSCH. SERV., ORDER CODE 98-928, THE WORLD TRADE ORGANIZATION: BACKGROUND AND ISSUES 1, 1–2 (2007), https://nationalaglawcenter.org/wp-content/uploads/assets/crs/98-928.pdf [https://perma.cc/DR27-YZEE] (providing historical background on the WTO).

World Trade Organization (WTO).[44] As part of establishing the WTO, member states also concluded the TRIPS Agreement, which established minimum standards for IP protection for all WTO members.[45]

TRIPS has been characterized as "upward harmonization," and it establishes high minimum standards for IP protection for all WTO countries.[46] This brief discussion will focus on requirements for patents. First, TRIPS requires that patentable subject matter in all member states must encompass "all fields of technology," including pharmaceuticals.[47] Notably, before joining TRIPS, over forty countries, including middle-income nations such as Brazil and Argentina, did not grant product patents on pharmaceuticals.[48] Additionally, TRIPS imposes procedural requirements on compulsory licenses, which arise when states issue licenses to third parties to practice a patented invention without the patentee's authorization.[49] While TRIPS permits compulsory licenses, it imposes requirements regarding negotiation and compensation that render granting them more burdensome.[50] Notably, TRIPS rules have real teeth. TRIPS provides for enforcing its provisions through a Dispute Settlement Understanding, which has "been an important mechanism in transforming national intellectual property legislation worldwide."[51]

The formation of the WTO and the TRIPS Agreement represented a quid pro quo between developed and developing countries that included the promise of greater technology transfer in exchange for adopting stronger intellectual property rights.[52]

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44. *Id.* at 2.

45. *See* TRIPS Agreement, *supra* note 10.

46. Amy Kapczynski, *Harmonization and Its Discontents: A Case Study of TRIPS Implementation in India's Pharmaceutical Sector*, 97 CALIF. L. REV. 1571, 1571 (2009).

47. TRIPS Agreement, *supra* note 10, art. 27.1.

48. Haochen Sun, *The Road to Doha and Beyond: Some Reflections on the TRIPS Agreement and Public Health*, 15 EUR. J. INT'L L. 123, 124 n.2 (2004).

49. TRIPS Agreement, *supra* note 10, art. 31.

50. *See generally id.* The requirement of negotiating with the patentee can be waived "in the case of a national emergency or other circumstances of extreme urgency or in cases of public non-commercial use." *Id.* art. 31(b).

51. Ruth L. Okediji, *Public Welfare and the Role of the WTO: Reconsidering the TRIPS Agreement*, 17 EMORY INT'L L. REV. 819, 820 (2003).

52. Ellen 't Hoen, *Protecting Public Health Through Technology Transfer: The Unfulfilled Promise of the TRIPS Agreement*, 24 HEALTH & HUM. RTS. J.

TRIPS provided developed countries with stronger IP protection for their technological and creative works in developing countries, many of which had not prioritized enforcing IP standards. For their part, developing countries obtained greater access to developed-country markets for agriculture, textiles, and other exports as well as a seat at the table when making global trade rules. Such "linkage bargaining" that tied greater market access to stronger IP standards helped convince developing countries to join the WTO and adopt the TRIPS Agreement.[53] Additionally, as examined further below, strengthening intellectual property rights was expected to increase technology transfer, especially from developed to developing counties. It is worth noting that many observers view TRIPS as a one-sided bargain that heavily favored the interests of developed countries.[54]

In its content and framing, the TRIPS Agreement reflects the view that strong intellectual property rights foster international technology transfer.[55] Article 7 states that "[t]he protection and enforcement of intellectual property rights should contribute to the promotion of technological innovation and the transfer and dissemination of technology."[56] TRIPS even creates an explicit obligation for developed countries to provide

211, 211 (2022) ("The promised trade-off from the TRIPS Agreement was that the higher levels of IP protection would lead to technology transfers from high-income to lower-income countries . . . ."); Kal Raustiala, *Innovation in the Information Age: The United States, China, and the Struggle Over Intellectual Property in the 21st Century*, 58 COLUM. J. TRANSNAT'L L. 531, 542 (2020) ("The comprehensive advantages of joining the WTO were very high, and so many nations swallowed hard and accepted TRIPs despite their many previous concerns about American efforts to impose strict IP rights on them.").

53. Chon, *Development*, *supra* note 22, at 2840.

54. *See, e.g.*, Maskus, *supra* note 22, at 222 ("Critics see TRIPS as a mechanism for enhancing the global market power of information developers, permitting them to act in monopolistic and abusive ways that would slow down [international technology transfer], especially to the poorest countries."); 't Hoen, *supra* note 52, at 211 ("However, TRIPS was ill-suited to the needs of developing and least-developed nations, representing the majority of the WTO's membership.").

55. While TRIPS exemplifies the modern rights-based model of international technology transfer, regional and bilateral intellectual property agreements also reflect the objective that intellectual property rights should promote international technology transfer. *See, e.g.*, Maskus, *supra* note 24, at 224–25 (quoting TRIPS Agreement, *supra* note 10, art. 7).

56. TRIPS Agreement, *supra* note 10, art. 7; *see* 't Hoen, *supra* note 52, at 212 ("Article 7 acknowledges that the protection and enforcement of IP should benefit society as a whole, not only rights holders.").

incentives for entities to transfer technologies to least-developed countries.[57]

In theory, stronger patents can promote international technology transfer in several ways.[58] First, strong patent protection can encourage greater international trade. For example, innovators in developed countries may be more likely to export their technological goods to developing countries offering strong patent protection, thereby reducing the risk of unauthorized copying of their products.[59] Given that "[n]ew products embody novel ideas," international trade provides an important avenue for disseminating technical knowledge abroad.[60] For instance, increased trade introduces local entities to foreign technologies that they can reverse engineer as well as new machinery and equipment.[61] Empirical research has found that increasing patent strength positively affects import volumes in many

57. TRIPS Agreement, *supra* note 10, art. 66.2; Jayashree Watal & Leticia Caminero, *Least-Developed Countries, Transfer of Technology and the TRIPS Agreement* 3 (Econ. Rsch. & Stat. Div., World Trade Org., Working Paper No. ERSD-2018-01, 2017) ("Developed countries have a positive, legal obligation to provide incentives to enterprises and institutions in their territories to promote and encourage technology transfer to least-developed countries . . . ."); *see also* Maskus, *supra* note 22, at 225–26 (listing reasons that Article 66.2 is merely aspirational).

58. *See, e.g.*, Bronwyn H. Hall, *Patents, Innovation, and Development*, INT'L REV. APPLIED ECON. 10 (2022), https://doi.org/10.1080/02692171.2021.2022295 (listing ways in which strong intellectual property rights can promote international technology transfer); Nagesh Kumar, *Intellectual Property Rights, Technology and Economic Development: Experiences of Asian Countries*, ECON. & POL. WKLY., Jan. 2003, at 209, 210 ("[S]tronger patent protection could contribute to economic growth rates once a particular level of development has been achieved."); Maskus, *supra* note 22, at 226 ("A well-functioning and balanced IP system can contribute positively to international technology transfer and its diffusion into the economy."). While this discussion focuses on patents, in theory strengthening other types of intellectual property—notably trade secrets—can also induce greater international technology transfer for similar reasons. Michael A. Klein, *Patents, Trade Secrets and International Technology Transfer*, 210 ECON. LETTERS 1, 3 (2021) ("I find that strengthening either patent or trade secret protection can stimulate FDI.").

59. Kumar, *supra* note 58, at 212 ("Stronger protection should help exporters by making imitation and counterfeiting more difficult.").

60. Hoekman et al., *supra* note 18, at 1588.

61. *Id.*

developing countries, particularly large ones.[62] Follow-up research similarly found that firms significantly increased exports to large- and middle-income developing countries that strengthened patent protection.[63]

Second, strong patent protection in a receiving country can motivate greater cross-border licensing of inventions. For similar reasons as above, innovators may be more inclined to license their patents to firms in countries that offer strong patent protection. This is another form of international technology transfer consisting of granting the legal right to practice an invention to a foreign entity rather than directly exporting finished goods to that country. Importantly, licensing may provide access to not only a technology but also the underlying technical knowledge necessary to exploit it: "[c]ontracts typically involve the purchase of production or distribution rights and the underlying technical information and know-how."[64] More broadly, strong patent protection can facilitate vertically disintegrated, global value chains in which firms in different countries specialize in various functions to produce innovations and transfer intermediate technologies between them.[65] For example, a firm in one country may design and patent a technology, then license the patent to a foreign firm for manufacturing.[66] Adopting strong patent protection allows developing countries to more fully participate in such global value chains. Empirical research has found that patent strength significantly and positively affects the volume of

62. Keith E. Maskus & Mohan Penubarti, *How Trade-Related Are Intellectual Property Rights?*, 39 J. INT'L ECON. 227, 229 (1995) (finding that stronger patent laws among large developing economies led to greater-than-expected increases in imports from OECD countries); *see* Kumar, *supra* note 58, at 212 ("[I]n a sample of 14 countries . . . [the finding was that] the perceived weakness of intellectual property protection adversely affect[ed] the volume as well as the composition of [U.S.] FDI inflows to the [sampled] countries.").

63. Pamela J. Smith, *Are Weak Patent Rights a Barrier to U.S. Exports?*, 48 J. INT'L ECON. 151, 170 (1999) ("Indeed, weak patent rights are a barrier to U.S. exports, but only to countries that pose a strong threat of imitation. These tend to be emerging less-developed countries . . . .").

64. Hoekman et al., *supra* note 18, at 1589.

65. *See generally* Jonathan M. Barnett, *"Patent Tigers" and Global Innovation*, REGUL., Winter 2019–20, at 14.

66. *Id*. at 18 (describing a schematic example of an Israeli firm that designs semiconductors and licenses those designs to a Taiwanese foundry for manufacture).

licensing fees,[67] suggesting that when countries strengthen patents, licensing activity increases.

Third, strong patents can foster international technology transfer by spurring greater FDI. Multinational corporations may be more willing to build factories, laboratories, and other facilities in foreign countries and share technical information with local subsidiaries if those countries offer strong patent protection. However, while FDI is certainly an important channel for international technology transfer,[68] the evidence that patents promote FDI is somewhat mixed.[69] Some empirical research suggests that stronger patent laws exert a positive effect on inflows of FDI.[70] However, several studies have found that IP protection has little influence on inward FDI.[71] Additionally, stronger patents—which render licensing inventions to foreign entities more viable—may actually reduce the need for multinational

67. Guifang Yang & Keith E. Maskus, *Intellectual Property Rights and Licensing: An Econometric Investigation*, 137 WELTWIRTSCHAFTLICHES ARCHIV [REV. OF WORLD ECON.] 58, 60 (2001) ("[S]tronger patent laws have positive and significant effects on both the absolute flows and the relative flows (relative to trade volume) of U.S. receipts of unaffiliated royalties and licensing fees . . . ."); Lee G. Branstetter et al., *Do Stronger Intellectual Property Rights Increase International Technology Transfer? Empirical Evidence from U.S. Firm-Level Panel Data*, 121 Q.J. ECON. 321, 322 (2006) ("[T]hese changes provide additional indications that at least one component of the observable increase in licensing flows is associated with the introduction of new technology following patent reform.").

68. Hoekman et al., *supra* note 18, at 1588 ("Case studies suggest that substantial technology diffusion occurs due to FDI." (citation omitted)); Magnus Blomström & Ari Kokko, *Multinational Corporations and Spillovers*, 12 J. ECON. SURVS. 247, 247 (1998) ("The most important reason why countries try to attract foreign investment is perhaps the prospect of acquiring modern technology . . . .").

69. *See, e.g.*, Branstetter et al., *supra* note 67, at 323 n.4 (listing several studies that came to differing conclusions on the impact of patents on inward FDI).

70. *See, e.g.*, Hall, *supra* note 58, at 11 ("In summary, the literature indicates a positive correlation between FDI and the level of IPR enforcement."); *see also* Edwin Mansfield, *Intellectual Property Protection, Foreign Direct Investment, and Technology Transfer* 15 (Int'l Fin. Corp., Discussion Paper 19, 1994) (suggesting that U.S. multinational corporations considered IP enforcement when locating facilities in major developing countries).

71. *See* Kumar, *supra* note 58, at 212 (collecting sources).

corporations to directly transfer technologies using FDI.[72] One commentator has concluded that "the contention that stronger norms of [intellectual property] protection will facilitate greater inflows of FDI in the country is rather weak in either theoretical or empirical terms."[73] Other factors, such as local human capital and R&D capabilities, appear to be more important than local patent protection in determining where multinational corporations locate R&D facilities abroad.[74]

Despite some mixed empirical evidence, the content and framing of the TRIPS Agreement reflect the theory that strong patents promote international technology transfer. Developed countries emphasized this perceived link between patents and technology transfer as part of the grand bargain that led developing countries to sign on to TRIPS.

B. THE COUNTERNARRATIVE: WEAKENING PATENTS TO INCREASE ACCESS TO FOREIGN TECHNOLOGIES

While the TRIPS Agreement largely reflects the view that strengthening patents will promote international technology transfer, an important counternarrative has emerged. This view contends that patents can *inhibit* technology transfer and that weakening such rights can promote it.[75] At a theoretical level, it is easy to see how patents can inhibit international technology transfer. Patents confer exclusive rights, thus providing the

72. Hall, *supra* note 58, at 10 ("At the same time, if IPR protection is strong, foreign firms may prefer to license technologies instead of choosing to be a local presence . . . ."); Kumar, *supra* note 58, at 212 ("[S]tronger protection may encourage arm's length licensing of the knowledge and reduce the need for undertaking FDI." (citations omitted)); *cf.* Yang & Maskus, *supra* note 67, at 61 ("In the presence of weak patents, problems of transacting information with licensing, such as the non-excludability property of new knowledge, informational asymmetry, imitation risk and transfer costs, could provide an internalization motive for FDI." (citation omitted)).

73. Kumar, *supra* note 58, at 213.

74. *Id.* ("Therefore, availability of abundant trained low cost human resources and scale of ongoing R and D in their own fields appear to be more important considerations for location of R and D in developing countries than the strength of IPR regime.").

75. Hall, *supra* note 58, at 3 (noting reduced learning through imitation and technological spillovers with strong patent enforcement); Kumar, *supra* note 58, at 209 ("[S]trong IPP regime may inhibit diffusion of knowledge and even technology development in the countries that are technology followers.").

patentee with the ability to block any use (including transfer) of a proprietary technology.

The rapid industrialization of several countries reflects the principle that weak or limited IP protection can promote international technology transfer. Notably, "transfer" in this context refers not to innovators voluntarily selling or licensing their inventions in other countries, but to foreign entities copying and incrementally modifying technologies without authorization. Many countries benefitted from relatively weak IP protection during their industrialization.[76] Weak protection allowed these countries to rapidly assimilate and imitate foreign technologies.[77] The United States followed this pattern,[78] as have several Asian countries.[79] For example, during South Korea's industrialization, the "government tried . . . to minimize IPR protection to help domestic firms use foreign intellectual property."[80] Taiwan employed a similar policy.[81] Japan adopted utility models—watered-down versions of patents for incremental inventions—that facilitated local modifications of foreign technologies.[82] The

76. Kumar, *supra* note 58, at 215–17 (listing examples of East Asian countries that benefited from weak IP protection); Justin Hughes, *The Philosophy of Intellectual Property*, 77 GEO. L.J. 287, 293 (1988) (discussing the examples of Taiwan and South Korea).

77. *See* Kumar, *supra* note 58, at 211–12 (collecting and summarizing sources).

78. Raustiala, *supra* note 52, at 555–58 (explaining early America's weak IP policies).

79. Kumar, *supra* note 58, at 213–17 (describing IP policies in East Asia).

80. Won-Young Lee, *The Role of Science and Technology Policy in Korea's Industrial Development*, *in* TECHNOLOGY, LEARNING, AND INNOVATION: EXPERIENCES OF NEWLY INDUSTRIALISING ECONOMIES 269, 284 (Linsu Kim & Richard R. Nelson eds., 2000); *accord* Hoekman et al., *supra* note 18, at 1593 ("Korea encouraged learning via 'duplicative imitation' of mature technologies that were in the public domain or available cheaply. IPR protection was weak and encouraged imitation and adaptation." (citation omitted)).

81. Kumar, *supra* note 58, at 215 ("Taiwan has also employed a weak IPR policy to facilitate local absorption of foreign knowledge through reverse engineering . . . .").

82. *Id*. at 214; *see also* Hoekman et al., *supra* note 18, at 1593; Stephen P. Magee, *Information and the Multinational Corporation: An Appropriability Theory of Direct Foreign Investment*, *in* THE NEW INTERNATIONAL ECONOMIC ORDER 317, 337 (Jagdish N. Bhagwati ed., 1977); Alfred D. Chandler, *Organizational Capabilities and the Economic History of the Industrial Enterprise*, 6 J. ECON. PERSPS. 79, 84 (1992) ("[O]rganizational learning permitted Japanese firms, first, to carry out a massive transfer of technology from the west to Japan;

long absence of product patents on pharmaceuticals in India encouraged local manufacturing of medicines that were patented elsewhere.[83]

Even the TRIPS Agreement, which generally strengthens intellectual property standards, reflects the concern that overly strong intellectual property rights can hinder technology transfer. This concern was particularly salient in North-South debates between developed and developing countries about the potential benefits and harms of strong exclusive rights.[84] For example, least-developed countries received prolonged transition periods (and subsequent extensions) before having to fully implement TRIPS provisions, particularly for pharmaceuticals.[85] These transitions have allowed these countries to maintain weaker patent protection, which can enhance access to patented technological goods from abroad. Additionally, TRIPS Article 8.2 recognizes that countries may prevent the abuse of intellectual property rights or practices that "adversely affect the international transfer of technology."[86] As mentioned, Article

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then, as Japan's domestic market grew enough to permit building enterprises large enough to exploit potential economies of scale and scope, to develop organizational capabilities necessary for competitive advantage in international markets.").

83. Kumar, *supra* note 58, at 218 ("A number of quantitative studies have shown that the innovative activity of Indian domestic enterprises was facilitated by the softer patent regime under the 1970 [Indian Patents] Act." (citations omitted)).

84. *See generally* Yu, *supra* note 16, at 1025–39 (contextualizing the North-South debate on technology transfer).

85. *See Developing Countries' Transition Periods*, WORLD TRADE ORG. (Sept. 2006), https://www.wto.org/english/tratop_e/trips_e/factsheet_pharm04_e.htm [https://perma.cc/9PRQ-3AQU]; *WTO Members Agree to Extend TRIPS Transition Period for LDCs Until 1 July 2034*, WORLD TRADE ORG. (June 29, 2021), https://www.wto.org/english/news_e/news21_e/trip_30jun21_e.htm [https://perma.cc/69BB-VP5S]; J.H. Reichman, *The TRIPS Agreement Comes of Age: Conflict or Cooperation with the Developing Countries?*, 32 CASE W. RSRV. J. INT'L L. 441, 444 (2000) (distinguishing between the amount of time for compliance allowed for more- and less-developed countries).

86. TRIPS Agreement, *supra* note 10, art. 8.2; *see* 't Hoen, *supra* note 52, at 212 (discussing Article 8).

31 permits states to grant compulsory licenses.[87] Such licenses can also increase access to patented foreign technologies.[88]

Since the establishment of TRIPS, several examples illustrate the principle that weakening patents can promote greater access to foreign technologies. This principle is evident, for instance, in the controversy over access to patented HIV/AIDS medicines. In the 1990s, tens of millions of people living with HIV/AIDS in developing countries desperately sought patented AIDS medications, which were prohibitively costly.[89] In 1997, South Africa adopted legislation permitting compulsory licenses to manufacture generic versions of patented HIV/AIDS drugs.[90] The patents were held by multinational drug companies, which challenged the law as violating the South African Constitution and South Africa's obligations under the TRIPS Agreement.[91] After significant public backlash, the pharmaceutical companies withdrew the lawsuit.[92] Among other legacies, the controversy underscored how strong patents can deter certain forms of international technology transfer. While pharmaceutical companies had technically "transferred" patented HIV/AIDS drugs to South Africa, patents enabled high prices that limited local access to these foreign technologies. In the wake of the withdrawn litigation, the WTO adopted reforms that strengthened the ability of

87. TRIPS Agreement, *supra* note 10, art. 31; *accord* Maskus, *supra* note 22, at 228 ("Under limited circumstances set out in Article 31, governments may resort to compulsory licensing to promote public health, welfare, security, competition . . . , and other objectives.").

88. Subsequent amendments to the TRIPS Agreement more explicitly provide for the transfer of patented products between nations via compulsory licenses. Press Release No. WT/L/641, World Trade Org., Amendment of the TRIPS Agreement (Dec. 6, 2005) [hereinafter Amendment of the TRIPS Agreement], http://www.wto.org/english/tratop_e/trips_e/wtl641_e.htm [https://perma.cc/KDH5-6AFC].

89. *See* Erika George, *The Human Right to Health and HIV/AIDS: South Africa and South-South Cooperation to Reframe Global Intellectual Property Principles and Promote Access to Essential Medicines*, 18 IND. J. GLOB. LEGAL STUD. 167, 169–70 (2011).

