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AN ORGANIZATIONAL THEORY OF INTERNATIONAL TECHNOLOGY TRANSFER

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International technology transfer plays a critical role in global welfare and economic growth. 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 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. This Article argues that separate from patents, multinational organizational structures play an important and underappreciated role in transferring technical knowledge between countries. In so doing, this Article offers a new gloss on the knowledge-based theory of the firm. Among other contentions, this theory emphasizes the advantages of firms in transferring tacit knowledge—personal, experiential knowledge that is not amenable to codification (and not disclosed in patents). 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—play a critical and underappreciated role in transferring technical knowledge abroad. Notably, multinational bounded entities facilitate technology transfer even for inventions that have been publicly disclosed in patents and even when innovators try to assert intellectual property rights to limit such transfer. Illustrating these dynamics, this Article explores the role of multinational bounded entities in efforts to increase global manufacturing of patented COVID-19 vaccines and the controversy over "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, involuntary, and organizational channels.

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CONTENTS

"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 on technologies, encourage technological exports, cross-border licensing, and foreign direct investment (FDI).[3] A vocal counternarrative, however, argues that weakening patents increases access 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 both 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.

Consider, for example, the challenge of transferring patented COVID-19 vaccine technology to foreign counties. 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,

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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 Vrendenburg & Percy Garcia, *Technology Transfer in International Business: The Role of the Multinational Corporation in Building Capacity in Developing Countries*, 7 INT'L J. BUS. STRAT. 141, 144 (2007); United Nations Conference on Trade and Development, Foreign Direct Investment, the Transfer and Diffusion of Technology, and Sustainable Development 4 (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 literature. 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.
[6] *See generally* Sharon LaFraniere et al., *Politics, Science and the Remarkable Race for a Coronavirus Vaccine*, N.Y. TIMES (Nov. 30, 2020); Cecilia Martin & Drew Lowery, *mRNA Vaccines: Intellectual Property Landscape*, 19 NATURE REV. 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.

vaccine access remains grossly unequal between developed and developing countries,[8] and 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 enforcing patents on COVID-19 vaccines for most developing countries.[10] While this waiver aims to increase generic production of COVID-19 vaccines, weakening patents alone is unlikely to increase vaccine manufacturing.[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. 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. Vaccine patentees contend that they can only transfer such private technical knowledge through direct interactions with technology adopters.[12] In this context, neither strengthening nor weakening patents is enough. Organizational linkages between vaccine developers and foreign manufacturers are necessary to transfer patented vaccine technology.

In some contexts, organizational connections promote international technology transfer even when innovators try to assert intellectual property rights to limit such transfer. This dynamic is evident in the longstanding U.S.-China trade war.[13] The United States has repeatedly accused China of engaging in "forced technology transfer." This rather amorphous term encompasses several policies by which China allegedly compels foreign firms to transfer IP and technical know-how to Chinese counterparts.[14] One of these policies requires foreign companies to form joint ventures with Chinese firms to enter certain Chinese markets.[15] 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

[8] As of December 1, 2022, 72.8% of people in high-income countries had received at least one dose, while only 28.3% of people in the lowest income countries had received one dose. United Nations Development Program, Global Dashboard for Vaccine Equity, https://data.undp.org/vaccine-equity/ (last visited December 1, 2022). 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); Walden Bello, *The West Has Been Hoarding More Than Vaccines*, N.Y. TIMES (May 3, 2021); Matthew Kavanagh & Madhavi Sunder, *Opinion: Poor Countries May Not Be Vaccinated Until 2024. Here's How to Prevent That*, WASH. POST (March 10, 2021).

[9] Achal Prabhala, *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/.

[10] WORLD TRADE ORG., DRAFT MINISTERIAL DECISION ON THE TRIPS AGREEMENT (June 17, 2022), https://docs.wto.org/dol2fe/Pages/SS/directdoc.aspx?filename=q:/WT/MIN22/W15R1.pdf&Open=True [hereinafter WORLD TRADE ORG., DRAFT MINISTERIAL DECISION].

[11] Eric Martin & Susan Decker, *U.S. Weighs Global Vaccine-Expansion Move Opposed by Drugmakers*, BLOOMBERG LAW NEWS (Apr. 22, 2021); Christopher Rowland et al., *Drug Companies Defend Vaccine Monopolies in Face of Global Outcry*, WASH. POST. (March 21, 2021).