90. Medicines and Related Substances Control Amendment Act 90 of 1997 § 22F(1)(a) (S. Afr.).

91. George, *supra* note 89, at 182–83 (describing the pharmaceutical companies' litigation challenging the South African legislation).

92. *Id.* at 186.

countries to issue compulsory licenses to increase access to patented technologies, including those from foreign countries.[93]

The link between weakening patents and promoting international technology transfer has renewed salience in light of the recent COVID-19 pandemic. Many medical products necessary to fight the pandemic—from respirators to diagnostic tests to drugs—are patented.[94] Amid concerns that patents were inhibiting access to these technologies, in October 2020, India and South Africa proposed a temporary waiver of TRIPS obligations to enforce intellectual property rights for technologies related to diagnosing, preventing, and treating COVID-19.[95] After protracted negotiations, in June 2022, the WTO adopted a narrower version of a TRIPS waiver limited to patented vaccines.[96] This Article will return to the TRIPS waiver below, but for present purposes it illustrates the view that weakening patents can increase access to foreign technologies.[97]

Sometimes the most telling insight from a debate is a shared presumption that neither side disputes. This Article seeks not to resolve the controversy over whether strengthening or weakening patents better promotes international technology transfer.

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93. Shortly after the South African litigation, the TRIPS Council issued the Doha Declaration on the TRIPS Agreement and Public Health. World Trade Organization, Ministerial Declaration on the TRIPS Agreement and Public Health, ¶¶ 4–5, WTO Doc. WT/MIN(01)/DEC/2 (2001) (reaffirming flexibilities in the TRIPS Agreement, including member states' right to issue compulsory licenses and determine circumstances meriting such licenses). A 2003 decision permitted countries to issue compulsory licenses to manufacture patented technologies for *export* to countries that could not manufacture them locally. Amendment of the TRIPS Agreement, *supra* note 88. This provision was officially ratified in 2017. Frederick M. Abbott & Jerome H. Reichman, *Facilitating Access to Cross-Border Supplies of Patented Pharmaceuticals: The Case of the COVID-19 Pandemic*, 23 J. INT'L ECON. L. 535, 540 (2020). Although procedural difficulties have prevented widespread use of this provision, it illustrates that limiting patents through compulsory licenses can promote international technology transfer.

94. *See generally* Susan Decker & Christopher Yasiejko, *World War II-Style Mobilization Order May Carry Risks*, BLOOMBERG L. (Mar. 20, 2020), https://www.bloomberglaw.com/bloomberglawnews/pharma-and-life-sciences/X6CREH7S000000 [https://perma.cc/USD5-JDNN].

95. Council for Trade-Related Aspects of Intellectual Property Rights, *Communication from India & South Africa: Waiver from Certain Provisions of the TRIPS Agreement for the Prevention, Containment and Treatment of COVID-19*, WTO Doc. IP/C/W/669 (Oct. 2, 2020) [hereinafter *India & South Africa*].

96. TRIPS Draft Ministerial Decision, *supra* note 10.

97. *See infra* Part IV.B.1.

Rather, it highlights the unstated assumption on both sides of the debate that patents are the gatekeepers to transferring technologies abroad. This Article, however, argues that much more is at play in international technology transfer. In particular, the dominant, patent-based view of technology transfer offers an incomplete account of how parties actually transfer technology and technical knowledge between nations.

II. FIRMS AS CONDUITS FOR TRANSFERRING TACIT KNOWLEDGE

This Article challenges the dominance of the patent-based model of international technology transfer. In so doing, it deconstructs the concept of international technology transfer itself. Legal commentary has tended to focus on how patents increase technological exports and cross-border licensing, both of which are important elements of international technology transfer. But arguably the most important element of technology transfer is transmitting technical *knowledge* itself. Such knowledge allows receiving countries to assimilate, exploit, and build upon foreign technologies and ultimately cultivate their own domestic innovative capacity.

Augmenting the patent-based model, this Part argues that transnational *organizations* play a critical and underappreciated role in transferring such technical knowledge abroad. Importantly, transnational organizations are critical to transferring technical knowledge for practicing patented inventions, even though such inventions are ostensibly fully "disclosed" in patents themselves. To begin the analysis, this Part first explores the classic theory of the firm, which posits that transaction costs determine whether parties coordinate the production of goods (such as technological products) through market-based transfers or within an integrated firm. It then turns to the knowledge-based theory of the firm, which argues that firms arise in substantial part to economize on the cost of transferring and exploiting knowledge, particularly tacit knowledge, which is inherently difficult to codify. Finally, this Part considers the knowledge-based theory of the multinational firm, which illustrates the significant role of multinational firms in transferring tacit knowledge abroad.

A. THE THEORY OF THE FIRM AND THE ROLE OF PATENTS IN LOWERING TRANSACTION COSTS

A natural place to begin examining the role of organizations in technology transfer is the theory of the firm.[98] In its classic formulation by economist Ronald Coase, the transaction-cost theory of the firm explains why firms perform some functions "in-house" while completing others by transacting with outside parties in the market.[99] For example, should an automobile maker manufacture tires in-house, or should it obtain them from independent tire suppliers in the market? Coase's major insight is that transaction costs determine the scope and boundaries of firms. Market transactions between separate parties are an efficient way to coordinate many aspects of production.[100] Sometimes, however, the transaction costs of market exchanges render market-based production less efficient than simply performing some function in-house.[101] Market exchanges entail numerous transaction costs, including the expense of determining prices; delineating obligations; and negotiating, monitoring, and enforcing contracts.[102] When the transaction costs of market exchanges exceed the costs of in-house production, integration represents the more efficient mode of production.

Although not initially framed in these terms, the theory of the firm has important implications for technology transfer. The production of a technological good, such as a COVID-19 vaccine, involves multiple functions, which at a gross level can be divided into invention and manufacturing. The benefits of specialization suggest separating these functions, with some firms focusing on invention while others focus on manufacturing. Applying the theory of the firm, low transaction costs enhance the viability of

98. There are in fact several theories of the firm. *See* Gorga & Halberstam, *supra* note 23, at 1129–30; Robert M. Grant, *Toward a Knowledge-Based Theory of the Firm*, 17 STRATEGIC MGMT. J. (SPECIAL ISSUE) 109, 109 (1996).

99. *See generally* R.H. Coase, *The Nature of the Firm*, 4 ECONOMICA 386 (1937) (articulating a widely influential theory of the firm).

100. *See id.* at 387–88.

101. *See id.* at 392.

102. Economists have identified several transaction costs that affect whether parties organize production within markets or an integrated firm. *See, e.g.*, Oliver E. Williamson, *Transaction-Cost Economics: The Governance of Contractual Relations*, 22 J.L. & ECON. 233, 234 (1979) (discussing opportunistic behavior in contracting); Sanford J. Grossman & Oliver D. Hart, *The Costs and Benefits of Ownership: A Theory of Vertical and Lateral Integration*, 94 J. POL. ECON. 691, 716 (1986) (discussing the "incompleteness" of contracts).

specialization by enabling market-based technology transfer between separate inventors and manufacturers. On the other hand, if transaction costs of market exchanges are high, it may be more efficient for a single, integrated firm to perform both functions (invention and manufacturing) "in-house." Importantly, integration does not eliminate the need for transfer. Within an integrated firm, inventive units still need to transfer technologies to manufacturing units. However, such "transfer" occurs internally within a firm rather than between two separate firms in the market.

Transactions involving technology are particularly costly, thus imperiling technology transfer between separate entities. According to the conventional view, technology is subject to significant risks of copying and unauthorized appropriation, which raises transaction costs between technology sellers and buyers. An innovator seeking to sell a novel invention in the market faces "Arrow's Information Paradox": a buyer of some technology will want to inspect it before paying for it; however, upon doing so, the buyer can take the informational content of the technology for free, thus leaving the seller with nothing.[103] Additionally, technology transactions are plagued by the inverse of Arrow's Information Paradox: a buyer may pay good consideration to be the sole owner of some technology, but the seller may turn around and sell it to another competitor as well.[104] Such opportunistic behavior raises the cost of technology transactions.

Importantly, however, patents lower some costs of technology transactions, thus enhancing the feasibility of market-based transfers between separate parties.[105] Patents primarily lower transaction costs by reducing appropriation risk. Armed with an exclusive right, innovators can market their patented wares to prospective buyers without fear of uncompensated

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103. Kenneth J. Arrow, *Economic Welfare and the Allocation of Resources for Invention*, *in* THE RATE AND DIRECTION OF INVENTIVE ACTIVITY: ECONOMIC AND SOCIAL FACTORS 609, 615 (1962). To be sure, staged disclosure, nondisclosure agreements, and reputational sanctions can safeguard against uncompensated appropriation in some contexts. Michael J. Burstein, *Exchanging Information Without Intellectual Property*, 91 TEX. L. REV. 227, 232–34 (2012). However, these mechanisms are not always effective, and they entail their own costs.

104. *See* Peter Lee, *Autonomy, Copyright, and Structures of Creative Production*, 83 OHIO ST. L.J. 283, 301 (2022) [hereinafter Lee, *Autonomy*].

105. Peter Lee, *Innovation and the Firm: A New Synthesis*, 70 STAN. L. REV. 1431, 1440 (2018) [hereinafter Lee, *Innovation*].

appropriation, thus resolving Arrow's Information Paradox.[106] For their part, buyers can pay for patent assignments or exclusive licenses without fear that a seller (or any other party) will use the technology without their authorization, thus resolving the inverse paradox as well.[107] Additionally, as discussed further below, patents require inventors to disclose their inventions, which codifies technical knowledge and allows it to be more easily packaged and commercialized.[108] By reducing transaction costs, patents enhance the feasibility of technology transfer between separate parties. Returning to our discussion of international technology transfer above, strong patent protection can lower the costs of technology transactions between nations, thus inducing innovators to transfer their technologies to foreign entities.[109]

B. THE INADEQUACY OF PATENTS IN TRANSFERRING TACIT KNOWLEDGE

While patents reduce some costs of technology transfer, significant costs often remain. This Section focuses on the significant *information* costs of transferring technologies, including patented technologies. For a transferee to practice an invention, it must have the technical knowledge necessary to do so. For patented inventions, the patent itself is supposed to supply this technical knowledge. All major patent jurisdictions, as well as the TRIPS Agreement, require that inventors disclose in their patents how to practice their inventions.[110] For example, under U.S. law, the enablement requirement mandates that a patent

106. *See* Robert P. Merges, *A Transactional View of Property Rights*, 20 BERKELEY TECH. L.J. 1477, 1486 (2005); Paul J. Heald, *A Transaction Costs Theory of Patent Law*, 66 OHIO ST. L.J. 473, 475 n.16 (2005); *cf.* Oren Bar-Gill & Gideon Parchomovsky, *Law and the Boundaries of Technology-Intensive Firms*, 157 U. PA. L. REV. 1649, 1653–55 (2009); Jonathan M. Barnett, *Three Quasi-Fallacies in the Conventional Understanding of Intellectual Property*, 12 J.L., ECON. & POL'Y 1, 10–17 (2016).

107. Lee, *Autonomy*, *supra* note 104, at 301.

108. Dan L. Burk, *The Role of Patent Law in Knowledge Codification*, 23 BERKELEY TECH. L.J. 1009, 1010–11 (2008).

109. *See supra* Part I.A.

110. TRIPS Agreement, *supra* note 10, art. 29.

itself must teach a person of ordinary skill in the art how to make and use the claimed invention.[111]

However, patent disclosure is limited in several ways. In particular, patents often do not disclose tacit knowledge that can be crucial to effectively practicing (and transferring) a technology.[112] In describing tacit knowledge, philosopher and scientist Michael Polanyi famously observed, "*we can know more than we can tell*."[113] Tacit knowledge refers to personal, experiential knowledge that is not easily codified.[114] For instance, a master chef may write a detailed recipe for preparing a dish, but that recipe will necessarily lack substantial tacit knowledge arising from the chef's years of experience, individual cooking talent, and even muscle memory. In the technological sphere, tacit knowledge represents "non-codified, disembodied know-how" that resides in the mind of the inventor.[115] It includes "intangible knowledge, such as rules of thumb, heuristics, and other 'tricks of the trade.'"[116] Conventional information economics posits that information moves easily and is readily appropriable by receiving parties.[117] This intuition is captured by the aphorism that

111. 35 U.S.C. § 112. The same provision requires that patents must adequately describe an invention and disclose any best mode known by the inventor for practicing it. *Id.* As we will see, however, the so-called "best mode" requirement has been rendered essentially toothless. *See infra* notes 365–66; David S. Levine & Joshua D. Sarnoff, *Compelling Trade Secret Sharing*, 74 HASTINGS L.J. 987, 1016 (2023).

112. As we will see, patents also do not disclose trade secrets that may be critical for effective technology transfer. There is some overlap between tacit knowledge, which resists codification, and trade secrets, which encompass codified and uncodified knowledge. *See infra* Part III.A.

113. MICHAEL POLANYI, THE TACIT DIMENSION 4 (1966); *see also* Kogut & Zander, *Combinative Capabilities*, *supra* note 1, at 383, 389–90.

114. *See* Kogut & Zander, *Combinative Capabilities*, *supra* note 1, at 389.

115. Jeremy Howells, *Tacit Knowledge, Innovation and Technology Transfer*, 8 TECH. ANALYSIS & STRATEGIC MGMT. 91, 92 (1996); Paul A. David & Dominique Foray, *Economic Fundamentals of the Knowledge Society*, 1 POL'Y FUTURES EDUC. 20, 25 (2003).

116. Ashish Arora, *Contracting for Tacit Knowledge*: *The Provision of Technical Services in Technology Licensing Contracts*, 50 J. DEV. ECON. 233, 234 (1996) [hereinafter Arora, *Contracting*] (noting the importance of tacit knowledge to technology transfer, particularly to developing countries); *see* ERIC VON HIPPEL, THE SOURCES OF INNOVATION 76 (1988) ("Know-how is the accumulated practical skill or expertise that allows one to do something smoothly and efficiently.").

117. *See generally* Arrow, *supra* note 103, at 614–16 (discussing the perceived low transmission costs of information).

"information wants to be free."[118] However, rather than moving easily, tacit knowledge is "sticky" and difficult to transfer.[119]

In exploring the relevance of tacit knowledge to technology transfer, it is useful to draw several distinctions. First, tacitness is a question of degree. At one end of the spectrum, purely tacit knowledge is simply incapable of codification.[120] However, some tacit knowledge is "latent," meaning that it is technically codifiable but presently uncodified.[121] Second, tacitness has a dynamic quality. Cutting-edge technologies often emerge initially with a significant tacit dimension, then lose their tacitness as they become generally accepted in a field.[122] Third, tacit knowledge manifests in several different types of entities. While individuals certainly possess tacit knowledge, organizations also develop tacit knowledge in the form of routines, processes, and even institutional cultures.[123] Finally, tacit knowledge from an inventor

118. *See* STEWART BRAND, THE MEDIA LAB 202, 211 (1987).

119. *See* Eric von Hippel, *"Sticky Information" and the Locus of Problem Solving: Implications for Innovation*, 40 MGMT. SCI. 429, 429 (1994); Margaret Chon, *Sticky Knowledge and Copyright*, 2011 WIS. L. REV. 177, 180; Gorga & Halberstam, *supra* note 23, at 1142, 1144. Other factors, such as information complexity, can compound the difficulty of transmitting tacit knowledge. *See* Kogut & Zander, *Combinative Capabilities*, *supra* note 1, at 388; Ajay Agrawal, *Engaging the Inventor: Exploring Licensing Strategies for University Inventions and the Role of Latent Knowledge*, 27 STRATEGIC MGMT. J. 63, 64 (2006); Howells, *supra* note 115, at 93.

120. *Cf.* RICHARD R. NELSON & SIDNEY G. WINTER, AN EVOLUTIONARY THEORY OF ECONOMIC CHANGE 73 (1982) (noting that the knowledge underlying "skills," such as serving a tennis ball, is largely tacit).

121. *See* Agrawal, *supra* note 119, at 64.

122. *See* Lynne G. Zucker et al., *Intellectual Human Capital and the Birth of U.S. Biotechnology Enterprises*, 88 AM. ECON. REV. 290, 291 (1998); Peter Lee, *Transcending the Tacit Dimension: Patents, Relationships, and Organizational Integration in Technology Transfer*, 100 CALIF. L. REV. 1503, 1525 (2012) [hereinafter Lee, *Transcending*]; *see also* D. J. Teece, *Technology Transfer by Multinational Firms: The Resource Cost of Transferring Technological Know-How*, 87 ECON. J. 242, 249 (1977) (arguing that tacitness of knowledge is a U-shaped function over time in which very new and very old technologies are difficult to transfer) [hereinafter Teece, *Technology Transfer*].

123. Robin Cowan & Dominique Foray, *The Economics of Codification and the Diffusion of Knowledge*, 6 INDUS. & CORP. CHANGE 595, 595–96 (1997); Robert Gibbons & Laurence Prusak, *Knowledge, Stories, and Culture in Organizations*, 110 AM. ECON. ASS'N PAPERS & PROC. 187, 187 (2020); Kogut & Zander, *Combinative Capabilities*, *supra* note 1, at 385; *see* NELSON & WINTER, *supra* note 120, at 72–73 (noting that "skills" inhere in individuals); *cf.* Gorga & Halberstam, *supra* note 23, at 1141–42 (observing that knowledge can reside in physical assets, organizations, or individuals).

may be useful for practicing some basic version of an invention, but it may be particularly useful for developing an invention into a commercial product.[124] Commercializing an invention often presents novel technical challenges for which the tacit knowledge of the original inventor is very helpful to surmount.[125]

Importantly, a technology can have a significant tacit dimension even when an inventor ostensibly "discloses" it in a patent. As noted, all jurisdictions require a patentee to disclose in the patent itself how to practice an invention.[126] This disclosure requirement encourages patentees to codify some knowledge that would otherwise remain tacit.[127] However, significant invention-related knowledge remains uncodified even when an inventor patents a technology. As noted, codification is impossible for purely tacit knowledge. While latent knowledge is capable of codification, it may be prohibitively expensive to do so based on the time, effort, and technical expertise required to explain tacit concepts. Importantly, patentees have significant incentive to disclose as little information as possible while appearing to satisfy the disclosure requirements of patentability.[128] In this manner, they can retain significant private knowledge—tacit and otherwise—for themselves.[129] Furthermore, it is exceedingly difficult for the U.S. Patent and Trademark Office (PTO) or courts to know whether patentees possess some relevant tacit

124. Lee, *Transcending*, *supra* note 122, at 1529.

125. *Id.* at 1530.

126. *See supra* notes 110–11 and accompanying text.

127. *See* Burk, *supra* note 108, at 1013 ("[C]odification results in commodification of knowledge, allowing it to be treated more as an object of trade or exchange.").

128. *See, e.g.*, Nurith Aizenman, *Moderna Won't Share Its Vaccine Recipe. WHO Has Hired an African Startup to Crack It*, NPR (Oct. 19, 2021), https://www.npr.org/sections/goatsandsoda/2021/10/19/1047411856/the-great-vaccine-bake-off-has-begun [https://perma.cc/5SDJ-Q7LE] ("[Moderna's patent is] written very carefully and cleverly to not disclose absolutely everything." (quoting Petro Terblanche, managing director of Afrigen Biologics and Vaccines)).

129. *See* Brenner v. Manson, 383 U.S. 519, 534 (1966) ("[There is a] highly developed art of drafting patent claims so that they disclose as little useful information as possible—while broadening the scope of the claim as widely as possible . . . ."); Sean B. Seymore, *The Teaching Function of Patents*, 85 NOTRE DAME L. REV. 621, 634–38 (2010); Jeanne C. Fromer, *Patent Disclosure*, 94 IOWA L. REV. 539, 552–53 (2009).

knowledge that they should disclose.[130] Finally, patent law's disclosure obligations generally focus on disclosing some basic version of an invention.[131] As such, patentees may refrain from disclosing additional knowledge (including tacit knowledge) related to developing and commercializing an invention.[132]

Tacit knowledge can be critical to effectively transferring a patented technology. This is particularly the case in the life sciences. For example, even when a biotech firm discloses a biologic compound in a patent, it often retains significant tacit knowledge regarding how to make and use it.[133] Codified disclosures, after all, cannot easily capture all the nuances of how inventors actually create and use complex biological macromolecules. Beyond being helpful to produce a biologic compound in a laboratory, tacit knowledge of inventors is especially helpful to ramping up the mass manufacture of such compounds.[134] As legal scholars Nicholson Price and Arti Rai note, "slight variations in the manufacturing process can change the quality, safety, or efficacy of the final product."[135]

The importance of tacit knowledge, moreover, reveals significant limitations in the dominant, patent-based model of international technology transfer. In some cases, patent licensees may be unable to practice an invention without tacit knowledge retained by the patentee. To be sure, economists have explored how parties can "bundle" together patents with tacit knowledge, such that adopters can license both patent rights and tacit

130. As discussed further below, the "best mode" requirement of U.S. patent law requires inventors to disclose private knowledge of the best way to practice their inventions. 35 U.S.C. § 112; *see infra* Part VI.B.1. However, the PTO "does not typically inquire into whether an applicant has in fact disclosed the best mode for practicing each claim of a patent application." Levine & Sarnoff, *supra* note 111, at 1016.

131. *See* Levine & Sarnoff, *supra* note 111, at 1013–14; *cf.* DSL Dynamic Scis. Ltd. V. Union Switch & Signal, Inc., 928 F.2d 1122, 1126 (Fed. Cir. 1991) (holding that an invention need not be commercially satisfactory to be "reduce[d] to practice").

132. *In re* Gay, 309 F.2d 769, 774 (C.C.P.A. 1962) (observing that patents are not intended to be production specifications).

133. *Cf.* OFF. OF TECH. ASSESSMENT, OTA-BA-218, COMMERCIAL BIOTECHNOLOGY: AN INTERNATIONAL ANALYSIS 368 (1984).

134. W. Nicholson Price II & Arti K. Rai, *Manufacturing Barriers to Biologics Competition and Innovation*, 101 IOWA L. REV. 1023, 1028 (2016).

135. *Id.*

knowledge to practice an invention.[136] However, such transfers typically do not unfold as quick, one-off market exchanges; they require intensive, longer-term interactions between inventors and adopters.[137] In general, the limitations of patents in directly transferring tacit knowledge create a need for other mechanisms to perform this function, a topic to which the next Section now turns.

C. THE KNOWLEDGE-BASED THEORY OF THE FIRM

To shed new light on technology transfer, this Section mobilizes insights from an underutilized source: the knowledge-based theory of the firm. As discussed, patents do not directly disclose tacit knowledge that is valuable for practicing (and transferring) novel technologies. This Section examines the advantages of firms as conduits for transferring such private knowledge.

Given that tacit knowledge is not amenable to codification—in patents or other documents—oftentimes the most effective way to transfer such knowledge is through direct interpersonal interactions between inventors and technology adopters.[138] As Bruce Kogut and Udo Zander note, teaching know-how frequently requires "interaction within small groups, often through the development of a unique language or code."[139] Similarly, economist Joanne Oxley observes that tacit knowledge is "extremely difficult to transfer without intimate personal contact, involving teaching, demonstration, and participation."[140]

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136. Arora, *Licensing*, *supra* note 20, at 42; Hoekman et al., *supra* note 18, at 1589.

137. *See* Arora, *Licensing*, *supra* note 22, at 43–44.

138. *See* Arora, *Contracting*, *supra* note 116, at 235; Arora, *Licensing*, *supra* note 20, at 43; Howells, *supra* note 115, at 93; Scott Shane, *Selling University Technology: Patterns from MIT*, 48 MGMT. SCI. 122, 124 (2002) ("[W]hen information is tacit, it must be transferred through interpersonal contact, and economic actors must develop relationship-specific assets to facilitate that transfer." (citation omitted)); Lynne G. Zucker et al., *Commercializing Knowledge: University Science, Knowledge Capture, and Firm Performance in Biotechnology*, 48 MGMT. SCI. 138, 141 (2002) (noting that transferring tacit knowledge in biotechnology requires hands-on work); *cf.* David J. Teece, *Firm Organization, Industrial Structure, and Technological Innovation*, 31 J. ECON. BEHAV. & ORG. 193, 196 (1996) ("[T]echnology transfer is often difficult without the transfer of key individuals.").

139. Kogut & Zander, *Combinative Capabilities*, *supra* note 1, at 389.

140. Joanne E. Oxley, *Appropriability Hazards and Governance in Strategic Alliances: A Transaction Cost Approach*, 13 J.L., ECON., & ORG. 387, 393 (1997) (citation omitted).

A shared organizational environment can facilitate the common context and repeat interactions necessary to transfer tacit knowledge.[141] The efficiencies of transferring tacit knowledge within a shared organization, moreover, inform a knowledge-based theory of the firm that augments the classic theory of the firm. Coasian scholars focus on "traditional" transaction costs—such as the costs of negotiating, monitoring, and enforcing contracts—to explain whether economic actors coordinate production in markets or within integrated firms. The knowledge-based theory of the firm, however, posits that firms economize on a qualitatively different kind of transaction cost: the cost of transferring technical information.[142] Put differently, the efficiencies of transferring knowledge within a unified organization provide an independent motivation for firms to integrate rather than engage in market transactions as separate entities.[143]

In the knowledge-based theory of the firm, much of the value and competitive advantage of firms derives from efficiencies in generating, transferring, and exploiting knowledge.[144] As Érica Gorga and Michael Halberstam argue, "[k]nowledge-based costs help explain both why firms exist—that is, why firms prefer internalizing production to contracting for specific goods or services in the marketplace—and why firms have a particular organizational form."[145] Similarly, as Kogut and Zander argue, "[i]n our view, firms are efficient means by which knowledge is

141. Nickerson & Zenger, *supra* note 23, at 626; Grant, *supra* note 98, at 115–16.

142. *See* Harold Demsetz, *The Theory of the Firm Revisited*, 4 J.L., ECON., & ORG. 141, 141 (1988); Gorga & Halberstam, *supra* note 23, at 1125. *But see* Nickerson & Zenger, *supra* note 23, at 617–18 (articulating tensions between competing knowledge based-theories of the firm).

143. Given that Coase did not specify transaction costs precisely, it is possible, in principle, to include knowledge-transfer costs within the broad ambit of transaction costs. However, knowledge costs differ in kind from traditional transaction costs, and "[t]hey cannot simply be subsumed within the general concept of transaction costs advanced by Coase." Gorga & Halberstam, *supra* note 23, at 1133.

144. *Id.* at 1125; *cf.* Demsetz, *supra* note 142, at 148 (arguing transaction cost theory oversimplifies unique characteristics of each firm's transaction and management costs); Grant, *supra* note 98, at 111.

145. Gorga & Halberstam, *supra* note 23, at 1126–27.

created and transferred."[146] These knowledge-transfer efficiencies are particularly salient for tacit knowledge, which is intrinsically difficult to convey.[147] Quite simply, it is easier to transfer tacit knowledge within a single organization rather than between two separate ones.

D. THE KNOWLEDGE-BASED THEORY OF THE MULTINATIONAL FIRM

Economists have built upon the knowledge-transfer efficiencies of firms to articulate a knowledge-based theory of the multinational firm. While transferring tacit knowledge is challenging in the domestic context, these challenges are even greater in the international context.[148] Economist David Teece's influential empirical analysis of twenty-six international technology transfer projects revealed that transfer costs accounted for nineteen percent of total project costs.[149] Such transfers entail particularly high information costs. Economists have long recognized that international technology transfer requires innovators to convey tacit knowledge along with more formal and codified elements of technology.[150] The tacit nature of this knowledge renders it "slow and costly to transmit," even for technologies that inventors have disclosed in patents.[151] The physical distance between technology inventors and adopters burdens international tacit knowledge transfer.[152] Additionally, difficulties of

146. Bruce Kogut & Udo Zander, *Knowledge of the Firm and the Evolutionary Theory of the Multinational Corporation*, 24 J. INT'L BUS. STUD. 625, 631 (1993) [hereinafter Kogut & Zander, *Multinational*]; *see* Nickerson & Zenger, *supra* note 23, at 623.

147. Gorga & Halberstam, *supra* note 23, at 1145.

148. Teece, *Technology Transfer*, *supra* note 122, at 242–43; Kogut & Zander, *Multinational*, *supra* note 146, at 629; *cf.* X Martin & R Salomon, *Knowledge Transfer Capacity and Its Implications for the Theory of the Multinational Corporation*, 34 J. INT'L BUS. STUD. 356, 358 (2003) ("[K]nowledge transfer is often difficult and time consuming, and substantially affects the performance of foreign operations." (citations omitted)).

149. Teece, *Technology Transfer*, *supra* note 122, at 247.

150. Arora, *Contracting*, *supra* note 116, at 234; Teece, *Technology Transfer*, *supra* note 122, at 245.

151. David J. Teece, *The Market for Know-How and the Efficient International Transfer of Technology*, 458 ANNALS AM. ACAD. POL. & SOC. SCI. 81, 83 (1981) [hereinafter Teece, *Know-How*].

152. *See* Gorga & Halberstam, *supra* note 23, at 1146 ("The transmission of tacit knowledge both within and between firms is facilitated by geographical proximity . . . .").

facilitating interpersonal interactions and differences in language, culture, educational backgrounds, and even measurement units all complicate international technology transfer.[153] Technology transfer is particularly difficult from developed to developing countries, where transferees may require substantial tacit knowledge to assimilate a new technology.[154] In short, transmitting tacit knowledge represents a major challenge of international technology transfer.[155]

The knowledge-based theory of the multinational firm posits that multinational corporations enjoy significant efficiencies in transferring tacit knowledge internationally.[156] Curiously, legal analyses of technology transfer, which tend to focus on patents and other intellectual property rights, have underappreciated this dynamic. As in the domestic context, international tacit knowledge transfer often requires interpersonal interactions between technology originators and adopters over extended time periods.[157] Having technical personnel on the ground at foreign sites is particularly helpful to solve unexpected problems and adapt transferred technology.[158] Multinational corporations facilitate the shared context and repeat interactions that accelerate international tacit knowledge transfer.[159] Importantly, this

153. *See* Teece, *Technology Transfer*, *supra* note 122, at 255–56.

154. Arora, *Licensing*, *supra* note 20, at 42–43; *cf.* Jack Baranson, *Technology Transfer Through the International Firm*, 60 AM. ECON. REV. 435, 438 (1970) (noting that technology transfer to developing countries often involves an "intensive and sustained relationship associated with significant ownership and control").

155. Martin & Salomon, *supra* note 148, at 360.

156. *Cf. id.* at 367 ("Tacitness still places a premium on tight coordination between recipient and source, and beyond some point discourages knowledge transfer.").

157. Teece, *Know-How*, *supra* note 151, at 83 (likening tacit knowledge transfer to a model in which an apprentice works directly alongside a master craftsperson); *id.* at 89 ("[A] buyer of intangible know-how typically needs ongoing, future cooperation from the seller to obtain the full benefit of the know-how purchased."); Teece, *Technology Transfer*, *supra* note 122, at 246.

158. *See* Teece, *Technology Transfer*, *supra* note 122, at 246.

159. *See* Sazali Abdul Wahab et al., *Exploring the Technology Transfer Mechanisms by the Multinational Corporations: A Literature Review*, 8 ASIAN SOC. SCI. 142, 144 (2012); Teece, *Know-How*, *supra* note 151, at 87 ("[A]n important attribute of the multinational firm is that it is an organizational mode capable of internally transferring know-how among its various business units in a relatively efficient and effective fashion."); Magee, *supra* note 82, at 318

may constitute "internal" transfer within a multinational firm that straddles national borders.[160] As Teece notes, "the arms-length market for know-how has been shown to be exposed to a number of hazards and inefficiencies, many of which can be overcome by internalizing the process within the multinational firm."[161] In a broader sense, the knowledge-based theory of multinational firms illustrates how organizations fill important knowledge gaps left by the patent-based model of international technology transfer.

III. BOUNDED ENTITIES AND TECHNOLOGY TRANSFER

This Part expands upon the knowledge-transfer advantages of firms to articulate a broader knowledge-based theory of "bounded entities." Focusing for present purposes on the domestic context, it extends the knowledge-based theory of the firm in two ways. First, the knowledge-based theory of bounded entities argues that firms (and, as we shall see, organizations more broadly) promote the internal transfer of not only tacit knowledge but also trade secrets, which may be codified. Firms have boundaries, and the "bounded" nature of these entities prevents knowledge leakage to outside parties, thus creating a hospitable environment for sharing trade secrets. Like tacit knowledge, trade secrets may be critical for practicing patented inventions. Second, the knowledge-based theory of bounded entities holds that the advantages of firms in transferring tacit knowledge and trade secrets extend to a broader class of entities beyond classic, integrated firms. This Article introduces the term "bounded entities" to refer to these constructs, which span integrated firms as well as quasi-integrated structures. They include firms, joint ventures, and thick contractual relationships between long-term partners.

("Multinational corporations are specialists in the production of information that is less efficient to transmit through markets than within firms."); Kogut & Zander, *Multinational*, *supra* note 146, at 636 ("[F]irms specialize in the transfer of knowledge that is difficult to understand and codify.").

160. *See* Jeoung Yul Lee et al., *Technological Knowledge Transfer Within Chaebols After the 1997-98 Crisis*, 43 LONG RANGE PLAN. 585, 596–98 (2010) (describing organizational structures to support intensive knowledge transfer between headquarters and foreign subsidiaries within Korean conglomerates).

161. Teece, *Know-How*, *supra* note 151, at 95; *see* Peter Enderwick & Peter J. Buckley, *Beyond Supply and Assembly Relations: Collaborative Innovation in Global Factory Systems*, 103 J. BUS. RSCH. 547, 548–49 (2019) (discussing the internalization of imperfect markets within multinational firms).

In sum, bounded entities solve two problems with transferring two kinds of technical knowledge. They facilitate the shared context and repeat interactions necessary to transfer tacit knowledge. Additionally, they prevent information leakage to outside parties and thereby safeguard the sharing of easily appropriable trade secrets.

A. BEYOND TACIT KNOWLEDGE: PROMOTING THE TRANSFER OF TRADE SECRETS BY PREVENTING KNOWLEDGE LEAKAGE

Tacit knowledge is not the only kind of "sticky" knowledge that resists transfer. While information may want to be free, innovators often deliberately conceal valuable information as trade secrets. In general, a trade secret encompasses technical and business information that is the subject of reasonable efforts to maintain secrecy and that derives economic value from such secrecy.[162] Notably, patentees may "disclose" their inventions in a patent yet deliberately withhold invention-related trade secrets to maintain commercial advantage.[163] For example, biopharmaceutical firms may disclose the basic invention of COVID-19 vaccines in a patent yet maintain the "recipe" for manufacturing vaccines in industrial quantities as a trade secret.[164] As with tacit knowledge, access to such trade secrets may be critical to effectively practicing and transferring patented technologies.

Although there is some overlap between tacit knowledge and trade secrets, the latter encompasses a broader array of information, including codified information that may be intrinsically easy to understand. Due to its difficult-to-convey nature, tacit knowledge is well-positioned to satisfy the "secret" requirement of trade secret subject matter, and many firms protect tacit

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162. *See* UNIF. TRADE SECRETS ACT § 1(4) (UNIF. L. COMM'N 1985); Defend Trade Secrets Act, 18 U.S.C. § 1839(3).

163. Branstetter et al., *supra* note 67, at 324.

164. *See* Levine & Sarnoff, *supra* note 111, at 993–94 (describing several elements of producing COVID-19 vaccines that may be protected as trade secrets, including manufacturing processes); Olga Gurgula & John Hull, *Compulsory Licensing of Trade Secrets: Ensuring Access to COVID-19 Vaccines via Involuntary Technology Transfer*, 16 J. INTELL. PROP. L. & PRAC. 1242, 1246 (2021) (describing the prevalence of trade secrets in the multi-step process of producing mRNA COVID-19 vaccines).

knowledge as trade secrets.[165] However, trade secrecy protection also extends to codified knowledge, such as confidential instructional manuals, experimental protocols, and manufacturing specifications. Unlike tacit knowledge, such codified trade secrets are "sticky" not because they are intrinsically difficult to communicate or assimilate. Rather, they are "sticky" because an innovator deliberately keeps them secret.

The knowledge-based theory of bounded entities argues that firms (and organizations more broadly) are efficient conduits for internally transferring trade secrets. In so doing, this theoretical construct adds a novel extension to the knowledge-based theory of the firm, which focuses on firms' advantages in transferring tacit knowledge. For ease of exposition, this discussion will focus on trade secrets that are not tacit, such as codified manufacturing specifications. The problem with transferring such information is not that it is intrinsically difficult to convey. Rather, the problem is that such information may be too easily misappropriated by external parties (such as outside vendors or contractors), thus eliminating its value.[166] The knowledge-based theory of bounded entities posits that the "bounded" nature of firms prevents the leakage of otherwise easily appropriable trade secrets, thus safeguarding their transfer.[167]

It is possible, of course, for a firm to license trade secrets to external entities via market exchanges.[168] In this sense, strong legal protection for trade secrets (like strong patent protection) can promote technology transfer.[169] However, constraining information leakage through internal physical and managerial controls is generally more effective than relying on trade secret law

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165. However, tacit knowledge that is well known throughout an industry would not qualify as "secret" and would not be protectable as a trade secret. UNIF. TRADE SECRETS ACT, *supra* note 162, § 1(4)(i).

166. Misappropriation may arise if an external party obtains information in an illicit manner or if it uses or discloses legitimately acquired information in an unauthorized manner.

167. Of course, internally transferred trade secrets are also susceptible to misappropriation, for instance by departing employees. Branstetter et al., *supra* note 67, at 324–25.

168. *See, e.g.*, Metallurgical Indus. Inc. v. Fourtek, Inc., 790 F.2d 1195, 1200 (5th Cir. 1986) ("We conclude that a holder may divulge his information to a limited extent without destroying its status as a trade secret.").

169. *See* James Pooley, *Trade Secrets: The Other IP Right*, WORLD INTELL. PROP. ORG. MAG. (June 2013), https://www.wipo.int/wipo_magazine/en/2013/03/article_0001.html [https://perma.cc/QQM7-NFC4].

to safeguard transactions with outside parties. Furthermore, preventing the leakage of trade secrets through organizational mechanisms is preferable to trying to obtain legal remedies for misappropriation after the fact. More generally, too much licensing can imperil the "secret" nature of a trade secret. Licensing involves some risk of misappropriation by the licensee—who may disclose or use the information in an unauthorized manner[170]—or by third parties who may gain access to the information. In the language of the theory of the firm, this increased risk of misappropriation raises the transaction costs of technology transfer between separate entities. Transferring trade secrets within an integrated organization reduces the risk of misappropriation. Put differently, it is less likely that trade secrets will be misappropriated if a firm transfers them internally than if it licenses them to external parties.[171]

B. BEYOND FIRMS: BOUNDED ENTITIES AS CONDUITS FOR TRANSFERRING TACIT KNOWLEDGE AND TRADE SECRETS

In addition to emphasizing the advantages of firms in transferring trade secrets, the knowledge-based theory of bounded entities extends the knowledge-based theory of the firm in a second way as well. The knowledge-based theory of the firm, as its name suggests, focuses on integrated *firms* as conduits for transferring tacit knowledge. However, the knowledge-based theory of bounded entities recognizes that the knowledge-transfer efficiencies of firms (which also include safeguarding the transfer of trade secrets) extend beyond firms to less integrated organizational constructs. This Article coins the term "bounded entities" to refer to a range of organizational forms—including integrated firms, joint ventures, and thick, long-term contractual relationships—featuring firm-like properties. The defining characteristic of bounded entities is that participants are organizationally "bound" in some fashion—such as by corporate boundaries or durable (though finite) contractual obligations—that provide for intensive interaction. As such, bounded entities imply some degree of organizational integration, and they stand in

170. *See* Smith v. Dravo Corp., 203 F.2d 369, 377 (7th Cir. 1953) (holding that the defendant, which received trade secrets from the plaintiff for limited purposes, misappropriated trade secrets by exceeding those limits).

171. Gorga & Halberstam, *supra* note 23, at 1169 (noting that integrating production in-house rather than coordinating production through market transactions can prevent information spillovers).

contradistinction to one-off, arm's-length transactions between separate parties in the market.

Beyond integrated firms, other forms of bounded entities also facilitate the transfer of tacit knowledge.[172] Economists note that "[c]ollaborative arrangements can be structured to emulate many of the organizational properties of internal organization by creating specialized communication channels and coordination protocols."[173] For example, joint ventures between two distinct entities also enjoy efficiencies in tacit knowledge transfer.[174] Furthermore, thick contractual relationships between long-term partners promote transferring tacit knowledge.[175] For instance, "relational" contracts between long-term partners can facilitate significant interaction and organizational interpenetration, such as when one firm directly supervises the operations of another.[176] Relatedly, formally distinct organizations can operate

172. Even defining the boundaries of an "integrated" firm can be difficult. A firm may have one or more subsidiaries, which are entities in which the parent firm has at least a 50% ownership stake. Additionally, the firm may have one or more affiliates, which are entities in which the parent firm has less than a 50% ownership stake.

173. Gary P. Pisano et al., *Joint Ventures and Collaboration in the Biotechnology Industry*, *in* INTERNATIONAL COLLABORATIVE VENTURES IN U.S. MANUFACTURING 183, 198 (David C. Mowery ed., 1988).

174. Gorga & Halberstam, *supra* note 23, at 1203; Oxley, *supra* note 140, at 388.

175. *Cf.* Naomi R. Lamoreaux et al., *Beyond Markets and Hierarchies: Toward a New Synthesis of American Business History*, 108 AM. HIST. REV. 404, 409 (2003) ("[B]oth parties can benefit from the pooling of information and resources that trust makes possible."); *see, e.g.*, Enderwick & Buckley, *supra* note 161, at 553 (describing innovative collaborations between Apple and Foxconn based on trust and mutual understanding arising from "long standing supply and assembly relations"); Jeffrey H. Dyer & Kentaro Nobeoka, *Creating and Managing a High-Performance Knowledge-Sharing Network: The Toyota Case*, 21 STRATEGIC MGMT. J. 345, 346 (2000) (noting knowledge-sharing routines between Toyota and its suppliers that "result in superior interorganizational or network-level learning").

176. *See* Charles J. Goetz & Robert E. Scott, *Principles of Relational Contracts*, 67 VA. L. REV. 1089, 1090, 1091 (1981) (defining relational contracts as "continuing, highly interactive contractual arrangements" where "the parties are incapable of reducing important terms of the arrangement to well-defined obligations"); *id.* at 1093 (noting that relational contracts may allow principals to directly monitor and supervise agents' activities).

in networks—which may be structured by contracts—that facilitate significant tacit knowledge sharing.[177]

Additionally, the ability to safeguard the transfer of trade secrets extends beyond firms to less integrated bounded entities as well. As discussed above, integrated firms provide a hospitable environment for transferring trade secrets, as internal controls and corporate boundaries reduce spillovers to external parties.[178] In a somewhat analogous fashion, joint ventures can function as shared, closed spaces in which separate firms exchange trade secrets with each other but not outside parties. Firms routinely use contractual mechanisms, including nondisclosure agreements, to effectively extend the boundaries of the firm and prevent knowledge leakage when dealing with outside partners.[179] Thick, long-term contractual relationships, moreover, provide additional safeguards against knowledge leakage.[180] Among other considerations, such organizational meshing increases each partner's ability to monitor the other's handling of confidential information.[181] Furthermore, dense relationships can contribute to a collective identity and align financial incentives, both of which motivate partners to share trade secrets with

177. *See, e.g.*, Walter W. Powell et al., *Interorganizational Collaboration and the Locus of Innovation: Networks of Learning in Biotechnology*, 41 ADMIN. SCI. Q. 116, 119–22 (1996) (discussing individual firms' access to knowledge when operating in networks); Dyer & Nobeoka, *supra* note 175, at 345 (discussing advantages gained through "network-level knowledge-sharing processes"); Enderwick & Buckley, *supra* note 161, at 547 ("The global factory is effectively a commercial network, at the heart of which are complex flows of knowledge, intermediate products, and management skills."); *cf.* Laura G. Pedraza-Fariña, *Spill Your (Trade) Secrets: Knowledge Networks as Innovation Drivers*, 92 NOTRE DAME L. REV. 1561, 1575–76 (2017) (discussing intensive sharing of knowledge, including know-how, within epistemic communities in innovative industries).

178. *See supra* Part III.A.

179. Gorga & Halberstam, *supra* note 23, at 1149; Teece, *Know-How*, *supra* note 151, at 89.

180. *See* Enderwick & Buckley, *supra* note 161, at 555 (noting that structured interdependence discourages information leakage in collaborations between Apple and Foxconn).

181. *Cf.* Goetz & Scott, *supra* note 176, at 1093 (describing mechanisms for ensuring compliance with the terms of relational contracts).

each other while discouraging leaking trade secrets to outside parties.[182]

In elaborating this knowledge-based theory of bounded entities, this Article observes that "firm-like" qualities are not a binary on-off designation but a question of degree.[183] In articulating this view, this Article reflects the influential (though contested) conception of the firm as a nexus of contracts.[184] Firms may be understood as a collection of contracts, and at a certain point, thick contractual relationships between long-term partners, which engage in repeated and closed interactions, approximate the knowledge-sharing attributes of integrated firms.[185] In contradistinction, one-off market transactions between arm's-length parties are poorly situated to transfer tacit knowledge and prevent misappropriation of trade secrets.

It is also important to emphasize that bounded entities' advantages in transferring technical information are relative rather than absolute. Transferring tacit knowledge within a bounded entity can still be difficult.[186] Separate units within a bounded entity may actively conceal both tacit knowledge and

182. *See* Dyer & Nobeoka, *supra* note 175, at 351–52 (discussing Toyota's formation of a "network identity" among its suppliers and its ability to sanction partners that do not share information); *id.* at 357–59 (describing how Toyota openly shares information with suppliers but demands reciprocal openness in return); DOUGLASS C. NORTH, INSTITUTIONS, INSTITUTIONAL CHANGE AND ECONOMIC PERFORMANCE 55 (1990); Enderwick & Buckley, *supra* note 161, at 552 ("[A] shared focus and a recognition of the interdependency of rewards can serve to discourage misappropriative behaviour even when trust is embryonic."); *cf.* ROBERT C. ELLICKSON, ORDER WITHOUT LAW: HOW NEIGHBORS SETTLE DISPUTES 184–206 (1991) (arguing that efficient norms, such as norms against breaching agreements, are most likely to arise in communities that are "close-knit" and in which members interact repeatedly).

183. Lamoreaux et al., *supra* note 175, at 405.

184. Michael C. Jensen & William H. Meckling, *Theory of the Firm: Managerial Behavior, Agency Costs and Ownership Structure*, 3 J. FIN. ECON. 305, 310–11 (1976). *But see* Melvin A. Eisenberg, *The Conception That the Corporation Is a Nexus of Contracts, and the Dual Nature of the Firm*, 24 J. CORP. L. 819, 820 (critiquing aspects of the notion of the firm as a nexus of contracts).

185. Pisano et al., *supra* note 173, at 195 ("On the surface, it can be difficult to distinguish arms-length and collaborative relationships.").

186. Morten T. Hansen, *The Search-Transfer Problem: The Role of Weak Ties in Sharing Knowledge Across Organization Subunits*, 44 ADMIN. SCI. Q. 82, 107 (1999) (discussing the impact of the strength of organizational ties on knowledge sharing capabilities).

trade secrets from each other due to internal competition.[187] Additionally, internally transferred tacit knowledge and trade secrets may still be misappropriated, such as by departing employees.[188] These considerations notwithstanding, the organizational cohesiveness of bounded entities confers distinct advantages in transferring tacit knowledge and trade secrets relative to one-off market exchanges between arm's-length parties.

In sum, bounded entities address two different challenges of transferring two different kinds of technical knowledge. They facilitate the shared context and repeat interactions needed to share tacit knowledge, which is intrinsically difficult to convey. Additionally, they guard against the external leakage of codified trade secrets, which may be very easy to convey. In this sense, bounded entities define modular systems that facilitate intensive internal interactions and limit external interactions with outside parties.[189] In so doing, they are powerful conduits for transferring invention-related tacit knowledge and trade secrets, even for technologies ostensibly disclosed in patents.

C. EXAMPLES OF BOUNDED ENTITIES IN DOMESTIC TECHNOLOGY TRANSFER

In the domestic context, firms often rely on bounded entities to transfer tacit knowledge and trade secrets related to patented inventions. For example, university inventors and firms licensing their patents frequently form bounded entities to transfer tacit knowledge.[190] Licensee firms often hire faculty inventors as long-term consultants or bring them "in-house" as permanent scientific advisors.[191] Although patents themselves are supposed

187. Anthony M. Marino & Ján Zábojník, *Internal Competition for Corporate Resources and Incentives in Teams*, 35 RAND J. ECON. 710, 711 (2004); Lee et al., *supra* note 160, at 586 ("[M]anagers in multidivisional companies are often unaware of useful knowledge located outside their unit, and/or are unwilling to share their knowledge with others.").

188. *See* Branstetter et al., *supra* note 67, 324–25; Pedraza-Fariña, *supra* note 177, at 1594.

189. *See* Simon, *supra* note 31, at 473–74; Smith, *supra* note 31, at 1761–66.

190. Due to their embryonic, cutting-edge status, many patented university inventions have a significant tacit dimension. *See* Richard Jensen & Marie Thursby, *Proofs and Prototypes for Sale: The Licensing of University Inventions*, 91 AM. ECON. REV. 240, 243 (2001) (describing the need for ongoing inventor-licensee cooperation due to the "embryonic" nature of most patented university inventions).

191. Lee, *Transcending*, *supra* note 122, at 1551–52.

to disclose inventions, direct engagement with faculty inventors allows licensees to access invention-related tacit knowledge that does not appear in patents. Another form of bounded entity is the sponsored research agreement in which firms fund university research and obtain options to license any resulting patents.[192] Commercial sponsors often install their own scientists in academic laboratories, which facilitates tacit knowledge transfer from university researchers.

Less appreciated, academic-industrial bounded entities also prevent external knowledge leakage and promote the sharing of trade secrets. Private biotech firms often bind "star" academic scientists (whose patents they may be licensing) quite closely to access trade secrets and prevent knowledge sharing with competitors.[193] Historically, star scientists have also recognized the commercial value of their knowledge and "were very protective of their techniques, ideas, and discoveries . . . , tending to collaborate more within their own institution, which slowed diffusion to other scientists."[194] In sum, tight organizational linkages facilitate the transfer of both tacit knowledge and trade secrets between academic and industrial entities.

Bounded entities play a similar role in transferring technical knowledge between biotech firms and large pharmaceutical companies. As a rough schematic, small, research-intensive biotech firms develop (and patent) therapeutic biologic compounds, which they transfer to large pharmaceutical companies for commercialization. Sometimes, biotech firms rely on arm's-length licenses to transfer patented compounds to separate pharmaceutical companies.[195] Frequently, however, parties achieve such transfer through establishing a variety of bounded entities. One

192. *Id.* at 1549–51.

193. *See, e.g.*, Lynne G. Zucker & Michael R. Darby, *Star Scientists and Institutional Transformation: Patterns of Invention and Innovation in the Formation of the Biotechnology Industry*, 93 PROC. NAT'L ACAD. SCI. U.S. 12709, 12714 (1996) ("[S]tar scientists embodying the breakthrough technology are the 'gold deposits' around which new firms are created or existing firms transformed . . . .").

194. *Id.* at 12709.

195. Pisano et al., *supra* note 173, at 194 (describing licensing relationships between biotechnology firms and larger companies for further development or commercialization of R&D products); *cf.* Ashish Arora & Robert P. Merges, *Specialized Supply Firms, Property Rights and Firm Boundaries*, 13 INDUS. & CORP. CHANGE 451, 471 (2004) ("Independent research-intensive suppliers are more viable at the margin when stronger patents are available.").

form of bounded entity involves vertical integration of biotech and pharmaceutical firms, thus combining invention and commercialization under one roof.[196] For example, biotech firms have integrated forward into drug manufacturing,[197] and large pharmaceutical companies routinely integrate backward by acquiring small biotech firms.[198] Among other advantages,[199] integration accelerates tacit knowledge transfer across the research-commercialization interface. Other types of bounded entities in the biopharmaceutical industry that similarly transfer tacit knowledge include joint ventures,[200] long-term contracts, and networks.[201]

In addition to transferring tacit knowledge, such bounded entities also safeguard the transfer of trade secrets. Collaborative relationships—rather than arm's-length contracting—provide a more secure environment for exchanging sensitive information.[202] In sum, the challenges of transferring tacit knowledge and preventing knowledge leakage "drive the organization of innovation toward quasi-integrated (collaborative) and vertically integrated forms."[203]

IV. MULTINATIONAL BOUNDED ENTITIES AND INTERNATIONAL TECHNOLOGY TRANSFER

Extending the previous theoretical construct, this Part articulates a novel knowledge-based theory of multinational bounded entities. As noted, economists have long recognized that multinational firms enjoy significant efficiencies in transferring tacit knowledge overseas.[204] This Article adds the dual insights

196. Pisano et al., *supra* note 173, at 194, 199–200 ("The organizational problems of transferring know-how can be overcome by vertical integration between R&D and manufacturing.").

197. *Id.* at 197–98.

198. *See* Lee, *Innovation*, *supra* note 105, at 1455–66.

199. *See id.* at 1462–63 (examining several benefits of integration, including exploiting economies of scale, enhancing political influence, increasing revenues, and serving the interests of shareholders and venture capitalists).

200. Pisano et al., *supra* note 173, at 195.

201. *Id.* at 200; Powell et al., *supra* note 177, at 119 ("[T]he locus of innovation is found in a network of interorganizational relationships." (citation omitted)).

202. Pisano et al., *supra* note 173, at 195–96.

203. *Id.* at 195.

204. *See supra* Part II.D.

that multinational firms also enjoy efficiencies in transferring trade secrets and that the knowledge-transfer advantages of firms extend to a broader class of multinational bounded entities. This Part then illustrates the importance of multinational bounded entities to international technology transfer by examining the global manufacturing of COVID-19 vaccines and "forced technology transfer" in the U.S.-China trade war.

A. A KNOWLEDGE-BASED THEORY OF MULTINATIONAL BOUNDED ENTITIES

The knowledge-based theory of multinational bounded entities posits that multinational firms promote the transfer of not only tacit knowledge but also trade secrets to foreign countries. As in the domestic context, international transfers of trade secrets are subject to misappropriation risk.[205] To a certain extent, strong legal protection of trade secrets (like strong patent protection) can encourage greater international technology transfer. However, such safeguards are imperfect, particularly given the difficulties of monitoring and enforcing misappropriation of trade secrets in foreign jurisdictions. Transferring trade secrets within a multinational firm reduces such risk and provides stronger protection against information leakage. Multinational firms may even vertically integrate by taking over foreign production facilities or acquiring foreign firms to prevent knowledge spillovers.[206]

Additionally, the knowledge-based theory of multinational bounded entities recognizes that the knowledge-transfer efficiencies of multinational firms extend to a broader range of bounded entities. The core "bounded entity" is the integrated multinational firm. Such bounded entities facilitate the shared context and repeat interactions necessary to transfer tacit knowledge from, say, a parent company to a wholly owned foreign subsidiary. Multinational firms also prevent knowledge leakage and safeguard the sharing of trade secrets to foreign

205. Again, this discussion focuses on codified trade secrets that are not tacit. However, as noted, even tacit knowledge is capable of unauthorized appropriation, and its loss is particularly costly. Martin & Salomon, *supra* note 148, at 360.

206. Magee, *supra* note 82, at 333.

units.[207] Although subject to some limitations,[208] international joint ventures also facilitate the transfer of tacit knowledge and trade secrets across borders.[209] Additionally, thick cross-border contractual relationships, particularly between long-term partners, represent multinational bounded entities that facilitate tacit knowledge exchange. Within such bounded entities, organizational interpenetration often allows participants to monitor their partners' handling of sensitive information and align their financial interests,[210] both of which safeguard the transfer of trade secrets.

While multinational bounded entities of all kinds facilitate knowledge transfer, their effectiveness in transferring tacit knowledge and trade secrets increases with their degree of integration. Notably, firms are more likely to transfer their newest technologies—which encompass significant private knowledge—to wholly owned subsidiaries; conversely, they are more likely to transfer older technologies through joint ventures and licensing deals.[211] In sum, multinational bounded entities represent a solution to the challenges of transferring technical knowledge abroad. As modular systems, bounded entities establish an "information envelope" that facilitates internal knowledge flows and prevents external knowledge leakage.

Although measurements are difficult, evidence suggests that a substantial amount (perhaps the majority) of international technology transfer takes place through bounded

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207. This element of multinational bounded entities is subject to exception, for example in China's policy to promote mandatory joint ventures. *See infra* Part IV.B.2.

208. Kogut & Zander, *Multinational*, *supra* note 146, at 635 (arguing that, for "uncodified knowledge, the preferred vehicle is transfer between wholly owned units," not joint ventures).

209. *See* Wahab et al., *supra* note 159, at 146 ("[J]oint venture has been well accepted as an effective channel of technology transfer.").

210. *See supra* notes 176, 181–82 and accompanying text.

211. Edwin Mansfield & Anthony Romeo, *Technology Transfer to Overseas Subsidiaries by U. S.-Based Firms*, 95 Q.J. ECON. 737, 738–39 (1980) ("[T]he mean age of the technologies transferred through licenses, joint ventures, and channels other than subsidiaries tends to be higher than the mean age of the technologies transferred to subsidiaries."); Teece, *Know-How*, *supra* note 151, at 93; *cf.* Kogut & Zander, *Multinational*, *supra* note 146, at 639 ("[T]he attributes of knowledge influence the decision of where to draw the boundaries of the firm.").

entities.[212] A 2019 empirical examination of 160 multinational enterprises in fourteen economic sectors revealed that research collaborations with foreign partners were the main form of direct international technology transfer, occurring 1,453 times in the dataset.[213] International joint ventures were third, with 304 linkages.[214] International equity investments were fourth, with 205 linkages.[215] All of these channels would fall under the category of "bounded entities." As for patent licensing, the dataset reported 781 linkages, though that figure may be high because it counted out-licensing and in-licensing arrangements separately.[216] It is important to note that mere "counts" of various transfer channels may misrepresent their overall economic and technological importance. For instance, one international equity investment may facilitate an enormous volume of ongoing technology transfer compared to, say, one patent licensing agreement.[217] To provide a more textured account of multinational bounded entities, the next Section turns to case studies demonstrating how these entities operate in real-world contexts.

B. CASE STUDIES OF MULTINATIONAL BOUNDED ENTITIES AND INTERNATIONAL TECHNOLOGY TRANSFER

Case studies of multinational bounded entities illustrate their centrality to international technology transfer. They are particularly important for transferring technical knowledge—including tacit knowledge and trade secrets. For example, a wide management literature has documented how multinational corporations in the global automotive and electronics industries transfer technical knowledge to foreign suppliers, subsidiaries,

212. *See* UNCTAD, *supra* note 2, ¶ 15 ("The bulk of technology dissemination is undertaken through internalized channels within the networks of [transnational corporations].").

213. Andrea Andrenelli et al., *International Technology Transfer Policies* 26 (Org. for Econ. Co-Operation & Dev., Trade Pol'y Paper No. 222, 2019).

214. *Id.*

215. *Id.*

216. *Id.*

217. *Id.* at 27 ("[I]it is likely that – although more limited in number – these investment linkages are generally of greater economic significance compared to research collaboration and licensing linkages.").

and affiliates.[218] This Article highlights the underappreciated ways that bounded entities transfer technical knowledge even for technologies that inventors have ostensibly disclosed in patents. Going further, bounded entities facilitate technology transfer even when innovators try to assert intellectual property rights to *limit* technology transfer. These respective dynamics are evident in the two most prominent international technology transfer controversies of recent years: the challenge of expanding global manufacturing of patented COVID-19 vaccines and the conflict over "forced technology transfer" in the U.S.-China trade war.

1. Global Manufacturing of Patented COVID-19 Vaccines

The importance of bounded entities to international knowledge transfer—even for technologies ostensibly disclosed in patents—is evident in the challenge of increasing global manufacturing of COVID-19 vaccines. As noted, biopharmaceutical firms have developed several COVID-19 vaccines[219] and patented the technologies underlying these vaccines around the world.[220] These vaccines have saved countless lives, but limited access to these essential resources has been highly controversial.[221] While vaccine access has improved considerably over the past two years, developing countries still have virtually no access to (patented) mRNA vaccines,[222] which are the most effective vaccines against the newest COVID-19 variants. As we shall see, the perceived role of patents in preventing international technology transfer led to policy reforms to weaken such rights. However, the lack of access to technical knowledge for manufacturing patented vaccines has impeded the international transfer of mRNA vaccine technology, thus highlighting the role of

218. *See, e.g.*, Dyer & Nobeoka, *supra* note 175, at 345; Lee et al., *supra* note 160, at 585; Ramón Padilla-Pérez, *A Regional Approach to Study Technology Transfer Through Foreign Direct Investment: The Electronics Industry in Two Mexican Regions*, 37 RSCH. POL'Y 849, 852–58 (2008) (describing four organizational "levels" at which technology transfer occurs in multinational enterprises).

219. *See* Peter Lee, *Patents and the Pandemic: Intellectual Property, Social Contracts, and Access to Vaccines*, 17 WASH. J.L., TECH. & ARTS 193, 194–95 (2022) [hereinafter Lee, *Pandemic*] (describing the development of COVID-19 vaccines).

220. Martin & Lowery, *supra* note 6, at 57.

221. *See supra* notes 8–9 and accompanying text.

222. Prabhala, *supra* note 9.

multinational bounded entities in transferring such knowledge abroad.

To address the perceived role of patents in limiting access to COVID-related technologies, in October 2020, India and South Africa proposed a temporary waiver of various provisions of the TRIPS Agreement.[223] The Biden administration took the surprising move of supporting a narrower version of the TRIPS waiver limited to patented COVID-19 vaccines.[224] After protracted negotiations, the WTO adopted such a limited waiver in June 2022.[225] Proponents of the TRIPS waiver argued that temporarily relaxing patents would enable generic manufacturing of COVID-19 vaccines around the world, thus increasing access in developing countries.[226]

Biopharmaceutical companies steadfastly opposed the TRIPS waiver, and in so doing, they revealed the knowledge gaps endemic to the patent-based model of international technology transfer. Among various objections, vaccine patentees asserted that even if governments temporarily weakened patents, third-party manufacturers would be unable to produce COVID-19 vaccines without tacit knowledge and trade secrets from vaccine developers themselves.[227] Although vaccine developers have ostensibly disclosed their technologies in patents, significant

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223. *India & South Africa*, *supra* note 95.

224. Press Release, Off. Of the U.S. Trade Rep., Exec. Off. Of the President, Statement from Ambassador Tai on the Covid-19 Trips Waiver (May 5, 2021), https://ustr.gov/about-us/policy-offices/press-office/press-releases/2021/may/statement-ambassador-katherine-tai-covid-19-trips-waiver [https://perma.cc/R6Q9-UGS4]; Thomas Kaplan et al., *Taking 'Extraordinary Measures,' Biden Backs Suspending Patents on Vaccines*, N.Y. TIMES (May 5, 2021), https://www.nytimes.com/2021/05/05/us/politics/biden-covid-vaccine-patents.html [https://perma.cc/5PAU-NMZ3].

225. TRIPS Draft Ministerial Decision, *supra* note 10.

226. *See supra* Part I.B.

227. Lopez, *supra* note 12; Selam Gebrekidan & Matt Apuzzo, *Rich Countries Signed Away a Chance to Vaccinate the World*, N.Y. TIMES (March 21, 2021), https://www.nytimes.com/2021/03/21/world/vaccine-patents-us-eu.html [https://perma.cc/7SQU-2NTC]; Stephanie Nolen, *Here's Why Developing Countries Can Make mRNA Covid Vaccines*, N.Y. TIMES (Oct. 22, 2021), https://www.nytimes.com/interactive/2021/10/22/science/developing-country-covid-vaccines.html [https://perma.cc/8RQZ-9J8Y]. Opponents of compulsory licenses have previously made this argument as well. *See* World Intell. Prop. Org. [WIPO], *Patents and Health: A Proposal by the Delegation of the United States of America*, at 1, WIPO Doc. SCP/17/11 (Dec. 7, 2011), https://www.wipo.int/meetings/en/doc_details.jsp?doc_id=191200 [https://perma.cc/C7K5-DLSS].

tacit knowledge and trade secrets remain undisclosed. This argument had particular traction coming from Moderna. Early on, the company pledged to not assert its COVID-19 vaccine patents during the pandemic.[228] Before subsequently reneging on that pledge, it could have argued that its patents were not preventing generic manufacturing of its vaccine.[229] However, Moderna has refused to widely share its tacit knowledge and trade secrets for manufacturing its vaccine,[230] without which third parties have been unable to produce it in industrial quantities.

Tacit knowledge and trade secrets play an important role in the international transfer of patented COVID-19 vaccines.[231] Consistent with the views of vaccine patentees, academic commentators contend that for "complex COVID-19 vaccines and biological therapeutics, fast manufacturing, particularly of products originally developed by other firms, will require not only physical capacity but also access to knowledge not contained in patents or in other public disclosures."[232] Similarly, vaccine expert Alain Alsalhani from Doctors Without Borders observed:

> You need someone to share all the process, because it's a new technology . . . . One of the problems we have is that the scientific literature about industrial-scale manufacturing of mRNA vaccines is so slim.

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228. *Statement by Moderna on Intellectual Property Matters During the COVID-19 Pandemic*, MODERNA (Oct. 8. 2020), https://investors.modernatx.com/Statements—Perspectives/Statements—Perspectives-Details/2020/Statement-by-Moderna-on-Intellectual-Property-Matters-during-the-COVID-19-Pandemic/default.aspx [https://perma.cc/4GTS-ZBTD].

229. *Moderna's Updated Patent Pledge*, MODERNA (Mar. 7, 2022), https://investors.modernatx.com/Statements—Perspectives/Statements—Perspectives-Details/2022/Modernas-Updated-Patent-Pledge/default.aspx [https://perma.cc/CSU5-Y87V]; *see* Rebecca Robbins & Jenny Gross, *Moderna Sues Pfizer and BioNTech over Coronavirus Vaccine*, N.Y. TIMES (Aug. 26, 2022), https://www.nytimes.com/2022/08/26/business/moderna-covid-vaccine-lawsuit.html [https://perma.cc/48AZ-DNS8].

230. *See* Stephanie Nolen & Sheryl Gay Stolberg, *Pressure Grows on U.S. Companies to Share Covid Vaccine Technology*, N.Y. TIMES (Sept. 22, 2021), https://www.nytimes.com/2021/09/22/us/politics/covid-vaccine-moderna-global.html [https://perma.cc/CU97-UZJ3] (detailing the Biden administration's frustration with Moderna for not transferring its technology widely to other vaccine manufacturers).

231. Kaplan et al., *supra* note 224.

232. W. Nicholson Price II et al., *Knowledge Transfer for Large-Scale Vaccine Manufacturing*, 369 SCI. 912, 912 (2020).

> This is why it's not just about a recipe, it's about an active and full tech transfer.[233]

Transfer of private information—including tacit knowledge and trade secrets—is critical to manufacturing patented COVID-19 vaccines.

Vaccine patentees decried the difficulty of transferring technical knowledge as a reason to oppose the TRIPS waiver.[234] However, vaccine developers have actively transferred the technical knowledge to produce their patented technologies overseas, thus illustrating the feasibility of doing so. Notably, they have used multinational bounded entities to transfer patent-related tacit knowledge and trade secrets abroad.

One form of multinational bounded entity that vaccine developers have used is the integrated multinational firm. For instance, Moderna has announced plans to establish vaccine manufacturing facilities in Kenya, Australia, and Canada.[235] Doing so will allow Moderna to transfer its tacit knowledge and trade secrets internationally while keeping them "in-house." Such transfer within a single organization facilitates the shared context and repeat interactions necessary to transfer tacit knowledge. In Moderna's case, vaccine engineers from its U.S. headquarters can provide long-term, on-site assistance at Moderna facilities abroad to help ramp up vaccine

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233. Nolen & Stolberg, *supra* note 230 (quoting Alain Alsalhani, Doctors Without Borders).

234. *See* Ashleigh Furlong, *Big Vaccine Makers Reject Offers to Help Produce More Jabs*, POLITICO (May 14, 2021), https://www.politico.eu/article/vaccine-producers-reject-offers-to-make-more-jabs [https://perma.cc/4GZN-WJE5]. They have also cited difficulties of transferring technical knowledge in refusing numerous licensing requests from biopharmaceutical firms around the world. *Id.*; Nolen, *supra* note 227.

235. *See* Press Release, Moderna, Moderna to Build State-of-the-Art mRNA Facility in Africa to Manufacture up to 500 Million Doses per Year (Oct. 7, 2021), https://investors.modernatx.com/news/news-details/2021/Moderna-to-Build-State-of-the-Art-mRNA-Facility-in-Africa-to-Manufacture-up-to-500-Million-Doses-Per-Year/default.aspx [https://perma.cc/AC5M-KPZ2]; Press Release, Moderna, Moderna and Australia Announce Collaboration to Bring mRNA Manufacturing to Australia (Dec. 13, 2021), https://investors.modernatx.com/news/news-details/2021/Moderna-and-Australia-Announce-Collaboration-to-Bring-mRNA-Manufacturing-to-Australia/default.aspx [https://perma.cc/MEM9-UALM]; Press Release, Moderna, Moderna and Canada Announce Collaboration to Bring mRNA Manufacturing to Canada (Aug. 10, 2021), https://investors.modernatx.com/news/news-details/2021/Moderna-and-Canada-Announce-Collaboration-to-Bring-mRNA-Manufacturing-to-Canada/default.aspx [https://perma.cc/C7JZ-WNCE].

manufacturing. Such transfer within a single (multinational) firm also establishes a "closed" organizational environment that helps prevent the leakage of trade secrets to outside parties.[236]

Another kind of multinational bounded entity that vaccine developers have used is long-term, thick contractual relationships with foreign partners. For example, in May 2020, Moderna entered into a ten-year "strategic collaboration agreement" with Lonza, a Swiss chemicals and biotechnology company, to manufacture Moderna's COVID-19 vaccine.[237] The agreement involved establishing manufacturing facilities at Lonza's sites, and it provided that technology transfer would start in June 2020.[238] Within this multinational bounded entity, such "a long-term relationship between a source of R&D and a manufacturer can achieve many of the economies of team-learning that are normally possible within the same firm."[239] In September 2021, Moderna announced a multi-year agreement with Canadian firm National Resilience, Inc., which will produce mRNA for Moderna's COVID-19 vaccine.[240] Similarly, this long-term partnership will facilitate significant tacit knowledge and trade secret exchange between its partners.

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236. *Cf.* Blomström & Kokko, *supra* note 68, at 254 (showing that using a local, non-affiliated supplier can lead to unwanted information spillovers); Wahab et al., *supra* note 159, at 145 (highlighting that frequent interactions with local, outside firms can lead to technology spillovers).

237. Press Release, Moderna, Moderna and Lonza Announce Worldwide Strategic Collaboration to Manufacture Moderna's Vaccine (mRNA-1273) Against Novel Coronavirus (May 1, 2020) [hereinafter Moderna and Lonza], https://investors.modernatx.com/news/news-details/2020/Moderna-and-Lonza-Announce-Worldwide-Strategic-Collaboration-to-Manufacture-Modernas-Vaccine-mRNA-1273-Against-Novel-Coronavirus/default.aspx [https://perma.cc/4LXV-DYHJ]; Sydney Lupkin, *How Will Moderna Meet the Demand for Its COVID-19 Vaccine?*, NPR (Dec. 17, 2020), https://www.npr.org/sections/health-shots/2020/12/17/947628608/how-will-moderna-meet-the-demand-for-its-covid-19-vaccine [https://perma.cc/QR5S-CZHT].

238. *See* Moderna and Lonza, *supra* note 237.

239. Pisano et al., *supra* note 173, at 200.

240. Press Release, Moderna, Resilience to Manufacture mRNA for Moderna's COVID-19 Vaccine (Sept. 8, 2021), https://investors.modernatx.com/news/news-details/2021/Resilience-to-Manufacture-mRNA-for-Modernas-COVID-19-Vaccine/default.aspx [https://perma.cc/BX2P-S5CN]; Matthew Herper, *Moderna Turns to Biotech Startup to Ramp Up Covid Vaccine Manufacturing*, STAT (Sept. 8, 2021), https://www.statnews.com/2021/09/08/moderna-turns-to-biotech-startup-to-ramp-up-covid-vaccine-manufacturing [https://perma.cc/EVH7-BBVY].

Pfizer and its partner BioNTech have also established multinational bounded entities in the form of thick contractual relationships to transfer mRNA vaccine technology abroad.[241] At the most foundational level, Pfizer's partnership with BioNTech is itself a multinational bounded entity. German biotech firm BioNTech developed proprietary mRNA vaccine technology, and it partnered with Pfizer to coordinate global clinical trials, manufacturing, and distribution of a COVID-19 vaccine.[242] This collaboration features significant knowledge sharing between the two firms.[243] Blurring the organizational boundaries between the two companies, Pfizer has taken a sizable equity stake in BioNTech.[244]

Additionally, the Pfizer-BioNTech collaboration has utilized multinational bounded entities to facilitate vaccine manufacturing around the world. As of September 2021, the two companies had agreements with over twenty contract manufacturing organizations on four continents.[245] Importantly, these are not one-off market transactions. Such agreements include commitments to intensive interaction and knowledge sharing. According to Pfizer:

> The tech transfer process entails a litany of tasks, among them: establishing the scope, schedule, governance and budget; purchasing equipment; performing practice tests to train operators on the manufacturing process; carrying out tests and conducting quality and safety audits to meet Pfizer's standards and regulatory agency' [sic] expectations; undergoing regulatory agency inspection and receiving approval.
>
> For the COVID-19 vaccine, the team at the external facility would need to be trained on many aspects of this complex manufacturing process—from learning the intricacies of formulating lipid nanoparticles that encapsulate the mRNA and sterilizing the product to make it safe

241. *Pfizer and BioNTech Announce Further Details on Collaboration to Accelerate Global COVID-19 Vaccine Development*, BUS. WIRE (Apr. 9, 2020), https://www.businesswire.com/news/home/20200409005405/en [https://perma.cc/XNM7-MMJ4].

242. *Id.*

243. *See id.*

244. *Id.*

245. *Shot of a Lifetime: How Pfizer Is Partnering with CMOs to Increase COVID-19 Vaccine Production and Reach More People*, PFIZER (Oct. 7, 2021), https://www.pfizer.com/news/articles/shot_of_a_lifetime_how_pfizer_is_partnering_with_cmos_to_increase_covid_19_vaccine_production_and_reach_more_people [https://perma.cc/3HPJ-ZVLM].

> for injection to filling it into vials, labeling the vials, packaging them, and distributing them around the world.[246]

Pfizer reports that the typical technology transfer process can take up to three years, though it significantly accelerated that process to five to eighteen months for COVID-19 vaccines.[247]

While vaccine developers have ostensibly disclosed their technologies in patents, such disclosure is limited, and multinational bounded entities are crucial for transferring invention-related tacit knowledge and trade secrets abroad. Transfers to a foreign subsidiary or between long-term partners facilitate the shared context and repeat interactions necessary to communicate tacit knowledge. Additionally, keeping transfers "in-house" or between long-term partners safeguards the sharing of easily appropriable trade secrets, such as codified vaccine recipes.[248]

2. "Forced Technology Transfer" Between the United States and China

The importance of multinational bounded entities to transferring technical knowledge abroad is also evident in allegations of "forced technology transfer" in the U.S.-China trade war.[249] While there are many points of dispute, this Article will focus on U.S. allegations that China is forcing foreign firms to create joint ventures with local firms to participate in certain Chinese markets. Setting aside for now the legality or policy wisdom of these practices, this Subsection focuses on what they reveal about the role of multinational bounded entities in transferring tacit knowledge and trade secrets abroad. This is a rather striking

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246. *Id.*

247. *Id.*

248. Transfers within multinational bounded entities also prevent leakage of tacit knowledge. *Cf.* Wahab et al., *supra* note 159, at 144–45 (detailing that one of the benefits of FDI is the level of control multinational corporations retain over their technology). While tacit knowledge is to some extent naturally excludable, it is still capable of unauthorized appropriation. *See* Branstetter et al., *supra* note 67, at 324–25. Such appropriation, moreover, is quite costly given the high value of tacit knowledge. Arora, *Licensing*, *supra* note 20, at 42–43; *see* Martin & Salomon, *supra* note 148, at 360.

249. *See* Qin, *supra* note 15, at 743; Sykes, *supra* note 15, at 128; Yu, *supra* note 16, at 1005; OFF. OF THE U.S. TRADE REP., EXEC. OFF. OF THE PRESIDENT, FINDINGS OF THE INVESTIGATION INTO CHINA'S ACTS, POLICIES, AND PRACTICES RELATED TO TECHNOLOGY TRANSFER, INTELLECTUAL PROPERTY, AND INNOVATION UNDER SECTION 301 OF THE TRADE ACT OF 1974, at 4 (Mar. 22, 2018) [hereinafter SECTION 301 FINDINGS], https://ustr.gov/sites/default/files/Section%20301%20FINAL.PDF [https://perma.cc/8UQT-MFSW].

example of the centrality of multinational bounded entities to international technology transfer. Here, bounded entities are transferring tacit knowledge and trade secrets overseas despite innovators' attempts to use intellectual property rights to *limit* such transfer.

The United States has accused China of forcing "the transfer of foreign technologies and IP to Chinese competitors, often in exchange for access to the vast Chinese market."[250] This Subsection focuses on Chinese policies restricting foreign ownership of entities doing business in China. These policies have the practical effect of compelling foreign companies to form joint ventures (JVs) with local Chinese enterprises to access certain markets.[251] Notably, "[o]nce a foreign company forms a joint venture with a Chinese enterprise, it has no choice but to provide the partnering Chinese company with trade secrets and confidential information."[252] Such "mandatory" JVs represent one of the "most important sources" of forced technology transfer.[253]

Foreign-domestic mandatory JVs are multinational bounded entities that facilitate the transfer of tacit knowledge and trade secrets abroad. Tellingly, China has focused such efforts on "strategic emerging industries" that produce cutting-edge technologies.[254] The high-speed rail industry illustrates the

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250. ECONOMIC AGGRESSION, *supra* note 17.

251. Qin, *supra* note 15, at 745; *see* Dan Prud'homme et al., *"Forced Technology Transfer" Policies: Workings in China and Strategic Implications*, 134 TECH. FORECASTING & SOC. CHANGE 150, 157–58 (2018) (describing so-called "lose the market policies" conditioning market access on transferring foreign technology to Chinese partners); *see also* Hoekman et al., *supra* note 18, at 1591 ("For example, the Chinese policy has encouraged joint ventures . . . .").

252. Lee, *Forced*, *supra* note 17, at 332.

253. European Commission Memorandum WK 8329/2018 INIT, WTO-EU's Proposals on WTO Modernisation, at 6 (July 5, 2018), https://borderlex.net/wp-content/uploads/2018/07/2018-07-17-EU-REFORM-PROPOSALS-WTO.pdf [https://perma.cc/2245-9ST9]; *see* Lee, *Forced*, *supra* note 17, at 331 ("[China's] most well-known FTT policy is to use foreign ownership restrictions to facilitate de facto technology transfers from foreign companies to their Chinese partners."); Sykes, *supra* note 15, at 128. As a semantic matter, there is considerable debate over whether foreign ownership restrictions are properly characterized as "forced" technology transfer. Prud'homme et al., *supra* note 251, at 151–52; s*ee* Qin, *supra* note 15, at 746–47. After all, a U.S. firm could simply decline to do business in China and avoid forming a Chinese joint venture altogether. This Article uses this term consistent with prevailing academic and media commentary while acknowledging its contested nature.

254. Prud'homme et al., *supra* note 251, at 150.

success of mandatory JVs in transferring leading innovations to China.[255] In 2004, China's Ministry of Railways tendered bids to produce high-speed train sets.[256] The Ministry required successful bidders to enter into JVs with China South Rail (CSR) and China North Rail (CNR) and to transfer significant technology to them.[257] Three foreign-Chinese joint ventures won parts of the bid.[258] A Japanese consortium led by Kawasaki partnered with Chinese firm Sifang to transfer technology to subsidiaries of CSR.[259] Bombardier's German subsidiary also partnered with Sifang and similarly transferred technology to CSR.[260] Alstom, a French company, partnered with Chinese firm Changchun to transfer technology to CNR.[261] Illustrating the effectiveness of such transfer, within four years of partnering with Kawasaki, "CSR mastered and improved the technology to a level where it could indigenously innovate and no longer needed its cooperation agreement with Kawasaki."[262]

The inner workings of foreign-domestic JVs reveal their high capacity to transfer tacit knowledge and trade secrets.[263] In 2005, Siemens, a German company, won a contract with JV partner Tangshan Railway Company (a subsidiary of CNR) to supply technology for wide-body passenger trains.[264] While the first three trains were constructed at Siemens' German plant, the remaining fifty-seven were built at CNR's Tangshan Locomotive and Rolling Stock Works plant in Hebei.[265] As part of the JV, CNR sent over 1,000 technical staff members for training at Siemens' facilities in Germany.[266] Such in-person interactions are well suited for the intensive transfer of private knowledge.

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255. Qin, *supra* note 15, at 750–51.

256. Prud'homme et al., *supra* note 251, at 158, 165.

257. *Id.* at 165.

258. *Id.* at 158.

259. *Id.*

260. *Id.*

261. *Id.*

262. *Id.* at 162 (citations omitted).

263. While this analysis focuses on the ability of joint ventures to transfer *technical* tacit knowledge and trade secrets, they also facilitate the transfer of tacit knowledge concerning business, management, operations, and regulatory compliance. Sykes, *supra* note 15, at 160.

264. Prud'homme et al., *supra* note 251, at 158–59.

265. *Id.*

266. *Id.*

Mandatory JVs have also facilitated technical knowledge transfer in the alternative-energy automotive industry. In 2009, China promulgated Admittance Management Rules for New Energy Auto Manufacturing Companies and Products.[267] These rules required that foreign firms seeking manufacturing licenses, government procurement deals, and public subsidies "must first 'master' 'core' [New Energy Vehicle] technologies within a JV with a local Chinese partner."[268] Surveys indicate that "some foreign firms have complied with these requirements by assigning some core IP to their foreign-Sino JV and by transferring corresponding know-how to their Chinese JV partner so that they can produce NEV engines and other NEV technologies."[269]

In examining mandatory JVs in China, it is important to put these policies in context.[270] In some cases, foreign companies try to facially comply with mandatory JV rules while not transferring their leading technologies.[271] In the high-speed rail industry, for example, Alstom did not transfer its frontier rail technology to its Chinese partner.[272] Similarly, China has long required foreign-domestic JVs in the (traditional) automobile industry, but foreign companies have complied with these requirements while not transferring their most advanced technologies.[273] Finally, China has signaled a commitment to end some of its "forced technology transfer" policies, though critics are skeptical of reforms.[274]

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267. *Id.*

268. *Id.* at 158.

269. *Id.* at 159 (citation omitted).

270. This context includes the long history of China's forced technology transfer policies. *See* Qin, *supra* note 15, at 749 (noting that China has long pursued "market for technology" policies). *See generally* Lee, *Forced*, *supra* note 17, at 330 (recounting how the United States has accused China of forced technology transfer for several decades).

271. Prud'homme et al., *supra* note 251, at 160 ("Because foreign incumbents dominated mature technologies, they could transfer technology well behind the technological frontier (which they defined) to their Chinese partners in state-required JVs and still meet technology transfer requirements.").

272. *Id.* at 165–66.

273. Qin, *supra* note 15, at 751.

274. Lee, *Forced*, *supra* note 17, at 335–40; Keith Bradsher, *How China Obtains American Trade Secrets*, N.Y. TIMES (Jan. 15, 2020), https://www.nytimes.com/2020/01/15/business/china-technology-transfer.html [https://perma.cc/

Notably, multinational bounded entities such as foreign-domestic JVs transfer technology even when innovators would ordinarily assert intellectual property rights to restrict such transfer. First, such joint ventures transfer patented technologies in a manner exceeding what foreign patentees would normally allow. Until recent reforms, China's joint venture regulations stipulated that after the expiration of a technology transfer agreement, the Chinese partner of a joint venture could continue to use patented technologies subject to the agreement indefinitely.[275] The regulations also stipulated that technology transfer agreements involving JVs were limited to ten years.[276] So, for example, if a U.S. firm transferred a patented technology to a Chinese firm as part of a mandatory JV, it could only control the Chinese partner's use of that technology for up to ten years. Patents typically last twenty years from the date of filing,[277] which means that the Chinese partner could continue using the patent for several years after expiration of the technology transfer agreement without the authorization of the U.S. patentee.

Second, and more obviously, mandatory JVs are organizational vehicles for transferring confidential information that foreign innovators would ordinarily protect as trade secrets.[278] Notably, many U.S. companies, including American Superconductor Corporation, Corning, DuPont, Eli Lilly, and General Motors have sued JV partners as well as others for misappropriation of trade secrets in Chinese courts.[279] To be sure, this dynamic represents a deviation from the knowledge-based theory of bounded entities elaborated above. The theory holds that multinational bounded entities promote the voluntary transfer of trade secrets because they protect against external

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2KW6-C5VP]. For example, China's new Foreign Investment Law prohibits administrative entities from disclosing trade secrets of foreign investors. Qin, *supra* note 15, at 746. Critics argue, however, that these "prohibition[s]" are cosmetic and will simply allow these practices to persist in different form. Sykes, *supra* note 15, at 162.

275. Regulations for the Implementation of the Law on Sino-Foreign Equity Joint Ventures (promulgated by the State Council, Sept. 20, 1983, amended July 22, 2001, effective July 22, 2001), 2001 P.R.C. LAWS arts. 1 and 43(3) (China), http://www.asianlii.org/cn/legis/cen/laws/rftiotlosejv847 [https://perma.cc/D942-L5Y3].

276. *Id.*; SECTION 301 FINDINGS, *supra* note 249, at 50.

277. 35 U.S.C. § 154(a)(2).

278. *See, e.g.*, Bradsher, *supra* note 274.

279. SECTION 301 FINDINGS, *supra* note 249, at 28.

knowledge leakage. However, China's mandatory JV policy is explicitly aimed at *promoting* information leakage to specific entities—Chinese partners in joint ventures. In this context, ironically, the efficiency of bounded entities in facilitating knowledge transfer makes them effective vehicles for a kind of controlled leakage of trade secrets.

In sum, mandatory JVs illustrate the power of multinational bounded entities to transfer technologies abroad. Even when innovators seek to use intellectual property rights to restrict such transfer, organizational meshing effectuates transfer.

V. ANALYZING THE ROLES OF PATENTS AND BOUNDED ENTITIES IN INTERNATIONAL TECHNOLOGY TRANSFER

This Article has examined the conventional view that strong patents promote international technology transfer and the counternarrative that weakening patents promotes greater access to foreign technologies. Taking an orthogonal view, it has argued that neither strengthening nor weakening patents is enough to transfer many technologies abroad. Accordingly, it has elaborated an organizational theory of international technology transfer wherein parties use multinational bounded entities to transfer tacit knowledge and trade secrets overseas. Organizational structures play a crucial role in international technology transfer, even for technologies ostensibly disclosed in patents and even when innovators seek to assert intellectual property rights to limit such transfer.

This Part delves deeper to examine how patents and multinational bounded entities interact as channels to transfer technologies internationally. Specifically, it reveals how the strength of patent protection and the nature of technical knowledge needed to practice an invention significantly affect whether innovators use patents, multinational bounded entities, both, or neither to transfer technologies abroad. In general, where inventions are fully disclosable and patents are strong, patents are effective conduits for transferring inventions, and multinational bounded entities are not necessary to achieve this objective. However, where an invention requires significant private knowledge (such as tacit knowledge or trade secrets) to practice and/or patent strength is weak, bounded entities increase in importance as transfer channels. Patents and bounded entities, however, are not mutually exclusive, and these channels can

overlap in interesting ways. The upshot is that in some contexts, patents and multinational bounded entities are substitutes, while in others, they are complements.

Figure 1. Factors Influencing Preferred International Technology Transfer Channels

	Nature of Technical Knowledge to be Transferred	
Strength of Patent Protection in Receiving Country	**Publicly Disclosable**	**Private (Tacit Knowledge and/or Trade Secrets)**
Strong Patent Protection	(1) Patent-based	(2) Patent-based and bounded entity
Weak Patent Protection	(3) Limited transfer, bounded entity, or involuntary transfer	(4) Bounded entity

First, consider a scenario in which patent protection in a receiving country is strong and the knowledge necessary to practice a patented invention is readily disclosable (Figure 1, Box 1). In other words, public sources (including patents themselves) can fully disclose the invention, which has a low tacit dimension, and significant trade secrets are not necessary to practice it. In these circumstances, arm's-length patent licensing through market exchanges becomes more feasible, and patents alone are often adequate to transfer a technology. While in theory an innovator could establish a multinational bounded entity to transfer the invention, an organizational approach may not be cost-justified given the availability of relatively inexpensive and effective patent licensing.[280] In this context, patents can substitute for multinational bounded entities to transfer technologies. Under

280. *See* Hoekman et al., *supra* note 18, at 1592 (reporting that in countries with strong imitative capabilities, strengthening intellectual property rights tends to shift international technology transfer away from exports and FDI and toward licensing). *See generally* Kumar, *supra* note 58, at 212 (discussing the strength of patent laws and its effect on IP and licensing).

these conditions, for instance, older technologies or those that are relatively simple are well suited for patent-based transfer.[281]

Second, consider a scenario in which patent protection is strong but significant private knowledge—such as tacit knowledge and/or trade secrets—is necessary to practice an invention (Figure 1, Box 2). In these circumstances, patents often function as complements to multinational bounded entities. Strong patent protection in the receiving country reduces the risk of unauthorized copying and will likely induce patent licensing by innovators.[282] However, patent licensing alone will not be enough to transfer the technology.[283] If the knowledge necessary to practice the invention is tacit, organizational linkages between innovators and technology adopters may be necessary to transfer such knowledge. Innovators may create a wholly owned subsidiary or license a patent to a foreign entity while also forming a joint venture to transfer tacit knowledge.[284] Relatedly, economists have shown how patentees can bundle together licenses for patents and patent-related tacit knowledge.[285] In these deals, patent licenses constitute the scaffolding that supports thick relationships between licensors and licensees to exchange knowledge. Rather than one-off market exchanges, these thick relationships often entail long-term consulting engagements, personnel exchanges, and on-site training sessions.[286] Such long-term, information-intensive exchanges represent another kind of multinational bounded entity.

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281. *See* Wahab et al., *supra* note 159, at 145 ("[L]icensing is more appropriate for less complex technologies and technologies that can be easily diffused and learned by the affiliates or local subsidiaries."). Indeed, innovators are likely to patent particular inventions precisely because they are not amenable to trade secret protection. Arti Kaur Rai, *Regulating Scientific Research: Intellectual Property Rights and the Norms of Science*, 94 NW. U. L. REV. 77, 118 (1999).

282. *See* Hoekman et al., *supra* note 18, at 1592.

283. *See* Arora, *Licensing*, *supra* note 20, at 42 (describing how "[t]he transfer of know-how is especially important when the firm that is licensing in the technology does not have a great deal of experience with that particular class of technologies").

284. *See* Wahab et al., *supra* note 159, at 145.

285. Arora, *Licensing*, *supra* note 20, at 42–43.

286. *Cf.* DANIEL C.K. CHOW & EDWARD LEE, INTERNATIONAL INTELLECTUAL PROPERTY 418 (2d ed. 2012) ("In many cases, the most important part of the [patent] licensing arrangement is not the authorization itself but the continuing working relationship between the patent owner and the licensee.").

If the knowledge necessary to practice the invention is a (non-tacit) trade secret, a similar set of organizational options exists, though for different reasons. Again, the availability of strong patent protection will likely induce cross-border patent licensing.[287] However, to transfer patent-related trade secrets, an innovator may create a wholly owned subsidiary or joint venture with a foreign technology adopter.[288] While the innovator could simply license trade secrets to a foreign party, a one-off exchange in a spot market increases risks of misappropriation, even if legal protection of trade secrets is fairly strong.[289] To mitigate such risks, the innovator may embed the licensing of trade secrets in a thicker set of long-term contractual obligations. Such a thick, durable relationship would allow the innovator to monitor the foreign entity's handling of sensitive information.[290] Furthermore, it would also help align the financial interests of the adopter to maintain secrecy; the adopter may have more to gain from maintaining the secrets of its long-term partner than defecting by misusing or revealing such information. Such thick relationships between formally distinct entities represent another kind of multinational bounded entity.

An example where patents and multinational bounded entities function as complements is Moderna's strategic partnership with Lonza to produce COVID-19 vaccines. Moderna has licensed its patents to Lonza, and it has also formed a thick, long-

287. *See* Hoekman et al., *supra* note 18, at 1592.

288. *See* Wahab et al., *supra* note 159, at 144. Transfer within an organizational channel helps curb the leakage of not only codified trade secrets but also tacit knowledge. *See* Baranson, *supra* note 154, at 437 (observing that firms prefer direct investment when they fear that licensing will lead to the loss of valuable know-how).

289. *Cf.* Prud'homme et al., *supra* note 251, at 153–54 (noting less control over information directly increases the risk of unintentional knowledge/technology transfer). As this discussion suggests, the use of bounded entities to transfer trade secrets is also contingent on the strength of trade secret protection in a receiving jurisdiction. To a certain extent, strong trade secret protection can substitute for transferring confidential information in-house. However, internal transfer is likely to offer stronger protection than relying on trade secrecy. *See* Baranson, *supra* note 154, at 437.

290. *Cf.* Prud'homme et al., *supra* note 251, at 154 ("At the same time, the less control that foreign firms maintain over their technology transfers, the more unintentional technology/knowledge transfer in the form of spillovers is possible.").

term contractual relationship that facilitates the sharing of both tacit knowledge and trade secrets with its foreign partner.[291]

Third, consider a scenario in which patent protection in a receiving country is weak, and the information necessary to practice a technology is largely available from public sources (Figure 1, Box 3). This situation presents the greatest risk of unauthorized appropriation. Weak patent protection and the inability of an innovator to extract value from tacit knowledge or trade secrets may discourage it from transferring the technology at all.[292] As an alternative to forgoing the market entirely, an innovator may establish a multinational bounded entity to realize some gains from technology transfer. For example, a multinational corporation may create a subsidiary to commercialize a technology in a foreign country. However, rather than relying on patent exclusivity or private technical knowledge to appropriate returns, firms may exploit other institutional advantages, such as process efficiency (which may ultimately produce value-generating private knowledge), faster lead times, branding, or complementarities with organizational resources that are not easily imitated, such as superior customer service and support.[293]

While the foregoing discussion has focused on voluntary transfer by an innovator, it bears noting that weak patent protection and fully disclosed inventions create conditions ripe for involuntary technology transfer. Such a scenario is reflected in South Africa's use of compulsory licenses to manufacture generic versions of patented HIV/AIDS drugs in the 1990s.[294] Although South Africa had adopted the TRIPS Agreement, it authorized generic manufacturing and parallel imports, thus creating a weak patent regime.[295] Furthermore, due to the public

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291. *See* Moderna-Lonza, *Global Long Term Agreement*, SEC. & EXCH. COMM'N (Sept. 4, 2020), https://www.sec.gov/Archives/edgar/data/1682852/000168285220000023/lonzamodernagltafullye.htm [https://perma.cc/VMY9-T3AA]. *See also supra* notes 237–39 and accompanying text.

292. *See, e.g.*, Prud'homme et al., *supra* note 251, at 158 ("China's weak IP regime has discouraged transfer of frontier foreign technology to domestic firms." (citations omitted)).

293. *Cf.* Minyuan Zhao, *Conducting R&D in Countries with Weak Intellectual Property Rights Protection*, 52 MGMT. SCI. 1185, 1197 (2006) ("MNEs are substituting internal organization for external IPR protection in countries with poor institutional environments.").

294. *See supra* notes 90–93 and accompanying text.

295. Medicines and Related Substances Control Amendment Act 90 of 1997 § 22F(1)(a) (S. Afr.).

disclosure, age, and relative simplicity of HIV/AIDS drugs, which are small-molecule drugs, generic firms could easily manufacture them without tacit knowledge and trade secrets from patentees.[296] Because HIV/AIDS drugs were easily appropriable due to the lack of both legal and knowledge constraints, South Africa's actions established a credible threat of simply "transferring" this technology involuntarily. In this sense, they offer a telling contrast to COVID-19 mRNA vaccines, which are large-molecule constructs for which tacit knowledge and trade secrets are critical for industrial manufacturing.[297]

Fourth, consider a scenario in which patent protection is weak and transferring a technology would require significant tacit knowledge and/or trade secrets (Figure 1, Box 4). Under these conditions, multinational bounded entities may substitute for patents as channels for international technology transfer.[298] Due to the weak IP regime, patent licensing is unattractive to innovators. If the knowledge necessary to practice this invention is tacit, such tacitness provides some excludability, but it also hampers the ability of parties to transfer this technology in one-off market transactions. Under these conditions, multinational bounded entities can facilitate the shared organizational context and repeat interactions necessary to transfer tacit knowledge. If the knowledge necessary to practice this invention is a trade secret, licensing this trade secret in a one-off market exchange creates risks of misappropriation. However, the "bounded" nature of multinational bounded entities can help safeguard the transfer of trade secrets abroad.[299]

While this analysis has focused on voluntary transfer, one variant of the "weak IP and significant private knowledge"

296. *See generally* Jeffrey L. Fox, *Antivirals Become a Broader Enterprise*, 25 NATURE BIOTECH. 1395, 1395–96 (2007) (discussing the historical predominance of small-molecule drugs as antiviral therapeutics for HIV/AIDS).

297. Gurgula & Hull, *supra* note 164, at 1246.

298. Prud'homme et al., *supra* note 251, at 153–54 ("For this reason, foreign firms prefer greenfield FDI in economies with weaker appropriability regimes." (citation omitted)); Hoekman et al., *supra* note 18, at 1589 (noting that with significant risk of unauthorized appropriation, "foreign firms may prefer FDI, may not engage in licensing at all, or may transfer lagging technologies").

299. *Cf*. Bharat N. Anand & Tarun Khanna, *The Structure of Licensing Contracts*, 48 J. INDUS. ECON. 103, 128 (2000) ("[J]oint ventures should be more likely to occur in industries with weak IPRs to the extent that it is easier to monitor and control the activities of partners in such arrangements than via arms-length licensing contracts.").

scenario involves so-called forced technology transfer. This includes, for example, China's policy of mandatory JVs between foreign and domestic firms.[300] In such cases, bounded entities provide the necessary conduit for transferring tacit knowledge and trade secrets, but weak intellectual property protection precludes such bounded entities from fully guarding against knowledge leakage.

Of course, these are not the only factors that affect whether and how firms transfer technologies internationally. For instance, an important driver of international technology transfer is market size.[301] Where a market is highly lucrative, international firms have been willing to transfer technologies even if patent protection is weak and appropriation risk is high.[302] Such conditions apply to China; U.S. firms decry its weak IP landscape and forced technology transfer policies, but they nonetheless participate in the Chinese market because of its enormous size.[303] Additionally, firms also consider political risk and the availability of low-cost, high-skilled labor in determining whether and how to transfer technologies abroad.[304] Relatedly, another important consideration (addressed further below) is the absorptive capacity of receiving nations to assimilate foreign technologies.[305] That being said, all things being equal, patent strength and the private or public nature of technical knowledge necessary to practice an invention play important roles in determining how firms transfer technologies abroad.

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300. *See supra* Part IV.B.2.

301. Hoekman et al., *supra* note 18, at 1589; Watal & Caminero, *supra* note 57, at 5.

302. Conversely, even if a jurisdiction has strong patent protection, firms may not transfer technologies there if the market is too small. *Cf.* Hoekman et al., *supra* note 18, at 1589 (arguing that market size is an important factor for licensing and FDI).

303. *See* Watal & Caminero, *supra* note 57, at 5; Prud'homme et al., *supra* note 251, at 153 (documenting China's attractiveness as a market due to its size).

304. Hall, *supra* note 58, at 11.

305. *See infra* notes 402–04 and accompanying text.

VI. NORMATIVE ASSESSMENTS AND PRESCRIPTIONS FOR IMPROVING INTERNATIONAL TECHNOLOGY TRANSFER

This Article has augmented the dominant, patent-centric model of international technology transfer by exploring the underappreciated role of multinational bounded entities in transferring technical knowledge abroad. It has articulated a novel knowledge-based theory of multinational bounded entities, and it has examined how the strength of patent protection and the nature of technical knowledge to be transferred shape preferred transfer modalities. Drawing on these insights, this Part provides a normative assessment of multinational bounded entities and proposes prescriptions to improve international technology transfer.

A. ASSESSING THE ROLE OF MULTINATIONAL BOUNDED ENTITIES IN INTERNATIONAL TECHNOLOGY TRANSFER

1. Evaluating Multinational Bounded Entities Generally

Perhaps the most normatively salient attribute of multinational bounded entities is that they reveal the limitations of arm's-length technology transfer between separate entities. In the context of patented inventions, the prevalence of bounded entities reflects the deficiencies of patents, on their own, to transfer technical knowledge between separate parties. As we have seen, patents do not convey tacit knowledge and trade secrets that are critical to practicing many patented technologies.[306] This deficiency raises the cost of voluntary technology transfer, leading parties to employ organizational connections to substitute for or supplement patent licenses. Additionally, this deficiency renders much involuntary technology transfer ineffective, as compulsory licenses do not transfer needed tacit knowledge and trade secrets.

Within this context, multinational bounded entities represent a valuable, if costly, alternative or complement to patent-based technology transfer. Organizational meshing between technology generators and adopters accelerates the transfer of tacit knowledge and trade secrets that patents leave undisclosed. However, these gains must be weighed against efficiency

306. See *supra* Parts II.B and III.A.

losses from decreased specialization and the costs of managing large organizational complexes.[307] Returning to the classic theory of the firm, low transaction costs enable firms to disaggregate production among various actors via market-based transfers.[308] This enables firms to specialize in particular functions, such as invention or manufacturing, in creating technological products.[309] However, multinational entities, particularly those which are highly integrated, lose some of these benefits of specialization.[310] Furthermore, while bounded entities economize on external transfer costs, they incur higher internal management costs.[311] After all, administering large bureaucracies, coordinating joint ventures, and monitoring thick contractual relationships are all costly endeavors.[312] While multinational bounded entities are sometimes the only or most expedient way to transfer tacit knowledge and trade secrets, they entail tangible costs.

From a social perspective, moreover, the "closed" nature of multinational bounded entities may limit beneficial information spillovers. One of the primary social benefits of patents is that they publicly disclose new inventions. For innovators, however, one of the main advantages of a multinational bounded entity is that it (usually) prevents leakage of information to outside parties. Such spillovers would be highly useful to competitors and society at large.[313] Indeed, one could question if tacit knowledge and trade secrets transferred within a multinational bounded entity are meaningfully "transferred" to a foreign country if they remain locked within a transnational organizational silo.[314]

This critique of multinational bounded entities, however, is subject to two qualifications. First, due to appropriation risk,

307. *See* Pisano et al., *supra* note 173, at 202.

308. *See supra* Part II.A.

309. *See supra* Part II.A.

310. *Cf.* Pisano et al., *supra* note 173, at 202.

311. *Cf.* Coase, *supra* note 99, at 394–95 (discussing "diminishing returns to management" in large firms).

312. *Id.*

313. Brett M. Frischmann & Mark A. Lemley, *Spillovers*, 107 COLUM. L. REV. 257, 268 (2007) ("[A] wealth of economic evidence teaches us that spillovers are good for society.").

314. Vredenburg & Garcia, *supra* note 2, at 144; *see* UNCTAD, *supra* note 2, ¶ 26 ("R&D centres with a global role and located in developing countries do not necessarily establish significant knowledge links with local firms and may become 'islands of excellence' that do not contribute to the host country innovation system.").

private entities may refuse to transfer technical knowledge at all to particular countries if not for multinational bounded entities. From this perspective, some transfer (even within an organizational silo) is preferable to none.

Second, in the long run, tacit knowledge and trade secrets transferred through a multinational bounded entity are likely to eventually diffuse to external parties in a receiving country.[315] For example, FDI, which is one form of multinational bounded entity, generates knowledge spillovers for receiving countries through "demonstration effects" and forcing local subcontractors to keep up with the latest foreign technologies.[316] In some ways, information really does want to be free. Multinational bounded entities train local employees, thus increasing their technical acumen.[317] Employees of wholly owned subsidiaries move to local competitors and bring private knowledge with them.[318] Foreign subsidiaries share knowledge with local vendors and distributors.[319] Furthermore, foreign competitors eventually reverse engineer trade secrets.[320] In the long run, the presence of multinational bounded entities promises to enrich the technical capacity of receiving countries.[321]

In some cases, however, long-term diffusion of tacit knowledge and trade secrets takes longer than countries can

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315. *See* Padilla-Pérez, *supra* note 218, at 851–52 (presenting a multilevel framework for technology transfer from multinational corporations to foreign subsidiaries; local personnel within subsidiaries; locally owned firms, local organizations, spin-offs, and local managers; and indirect spin-offs).

316. Wahab et al., *supra* note 159, at 144–45; *see* Hoekman et al., *supra* note 18, at 1588–89 (summarizing case and econometric studies on spillover effects of FDI); Blomström & Kokko, *supra* note 68, at 248 (listing types of spillovers FDI might cause in receiving countries); UNCTAD, *supra* note 2, at 12–13, 15–18 (illustrating examples of FDI-generated spillovers).

317. Blomström & Kokko, *supra* note 68, at 259–60.

318. *See* Hoekman et al., *supra* note 18, at 1589–90 (discussing conditions that allow spillovers from local labor turnover); Sykes, *supra* note 15, at 145–46 (describing how innovation "'spills over' from firm to firm" when local workers change jobs).

319. Hoekman et al., *supra* note 18, at 1588–89.

320. Wahab et al., *supra* note 159, at 146–47.

321. *See* Blomström & Kokko, *supra* note 68, at 260 (describing spillovers of technical skills). Somewhat relatedly, entry by a multinational enterprise creates an independent benefit by increasing competition, which ultimately forces local firms to improve their performance to protect market shares and profits. *Id.* at 251. Additionally, local firms may enjoy spillovers from greater global market access due to increased FDI in a host country. *Id.* at 253–54.

afford to wait. Take, for example, the technical knowledge necessary to manufacture patented COVID-19 vaccines. The recent announcement that South African researchers reverse engineered Moderna's patented mRNA vaccine suggests that, as mentioned, private technical information eventually becomes public.[322] Nonetheless, these efforts would have occurred much earlier if researchers had direct access to Moderna's or Pfizer's tacit knowledge and trade secrets.[323] As discussed further below, governments can use other policy mechanisms, such as reforming patent law, leveraging public R&D funds or even compulsorily licensing trade secrets, to unlock such private technical knowledge.[324]

Another macroscopic critique of multinational bounded entities is that the benefits of these entities tend to be concentrated in a limited number of countries and technological fields. Transnational corporations are the primary drivers of multinational bounded entities.[325] As indicated above, market size is a significant factor in determining where such corporations transfer

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322. Amy Maxmen, *South African Scientists Copy Moderna COVID Vaccine*, 602 NATURE 372, 372 (2022); *see Toward Africa's First mRNA Vaccine Technology Transfer Hub*, WORLD HEALTH ORG. AFR. (Sept. 17, 2021), https://www.afro.who.int/news/towards-africas-first-mrna-vaccine-technology-transfer-hub [https://perma.cc/E8Y7-HBY7]. While the researchers created their mRNA COVID-19 vaccine based on Moderna's publicly disclosed sequence, neither Moderna nor Pfizer collaborated with the research effort. Levine & Sarnoff, *supra* note 130, at 1011–12.

323. Levine & Sarnoff, *supra* note 130, at 1011–13. Some might argue that "diffusion" of this private knowledge is unnecessary. Rather, governments should simply infuse Moderna and Pfizer with resources so that they can ramp up vaccine production (through their multinational bounded entities). *See, e.g.*, Luciana Borio & Scott Gottlieb, Opinion, *Patent Busting Won't Help Vaccinate the World Faster*, WALL ST. J.: OPINION (May 9, 2021), https://www.wsj.com/articles/patent-busting-wont-help-vaccinate-the-world-faster-11620591133?reflink=desktopwebshare_twitter [https://perma.cc/HX9Y-RHMX] (arguing that the U.S. and WTO should promote expanded manufacturing and exporting of vaccines instead of waiving patent protections). However, widespread diffusion of tacit knowledge and trade secrets to allow parallel manufacturing of vaccines promises the greatest increase in production, encourages responsiveness to local needs, and creates the most fertile base for ongoing research and development for the next pandemic.

324. *See infra* Part VI.B.

325. *See* UNCTAD, *supra* note 2, ¶¶ 8–9 (outlining transnational corporations' outsized role in research and development and global innovation generally).

technologies.[326] Evidence suggests that among developing countries, multinational corporations focus transfer efforts on a handful of large countries, such as China, India, and Brazil.[327] Furthermore, the world's largest R&D spenders are concentrated in a few industries, notably IT hardware, automobiles, pharmaceuticals, and biotechnology.[328] From a social perspective, the benefits of multinational bounded entities are limited by geography and industry relative to, say, widely available patent disclosures or broad-based investment in a developing country's innovation system across multiple sectors.

More broadly, while this Article has focused on multinational bounded entities' role in transferring technical knowledge abroad, these benefits must be weighed against their other social impacts, particularly in developing countries. Multinational enterprises have a complex and often fraught relationship with development.[329] While they drive significant wealth generation and knowledge transfer, they also contribute to economic exploitation, social inequality, and environmental degradation.[330] This Article focuses on just one dimension of multinational bounded entities' multifaceted impact on global welfare.

2. Evaluating Mandatory Joint Ventures and "Forced Technology Transfer"

At this point, it is useful to assess the role of multinational bounded entities in "forced technology transfer." As noted, China's policy of compelling joint ventures between foreign and domestic firms transfers significant tacit knowledge and trade secrets to China.[331] This Article does not evaluate the legality of this policy, though at least one comprehensive analysis

326. *See supra* notes 301–03 and accompanying text.

327. UNCTAD, *supra* note 2, ¶ 17.

328. *Id.* annex.

329. *See, e.g.*, Gerald Epstein, *The Role and Control of Multinational Corporations in the World Economy*, *in* THE HANDBOOK OF GLOBALISATION 165, 165 (Jonathan Michie ed., 3d ed. 2019) ("[C]ritics contend that . . . [multinational corporations] in particular are creating a 'race to the bottom' around the globe, enhancing profits and political power for [multinational corporations] and local elites who benefit from their presence, while eroding wages, tax bases, social protections and the environment.").

330. *Id.*

331. *See infra* Part IV.B.2.

concludes that it does not clearly violate China's legal obligations.[332] Rather, it focuses on overarching normative assessments of this kind of so-called forced technology transfer. Not surprisingly, the desirability or undesirability of this practice rests largely on the normative framework that one adopts.

From the perspective of maintaining U.S. economic competitiveness relative to China, such forced technology transfer appears highly detrimental.[333] Certainly, the U.S. government and the U.S. Chamber of Commerce have loudly criticized mandatory JVs that "force" U.S. firms to transfer sensitive technical knowledge to Chinese firms.[334] Nationalist concerns are particularly acute to the extent that mandatory joint ventures transfer technical information with military or national security implications overseas.[335]

This Article, however, adopts a more conventional, and less nationalistic, normative framework that focuses on aggregate welfare. Though U.S. firms complain about losing tacit knowledge and trade secrets, they continue to participate in joint ventures with Chinese partners, which suggests that doing so enhances their individual welfare.[336] At a more macroscopic level, however, a U.S. firm's participation in a Chinese joint venture may create negative externalities for other U.S. companies (and even, in some circumstances, its own long-term

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332. Sykes, *supra* note 15, at 134–39 (finding no clear violations of general WTO obligations, China's WTO Protocol of Accession, or China's Phase One Trade Agreement with the United States). One possible exception is that insistence on technology transfer by a Chinese state-owned enterprise may violate China's WTO accession protocol. *Id.* at 136.

333. *See id.* at 127–28 ("U.S. concerns about Chinese policy span a range of issues, but the problem of 'forced technology transfer' is said to lie 'at the heart' of the issue." (citations omitted)).

334. ECONOMIC AGGRESSION, *supra* note 17, at 6; Press Release, U.S. Chamber of Com., U.S. Chamber Statement Regarding Executive Memorandum on China Technology Transfer Policies and IP Theft (Aug. 14, 2017), https://www.uschamber.com/international/us-chamber-statement-regarding-executive-memorandum-china-technology-transfer-policies [https://perma.cc/6RSR-EB2D].

335. *See* Sykes, *supra* note 15, at 130–31 (noting national security concerns arising from technology transfers involving military applications).

336. *Id.* at 130; *see* Hoekman et al., *supra* note 18, at 1591 (noting that overly strict investment restrictions may prevent foreign investment).

interests).[337] On the other side of the ledger, individual Chinese firms gain considerably from appropriating foreign technologies through joint ventures.[338] More broadly, China benefits as well—as long as such "restrictions" do not reduce foreign investment to an extent that outweighs their benefits.[339] As legal scholar Alan O. Sykes suggests, the global welfare effects are indeterminate.[340] It is likely that "forced" technology transfer simply transfers surplus between firms and countries without diminishing overall welfare, and it may even increase overall welfare.[341] As explored further below, there is little evidence that forced technology transfer policies have decreased overall innovation, and economic theory suggests that they may increase it.[342]

Indeed, information efficiency considerations suggest that, within certain limits, forced technology transfer confers a net social benefit. Like all technical knowledge, tacit knowledge and trade secrets are nonrival, meaning that their exploitation by one party does not limit their availability for others.[343] Thus, for instance, millions of entities (in the U.S., China, and other countries) could exploit the technical information inhering in an invention without "consuming" that information out of existence.[344] Classic information economics suggests that allowing free access to existing knowledge maximizes "static" efficiency; since information cannot be overconsumed, it should be freely

337. Sykes, *supra* note 15, at 142–48. Even if China abandoned this policy, China could (legally) restrict and harm foreign investors in other ways, such as by imposing taxes or fees for licenses to invest. *Id.* at 141–42, 148.

338. *See supra* notes 252–69 and accompanying text.

339. *See* Sykes, *supra* note 15, at 130; *see also* Hoekman et al., *supra* note 18, at 1591 (suggesting that China's policy of promoting joint ventures rather than inward FDI may lead to foreign firms transferring less advanced technology to China).

340. Sykes, *supra* note 15, at 131, 154–55.

341. *Id.*

342. *See infra* notes 343–45, 349–50 and accompanying text.

343. *See* Letter from Thomas Jefferson to Isaac McPherson (Aug. 13, 1813), https://founders.archives.gov/documents/Jefferson/03-06-02-0322 [https://perma.cc/R8B4-8X5C] ("[H]e who recieves an idea from me, recieves instruction himself, without lessening mine; as he who lights his taper at mine, recieves light without darkening me." (spelling original)).

344. Certainly, (rivalrous) materials, capital, and labor used to invent and manufacture technological products experience scarcity, but (nonrivalrous) technical designs do not.

available to all to use.[345] This in turn suggests a benefit to forced technology transfer, as it widens access to nonrival, inexhaustible technical knowledge.

Such free appropriation, however, leads to a provisioning problem: if technical knowledge were freely available to all, there would be little incentive for anyone to invest in developing it.[346] Patents (and other mechanisms) are commonly justified as solving this provisioning program.[347] By conferring exclusive rights, patents promote "dynamic" efficiency by shoring up incentives to invent new technologies on an ongoing basis.[348] They do so, however, at the cost of sacrificing some static efficiency by limiting access to nonrival assets.

Applying these principles to forced technology transfer, mandatory JVs that transmit tacit knowledge and trade secrets to China allow more entities to exploit (nonrival) technical knowledge. This greater access increases static efficiency. Greater access to technical knowledge may also have dynamic benefits by lowering the cost of downstream innovation and

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345. *See* Arrow, *supra* note 103, at 616–17 (noting information should ideally "be available free of charge"). Static efficiency relates to the most efficient allocation of resources at a given point in time. Because information is nonrival, maximizing static efficiency would entail allowing open access to information for anyone who wishes to use it. *See id.*

346. *See id.* at 619 ("[W]e expect a free enterprise economy to underinvest in invention and research . . . .").

347. *See* Peter Lee, *Patent Law's Externality Asymmetry*, 43 CARDOZO L. REV. 1923, 1927 (2022) (describing how patents prevent free riders and allow inventors to internalize positive externalities from inventions) [hereinafter Lee, *Asymmetry*]; *see also* Daniel J. Hemel & Lisa Larrimore Ouellette, *Innovation Policy Pluralism*, 128 YALE L.J. 544, 551–58 (2019) (discussing other ways to incentivize innovation).

348. Lee, *Asymmetry*, *supra* note 347, at 153 n.227. Commentators, however, have pointed out that patents can also inhibit dynamic efficiency by raising the cost of subsequent innovation, particularly when patented inputs are necessary to generate some technological output. *See, e.g.*, Michael A. Heller & Rebecca S. Eisenberg, *Can Patents Deter Innovation? The Anticommons in Biomedical Research*, 280 SCI. 698, 699 (1998) ("Each upstream patent allows its owner to set up another tollbooth on the road to product development, adding to the cost and slowing the pace of downstream biomedical innovation."); Carl Shapiro, *Navigating the Patent Thicket: Cross Licenses, Patent Pools, and Standard Setting*, *in* 1 INNOVATION POL'Y & ECON. 119, 120–21 (Adam B. Jaffe et al. eds., 2001) (describing a "patent thicket" companies must "hack [their] way through" to generate new technology).

increasing the number of actors engaged in parallel innovation.[349] The key empirical question is whether the static and dynamic benefits of greater access to foreign tacit knowledge and trade secrets are outweighed by the dynamic harms to incentives to invent. While the U.S. government and many firms complain about mandatory JVs and related policies, there is little evidence that such practices have appreciably harmed incentives to invent—particularly to a degree that such harms outweigh the welfare and innovation benefits of wide access to technical knowledge.[350]

Moving beyond conventional welfare and efficiency analysis, forced technology transfer also offers distributive benefits. Returning to traditional North-South debates, developing countries have long utilized foreign ownership restrictions or mandatory joint venture requirements for foreign investment.[351] In so doing, they extract not just knowledge but also rents from wealthier countries. Such wealth transfers from developed to developing countries have distributive benefits independent of welfare and efficiency considerations.[352] Furthermore, in some cases, such wealth transfers help reverse egregious distributive harms from colonial and other exploitative practices by developed countries.[353] Thus, even if mandatory joint ventures and other forced technology transfer policies are a net zero (or even slightly negative) from a welfare or efficiency standpoint, they may be

349. *Cf.* Robert P. Merges & Richard R. Nelson, *On the Complex Economics of Patent Scope*, 90 COLUM. L. REV. 839, 843–44 (1990) (arguing that technological development will generally be more robust in the presence of parallel innovation and competition rather than control by a single firm).

350. *See* Sykes, *supra* note 15, at 130 (noting the technology transactions between the U.S. and China are "win-win").

351. Teece, *Know-How*, *supra* note 151, at 88; *see also* Qin, *supra* note 15, at 752–53 (discussing performance requirements host countries impose); Lee, *Forced*, *supra* note 17, at 341–42 (noting that developing countries have used "trade-technology-for-market" policies since the 1970s). As commonly understood, "North-South debates" refer to conflicts between developed and developing countries, including developing countries that are located wholly or largely in the northern hemisphere.

352. *See* William W. Fisher & Talha Syed, *Global Justice in Healthcare: Developing Drugs for the Developing World*, 40 UC DAVIS L. REV. 581, 624–47 (2007) (summarizing distributive justifications for significant expenditures by developed countries to treat diseases afflicting people in developing countries).

353. *Id.* at 591–601.

macroscopically justified based on their contributions to distributive equity.[354]

Ultimately, this Article finds no reason to categorically condemn so-called forced technology transfer. It is certainly understandable why countries would want to "compel" joint ventures (within certain limits) to increase inward technology transfer. Indeed, there are close conceptual parallels between linking market access to "mandatory" joint ventures and linking market access to stronger IP protection, which developed countries demanded as part of developing countries' adoption of the TRIPS Agreement.[355] Within certain limitations, forced technology transfer can advance overall efficiency as well as distributive interests.

B. PRESCRIPTIONS FOR IMPROVING INTERNATIONAL TECHNOLOGY TRANSFER

This Article's examination of the role of bounded entities in international technology transfer suggests several policy reforms for improving such transfer. Enhancing technology transfer implicates dozens of policy levers, ranging from increasing immigration to reforming antitrust laws, a full exposition of which far exceeds the scope of this Article.[356] Accordingly, this Section will focus on prescriptions most closely tied to this Article's analysis of patents and multinational bounded entities. First, it proposes heightening the disclosure requirements of patentability. Greater disclosure of tacit knowledge and trade secrets would increase the effectiveness of both voluntary and involuntary patent-based transfer. However, multinational bounded entities will remain essential or preferable for some kinds of technology transfer. Therefore, second, this Section proposes mechanisms to shore up the effectiveness of multinational bounded entities, especially as conduits for sharing tacit knowledge and trade secrets abroad. In particular, it highlights

354. This distributive analysis focuses on international wealth differences, and it may be complicated by intranational wealth differences. For instance, it may be the case that China's mandatory joint venture policies primarily benefit monied, coastal Chinese elites rather than lower-income populations in the heartland, thus mitigating any distributive benefits of such transfers. *Id.* at 596.

355. *See supra* notes 52–54 and accompanying text.

356. *See generally* Hoekman et al., *supra* note 18 (discussing a range of policy options to improve the rate and scope of international technology transfer).

the need to invest in the capacity of receiving countries to absorb foreign technology and technical knowledge.

1. Enhancing Patent Disclosure and Bolstering Voluntary and Involuntary Patent-Based Transfers

One of the implications of this study is that the patent system, on its own, is ill-suited to transfer the newest and most sophisticated technologies—those that arguably have the greatest long-term value.[357] To help remedy this state of affairs, this Subsection first suggests raising the disclosure requirements of patentability. Increased disclosure would enhance the effectiveness of both voluntary and involuntary patent-based technology transfer.

The patent system is often characterized as a quid pro quo in which inventors disclose novel technologies in exchange for exclusive rights.[358] Indeed, one of the key functions of patent law is to incentivize the codification of private knowledge, including tacit knowledge and trade secrets.[359] Under U.S. patent law, this function is largely performed by the enablement requirement, which mandates that a patent must teach a technical artisan in a field how to make and use an invention without undue experimentation.[360] As patents on COVID-19 vaccines illustrate, however, an inventor can patent a technology while not disclosing valuable tacit knowledge and trade secrets.[361] Such nondisclosure undermines the adequacy of patents (along with general information sources) to convey the technical knowledge necessary to practice patented inventions. This ability of patentees to

357. *Cf.* Wahab et al., *supra* note 159, at 143 (summarizing studies indicating that FDI is the appropriate transfer mode when technologies are "new, young and complex"); Udo Zander & Bruce Kogut, *Knowledge and the Speed of the Transfer and Imitation of Organizational Capabilities: An Empirical Test*, 6 ORG. SCI. (FOCUSED ISSUE: EURO. PERSP. ON ORG. THEORY) 76, 78 (1995) (suggesting that licensing is the more appropriate transfer mode for less complex technologies).

358. *See, e.g.*, Universal Oil Prods. Co. v. Globe Oil & Refining Co., 322 U.S. 471, 484 (1944) ("[T]he *quid pro quo* is disclosure of a process or device in sufficient detail to enable one skilled in the art to practice the invention once the period of the monopoly has expired . . . .").

359. *See* Burk, *supra* note 108, at 1012.

360. 35 U.S.C. § 112.

361. *See supra* notes 230–33 and accompanying text.

retain crucial private knowledge while enjoying exclusive rights offends the quid pro quo at the heart of the patent system.[362]

To increase patent disclosure, this Article proposes rehabilitating the "best mode" requirement of U.S. patent law. This requirement mandates that a patent applicant must disclose any "specific instrumentalities or techniques" known to the applicant as the best way of practicing an invention.[363] As such, it extends beyond the enablement standard, which only requires that a patentee disclose enough information to practice a basic version of an invention.[364] For example, if an inventor seeking to patent a COVID-19 vaccine had specialized knowledge on the date of filing of the best way to manufacture that vaccine, the best mode requirement would compel disclosure of this knowledge in the patent application.

Ironically, the best mode requirement is currently a requirement of patentability in the United States, but it is rarely enforced.[365] Concerns that the best mode requirement increased the cost and complexity of patent litigation motivated legislative reforms in 2011 that render it largely toothless.[366] This Article suggests rehabilitating the best mode requirement in U.S. patent law as a fully enforceable requirement of patentability. Ideally, the TRIPS Agreement would also require patentees to disclose the best mode for practicing their inventions.[367] However, such a reform would be unnecessary given that patentees

362. *See* United States v. Dubilier Condenser Corp., 289 U.S. 178, 187 (1933) ("[U]pon the expiration of [the patent] period, the knowledge of the invention enures to the people, who are thus enabled without restriction to practice it and profit by its use. To this end the law requires such disclosure to be made in the application for patent that others skilled in the art may understand the invention and how to put it to use." (citations omitted)); *cf.* Brian J. Love & Christopher B. Seaman, *Best Mode Trade Secrets*, 15 YALE J.L. & TECH. 1, 3 (2012) ("Traditionally, trade secrecy and patent rights have been considered mutually exclusive.").

363. Spectra-Physics, Inc. v. Coherent, Inc., 827 F.2d 1524, 1532 (Fed. Cir. 1987).

364. *Id.*; 35 U.S.C. § 112; Levine & Sarnoff, *supra* note 130, at 1013–14.

365. 35 U.S.C. § 112; Levine & Sarnoff, *supra* note 130, at 1015 ("[B]est mode has become nearly an afterthought in patent law practice and doctrine.").

366. Love & Seaman, *supra* note 362, at 8–9. The Leahy-Smith America Invents Act significantly weakened the best mode requirement by establishing that noncompliance with the requirement is no longer a ground for cancelling, invalidating, or rendering a patent unenforceable. *Id.*; 35 U.S.C. § 282(b)(3)(A).

367. Importantly, the TRIPS Agreement allows countries to require disclosure of a best mode. TRIPS Agreement, *supra* note 10, art. 29.

worldwide routinely secure U.S. patent protection for commercially significant inventions.[368] A strengthened best mode requirement in U.S. patent law would compel patentees to disclose more tacit knowledge and trade secrets for effectively practicing their inventions.[369]

Against critiques that this proposal would increase the cost and complexity of patent prosecution, it is important to emphasize that it merely seeks to enforce an existing requirement of U.S. patent law with which applicants should already comply. Furthermore, requiring disclosure of a best mode may actually decrease the cost and complexity of litigation in some cases. Because patentees would have to disclose more trade secrets in their patents, enforcing the best mode requirement would reduce instances when plaintiffs asserted both patent infringement and misappropriation of trade secrets in litigation.[370]

Of course, purely tacit knowledge is not capable of codification and would presumably fall outside the scope of a rehabilitated best mode requirement.[371] Furthermore, an overly stringent best mode requirement may force inventors to engage in costly and unnecessary disclosures or motivate them to forego patenting altogether in favor of trade secrecy.[372] However, a balanced best mode requirement would do valuable work in compelling patentees to disclose patent-related private knowledge. For instance, vaccine patentees have submitted detailed information for manufacturing vaccines to regulatory authorities, but they have not publicly disclosed that information in patents.[373] Under

368. *See* Bingbin Lu, *Best Mode Disclosure for Patent Applications: An International and Comparative Perspective*, 16 J. INTELL. PROP. RTS. 409, 415 (2011) ("[M]any multi-national foreign patent holders tend to file patent in the US . . . .").

369. *Cf. In re* Gay, 309 F.2d 769, 772 (C.C.P.A. 1962) ("[T]he sole purpose of the [best mode] requirement is to restrain inventors from applying for patents while at the same time concealing from the public preferred embodiments of their inventions which they have in fact conceived.").

370. Love & Seaman, *supra* note 362, at 16–18.

371. Lee, *Transcending, supra* note 122, at 1559 ("Tacit knowledge is, by definition, impossible or costly to codify, and heightened disclosure requirements would greatly enhance the expense and complexity of obtaining a patent.").

372. *Id.*

373. Price II et al., *supra* note 232, at 913; *see* Levine & Sarnoff, *supra* note 129, at 993 (noting that firms must submit clinical data to regulators to obtain marketing approval, but such data are not required to be made public).

this proposal, if they possessed such knowledge at the time of patent filing, they would be compelled to disclose it.

A more aggressive version of this proposal would extend the period over which disclosure obligations—including a rehabilitated best mode requirement—would apply to patent applicants and patentees. Currently, disclosure requirements apply as of the date of filing a patent application.[374] Patent applicants submit disclosures based on the state of their knowledge at that relatively early stage, and they have incentives to not amend those disclosures during prosecution.[375] However, inventors gain significant knowledge about their inventions throughout patent prosecution and commercialization.[376] For example, it is possible that mRNA vaccine patentees were unaware of a best mode when they submitted their patent applications and only developed optimal manufacturing techniques later, which would fall outside of the statutory requirement. As such, a more aggressive version of this proposal would reform the best mode requirement into an ongoing disclosure obligation extending for some reasonable time (for example, five years) after filing a patent application.[377] During this time, patentees would have to disclose any known best mode as a condition of obtaining and maintaining a patent. This alteration would necessitate certain technical reforms whereby a patent applicant could update a disclosure without losing a priority date, but such updates could not be the basis for broadening claims.[378]

374. Levine & Sarnoff, *supra* note 130, at 1013–15.

375. *Id*. at 1014 ("[M]ost biopharmaceutical patents are filed well before clinical trial development, based on in vitro testing that shows the promise of potential therapeutic efficacy."); *see* 35 U.S.C. § 132(a) (prohibiting the addition of "new matter" in the disclosure of a patent application undergoing reexamination).

376. Jeanne C. Fromer, *Dynamic Patent Disclosure*, 69 VAND. L. REV. 1715, 1718–20 (2016).

377. *See* Peter Lee, *New and Heightened Public-Private Quid Pro Quos: Leveraging Public Support to Enhance Private Technical Disclosure*, *in* INTELLECTUAL PROPERTY, COVID-19, AND THE NEXT PANDEMIC: DIAGNOSING PROBLEMS, DEVELOPING CURES (forthcoming 2023) (manuscript at 10–12) (on file with author).

378. *See id*. at 12.

Enhanced patent disclosure would increase the efficacy of patent-based technology transfer.[379] Relatedly, it would reduce the need for parties to use multinational bounded entities to transfer technical knowledge abroad. At the same time, increased patent disclosure of tacit knowledge and trade secrets would enrich the public domain, thus accelerating follow-on innovation by the inventive community at large.[380]

Importantly, enhanced patent disclosure would also increase the efficacy of involuntary patent-based technology transfer, such as compulsory licenses. As noted, TRIPS provides for flexibilities that allow countries to weaken patents in times of urgent need.[381] The paradigmatic example of this flexibility was South Africa's attempt to use compulsory licenses and parallel imports to enhance access to patented HIV/AIDS medications during the AIDS pandemic.[382] Critics of the TRIPS regime, however, contend that it renders compulsory licenses too difficult to grant and that countries suffer political backlash from powerful players when trying to issue compulsory licenses.[383] Additionally, this Article highlights another deficiency: even if governments grant compulsory licenses, third parties may not be able to manufacture patented technologies without tacit knowledge and trade secrets retained by patentees.[384] This dynamic is painfully evident in the controversy over the TRIPS waiver for patented COVID-19 vaccines.[385] However, greater codification of tacit knowledge and trade secrets in publicly accessible patents

379. Lu, *supra* note 368, at 415 (noting that a robust best mode requirement would ensure that developing countries could access patented technologies from developed countries "with sufficient and valuable information").

380. *See* Carolyn C. Cooper, *Nineteenth-Century American Patent Management as an Invisible College of Technology*, *in* LEARNING & TECHNOLOGICAL CHANGE 40, 40, 56–57 (Ross Thomson ed., 1993); MERGES & DUFFY, *supra* note 40, at 247.

381. *See supra* notes 49–50 and accompanying text.

382. *See supra* notes 90–93 and accompanying text.

383. *E.g.*, Pub. Citizen, *Existing TRIPS "Flexibilities" Unworkable for Necessary Scale Up of COVID-19 Medicines Production*, TRADE WATCH 4 (2021), https://www.citizen.org/wp-content/uploads/TRIPS-waiver_Existing-TRIPS-Flexibilities-Unworkable-for-Scale-Up-of-Covid-19-Medicines-Production-.pdf [https://perma.cc/MXM6-GHAR].

384. Maskus, *supra* note 22, at 231 (observing that a nation can issue a compulsory license to deal with a health emergency, but "the relevant know-how that is embodied in the personal knowledge of engineers or trade secrets but not in patent rights may be difficult to acquire").

385. *See supra* notes 223–33 and accompanying text.

would enhance the efficacy of TRIPS waivers and other involuntary transfers of patented technologies in times of need.

2. Increasing the Effectiveness of Multinational Bounded Entities

Even with enhanced patent disclosure, multinational bounded entities will remain necessary or preferred vehicles for international technology transfer in many contexts. Increased patent disclosure can only go so far, and sometimes parties must mobilize organizational approaches to transfer purely tacit knowledge. In other cases, innovators may opt to transfer technology through a multinational bounded entity to prevent exposing valuable trade secrets to outside parties. It bears emphasizing that increasing the disclosure obligations of patentability may shunt innovators into protecting more of their patentable technologies as trade secrets instead. Accordingly, this Subsection explores various policy levers to increase the effectiveness of multinational bounded entities.[386]

First, if governments value multinational bounded entities as conduits for transferring technical knowledge, they should financially support them. At the most direct level, governments can offer subsidies, tax breaks, and other public support to encourage private entities to form the organizational linkages required to transfer tacit knowledge and trade secrets.[387] Receiving countries can increase their attractiveness as targets for FDI by developing local innovation systems, targeting specific technologies and companies, and strengthening linkages between foreign and local entities.[388]

While receiving countries clearly benefit from incoming technology transfer, transferor countries sometimes seek to increase outgoing transfer.[389] For instance, early in the global

386. This Subsection addresses public policy interventions to improve multinational bounded entities. Private-sector managers of such entities can also do much to enhance their internal knowledge transfer capabilities. For instance, they can implement strategic job rotations and cross-functional teams to facilitate knowledge sharing within their organizations. Lee et al., *supra* note 160, at 586.

387. Hoekman et al., *supra* note 18, at 1590–91, 1594.

388. UNCTAD, *supra* note 2, ¶ 44.

389. Obviously, the type of technology at issue significantly impacts whether governments of innovator countries will voluntarily transfer it to other

rollout of COVID-19 vaccines, President Biden committed the United States to serving as the "arsenal of vaccines" for the world.[390] Here again, government support can catalyze multinational bounded entities that send technologies and technical knowledge abroad. As noted, much of the tacit knowledge and trade secrets for manufacturing mRNA vaccines reside in private patentees such as Moderna and Pfizer.[391] The government could have leveraged massive public expenditures benefitting these firms to help establish multinational bounded entities to transfer private knowledge abroad.

For example, in Operation Warp Speed, the U.S. government spent about $18 billion to fund COVID-19 vaccine development and purchase hundreds of millions of vaccine doses from Moderna, Pfizer, and other firms.[392] The government could have conditioned funds on vaccine developers actively transferring tacit knowledge and trade secrets to mutually agreed-upon vaccine manufacturers in foreign countries. To facilitate this objective, Operation Warp Speed could have funded repeat consulting engagements, in-person demonstrations, site visits, and other elements of multinational bounded entities between vaccine developers and manufacturers. In this case, the carrot of massive public funds can both incentivize and facilitate the formation of multinational bounded entities to transfer technical knowledge abroad.

Beyond providing funding, national and international authorities can directly establish multinational entities to

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countries. In general, for instance, governments are more likely to prioritize sharing biomedical technologies to serve pressing global health needs rather than sensitive technologies with military or national security applications.

390. Joseph R. Biden, U.S. President, Remarks by President Biden on the COVID-19 Vaccination Program and the Effort to Defeat COVID-19 Globally (June 10, 2021), https://www.whitehouse.gov/briefing-room/speeches-remarks/2021/06/10/remarks-by-president-biden-on-the-covid-19-vaccination-program-and-the-effort-to-defeat-covid-19-globally [https://perma.cc/6F6H-ZPEX]; *see* Sheryl Gay Stolberg, *Top U.S. Health Officials Say They Intend to Offer Other Nations Tech That Might Be Used Against Covid.*, N.Y. TIMES (Mar. 3, 2022), https://www.nytimes.com/2022/03/03/us/politics/fauci-us-health-officials-tech-covid.html [https://perma.cc/428T-S2NE].

391. *See supra* notes 227–33 and accompanying text.

392. Stephanie Baker & Cynthia Koons, *Inside Operation Warp Speed's $18 Billion Sprint for a Vaccine*, BLOOMBERG BUSINESSWEEK (Oct. 29, 2020), https://www.bloomberg.com/news/features/2020-10-29/inside-operation-warp-speed-s-18-billion-sprint-for-a-vaccine [https://perma.cc/52AD-GKJ8].

facilitate technical knowledge transfer. For instance, the World Health Organization (WHO) created the COVID-19 Technology Access Pool (C-TAP) to catalyze the sharing of intellectual property and tacit knowledge to fight the COVID-19 pandemic.[393] Rather than being a passive repository of information, C-TAP facilitates active interactions between technology generators and adopters.[394] One of the implementing elements of C-TAP, the Tech Access Partnership "facilitate[d] connections between experienced manufacturers and local manufacturers in developing countries to share key data, knowledge and other relevant support through a coordinated network."[395] Additionally, as noted, the WHO, COVID-19 Vaccines Global Access (COVAX), and a consortium of African countries have established a technology transfer hub for mRNA vaccines based in South Africa.[396] As of February 2022, this hub was actively transferring technical know-how to manufacture mRNA vaccines to six African countries.[397]

While such measures can strengthen multinational bounded entities, this Article also cautions that the "closed" nature of such entities must sometimes yield to the imperatives of public policy. In particular, governments should have greater flexibility to access private knowledge held by multinational bounded entities in times of public need. Existing law recognizes that exigent circumstances can justify compulsorily licensing patents.[398] In similar fashion, this Article argues that exigent circumstances should justify compelled sharing of certain forms of private knowledge.[399] Compulsory licensing of purely tacit knowledge is

393. *WHO COVID-19 Technology Access Pool*, WORLD HEALTH ORG., https://www.who.int/initiatives/covid-19-technology-access-pool [https://perma.cc/V5EF-WE6V].

394. *Id.*

395. *Tech Access Partnership*, UNITED NATIONS, https://www.un.org/technologybank/tech-access-partnership [https://perma.cc/ZK8S-T83J].

396. *Toward Africa's First mRNA Vaccine Technology Transfer Hub*, *supra* note 322.

397. Wendell Roelf & Alexander Winning, *African Countries to Get mRNA Vaccine Technology in WHO Project*, REUTERS (Feb. 18, 2022), https://www.reuters.com/world/africa/six-african-countries-receive-mrna-vaccine-technology-who-project-2022-02-18 [https://perma.cc/B7KU-2YF2].

398. *See supra* notes 87–88 and accompanying text.

399. It bears noting that India and South Africa originally proposed waiving TRIPS obligations that govern trade secrets and certain regulatory data

unworkable because it would require coerced, direct interpersonal interaction between technology generators and adopters. However, compulsory licensing is more feasible for codified trade secrets, such as vaccine recipes and manufacturing specifications. U.S. law establishes fairly broad powers by which government agencies can disclose private information for public purposes.[400] Furthermore, scholars have asserted that compulsory licensing of trade secrets is not prohibited under international law, including TRIPS.[401] While multinational bounded entities serve a valuable function in guarding trade secrets, sometimes national imperatives justify at least limited forms of compulsory information sharing.

This study of multinational bounded entities also underscores the importance of the capacity of receiving firms and countries to absorb, assimilate, and exploit foreign technical knowledge. Much commentary on transferring technical knowledge focuses on the challenges of innovators "pushing" technical knowledge—particularly tacit knowledge—to foreign entities. The efficacy of international knowledge transfer, however, depends significantly on the ability of foreign entities to receive such knowledge. Studies of technology transfer—particularly involving tacit knowledge—underscore the importance of the receiving entity's "absorptive capacity," or its ability to understand, assimilate, and exploit external knowledge.[402]

protection requirements for COVID-19-related products. *India & South Africa*, *supra* note 95; Levine & Sarnoff, *supra* note 130, at 991.

400. *See, e.g.*, Christopher J. Morten, *Publicizing Corporate Secrets,* U. PA. L. REV. (forthcoming 2023) (challenging the notion that public agencies cannot publicize corporate secrets under trade secrecy law); Christopher J. Morten & Amy Kapczynski, *The Big Data Regulator, Rebooted: Why and How the FDA Can and Should Disclose Confidential Data on Prescription Drugs and Vaccines*, 109 CALIF. L. REV. 493, 529–40 (2021) (examining the FDA's authority to disclose safety and efficacy data); Levine & Sarnoff, *supra* note 130, at 1041–50 (discussing several government mechanisms for compelling the sharing of trade secrets).

401. Gurgula & Hull, *supra* note 164, at 1249–51; *see* Levine & Sarnoff, *supra* note 130, at 1017, 1019–31 ("[T]he TRIPS Agreement does not expressly or impliedly prohibit governments from compelling trade secret sharing . . . ."). While investor-state dispute settlement (ISDS) proceedings may complicate compulsory trade secret sharing, ISDS proceedings would at most require some kind of compensation for the trade secret holder; they would not prohibit governments from compelling such sharing. *See* Levine & Sarnoff, *supra* note 130, at 1037–40.

402. Cohen & Levinthal, *supra* note 37, at 135.

Absorptive capacity is a broad concept that can apply to an individual, firm, or even an entire country.[403] Indeed, Hoekman et al. argue that "strong absorptive capacity and the ability to adapt foreign technology are important for [international technology transfer] to effect local technical change."[404] Enhancing the absorptive capacity of receiving countries (and firms in those countries) is a complex policy task involving shoring up R&D programs, educational systems, and the technical training of local scientists and engineers in those countries.[405]

The importance of transferee-nation absorptive capacity raises a final critique of the dominant, patent-based model of international technology transfer. As discussed in Part I, debates over international technology transfer have focused mainly on strengthening or weakening patents. Developed countries have mobilized enormous political and economic capital to strengthen patent protection around the world, most notably through "upward harmonization" embodied in the TRIPS Agreement.[406] Strengthening patents serves their own interests, but developed countries also argue that strong patents promote international technology transfer and benefit developing countries as well.[407] For their part, developing countries have expended significant political and economic capital to resist such upward harmonization. They have fought for compulsory licenses, TRIPS waivers, and other flexibilities on the theory that *weakening* patents will increase access to foreign technologies.[408] Supporting (or begrudgingly accepting) either approach—strengthening or weakening patents—allows countries to claim to have done something to promote international technology transfer and global development.

This battle over intellectual property rights, however, obscures and diverts resources away from other, more fundamental processes that drive international technology transfer. As this Article has shown, large swaths of technology transfer take place outside of (or in parallel to) the international patent

403. *Cf. id.* at 131–38 (describing absorptive capacity at different levels).

404. Hoekman et al., *supra* note 18, at 1588; *see* UNCTAD, *supra* note 2, ¶ 42; *see also* Baranson, *supra* note 154, at 435 (noting that technology transfer depends on several factors, including "absorptive capabilities").

405. Hoekman et al., *supra* note 18, at 1588, 1590.

406. *See supra* notes 46–51 and accompanying text.

407. *See supra* notes 58–70 and accompanying text.

408. *See supra* notes 84–97 and accompanying text.

system. For such innovations, strengthening or weakening patents does little to directly transfer tacit knowledge and trade secrets for practicing the latest and most cutting-edge technologies. In particular, policymakers' preoccupation with strengthening or weakening patents distracts attention from the need for foundational capacity building in developing countries to effectuate deeper forms of technology transfer.[409] Intellectual property rights are often presented as a predicate for robust international technology transfer. But the underlying knowledge and capacity to utilize a technology are even more foundational than exclusive rights. Increasing absorptive capacity creates a virtuous cycle in which developing countries will enhance their ability to not only assimilate foreign technologies but also cultivate their own domestic innovative capacity. While strengthening or weakening patents is important, investments in education, healthcare, scientific infrastructure, political stability, and human capital are critical to the most profound forms of international technology transfer, and, ultimately, human flourishing.

CONCLUSION

This Article has challenged the dominance of the patent-based model of international technology transfer. Proponents of strong patents argue that they promote technology transfer by encouraging foreign trade, cross-border licensing, and FDI, particularly from developed to developing countries. A vocal counternarrative contends that weakening patents is critical to accessing foreign technologies. Either way, the presence or absence of patents takes center stage. Beyond intellectual property rights, however, this Article has explored the underappreciated importance of transnational organizational structures in transferring technical knowledge between countries.

In so doing, this Article has elaborated a novel knowledge-based theory of multinational bounded entities. It has built on the knowledge-based theory of the firm, which posits that firms enjoy significant advantages in internally transferring tacit knowledge—personal, experiential knowledge not amenable to codification—relative to transferring such knowledge to external parties. It has expanded upon the knowledge-based theory of the

409. *Cf.* Vredenburg & Garcia, *supra* note 2, at 143 ("There is no doubt that most developing countries lack capacity within their educational institutions to absorb the transfer of technology.").

firm in two ways to articulate a broader knowledge-based theory of bounded entities. First, it has argued that firms also facilitate the transfer of trade secrets—which may be codified and easily appropriated—by enabling their transfer within a closed organizational environment, thus preventing the exposure of sensitive information to outsiders. Second, it has argued that the knowledge-transfer advantages of firms extend to a broader class of "bounded entities." In addition to integrated firms, quasi-integrated forms such as joint ventures and thick contractual relationships between long-term partners enjoy efficiencies in transferring tacit knowledge and trade secrets. Applying this model to the international context, this Article has argued that multinational bounded entities play an important and underappreciated role in transferring technical knowledge abroad. These dynamics are evident in the challenge of global manufacturing of COVID-19 vaccines and the conflict over "forced technology transfer" in the U.S.-China trade war.

This Article has further analyzed the respective roles of patents and bounded entities in international technology transfer. It has revealed how the strength of patent protection in a receiving country and the public or private nature of knowledge to be transferred help determine preferred transfer channels. In some contexts, patents and bounded entities are substitutes, while in others, they are complements. Turning to normative analysis, it has argued that bounded entities valuably augment the limitations of patent-based technology transfer, though in doing so they incur tangible costs. This Article has proposed increasing the disclosure requirements of patentability to increase the efficacy of patent-based technology transfer (both voluntary and involuntary) and reduce the need for parties to utilize multinational bounded entities. In some contexts, however, multinational bounded entities remain necessary or preferred, and this Article has suggested ways that governments can support their formation. It has cautioned that the preoccupation with strengthening or weakening patents diverts attention from fundamental processes by which technical knowledge moves between countries. It has further argued for greater investment in capacity building in developing countries to foster the conditions most conducive to robust international technology transfer.