[12] Ian Lopez, *Vaccine IP Enforcement Takes Stage in Global Immunization Fight*, BLOOMBERG LAW NEWS (Apr. 27, 2021).

[13] *See* 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); 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. LEG. ANAL. 127, 128 (2021).

[14] *See* Jyh-An Lee, *Forced Technology Transfer in the Case of China*, 26 B.U. J. SCI & TECH. L. 324, 326 (2020) [hereinafter Lee, *Forced*].

[15] Qin, *supra* note 13, at 747; Sykes, *supra* note 13, at 128-29; Bernard M. Hoekman et al., *Transfer of Technology to Developing Countries: Unilateral and Multilateral Policy Options*, 33 WORLD DEV. 1587, 1591 (2005).

firms doing business in China often protect their technologies with IP rights to limit or 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.

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 to other nations, 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 it also impacts the transfer of technical knowledge as well.[16] This Article focuses centrally 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, a substantial amount (perhaps the majority) of international technology transfer takes place in organizational contexts outside of the formal patent system.[17]

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. Despite significant literatures on international technology transfer[18] and the knowledge-based theory of the firm,[19] legal scholars have curiously overlooked how they 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 parties.[20] 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. 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.

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

[17] UNCTAD, *supra* note 2, at 9; *see infra* notes 190-195 and accompanying text.

[18] Examples are too numerous to mention, but they include Margaret S. Chon, *Intellectual Property and the Development Divide*, 27 CARDOZO L. REV. 2813, 2832 (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; Joshua D. Sarnoff, *The Patent System and Climate Change*, 16 VA. J.L. & TECH. 301 (2011).

[19] Prominent examples include Erica Gorga & Michael Halberstam, *Knowledge Inputs, Legal Institutions and Firm Structure: Towards a Knowledge-Based Theory of the Firm*, 101 NW. L. REV. 1123, 1129-30 (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).

[20] *See infra* Part II.C.

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 that may be critical to practicing new technologies—including patented technologies. Trade secrets encompass technical and business information that innovators deliberately keep secret. 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 it. Transferring 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 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 (which is difficult to transfer) and trade secrets (which may be too easily appropriated by outside parties) are not limited to classic, integrated firms. Rather, they extend to a broader range of integrated and quasi-integrated organizational forms. 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.[21] 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. The "enclosed" nature of bounded entities facilitates the transfer of trade secrets, which may be easily appropriated and thus risky to transfer to arm's length, external parties. Put differently, bounded entities represent modular systems that facilitate intensive internal knowledge sharing while limiting knowledge leakage to outside parties.[22]

This Article then extends this novel theory to international technology transfer by articulating a knowledge-based theory of multinational bounded entities. It argues that wholly owned foreign subsidiaries, foreign-domestic joint ventures, and "thick" cross-border contractual relationships represent 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 try to assert intellectual property rights to limit such transfer. This Article illustrates these phenomena through extended case studies of the two most important controversies involving international technology transfer in recent times: the challenge of global manufacturing of COVID-19 vaccines and "forced technology transfer" in the U.S.-China trade war.

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

[21] 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.

[22] *See* Herbert A. Simon, *The Architecture of Complexity*, 106 PROC. AM. PHIL. SOC'Y 467 (1962); Henry E. Smith, *Intellectual Property as Property: Delineating Entitlements in Information*, 116 YALE L.J. 1761-66 (2007).

bounded entities provide different options for firms to transfer different kinds of technologies abroad. 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.

Turning to normative analysis, this Article argues that multinational bounded entities are a valuable (though costly) alternative to patent-based technology transfer. Despite their "closed" nature, bounded entities ultimately contribute to beneficial informational spillovers in receiving countries. However, countries may have reason to accelerate such spillovers in cases of national urgency.

Drawing on its analysis, this Article proposes two sets of policy prescriptions to improve international technology transfer. It first argues for shoring up the disclosure requirements of patentability to increase dissemination of tacit knowledge and trade secrets related to patented inventions. This reform would increase the efficiency of patent-based technology transfer and involuntary transfers (such as through compulsory licenses). Concomitantly, it would lessen the need for innovators to use multinational bounded entities to transfer technical knowledge across borders. In some cases, however, bounded entities will remain necessary or preferred conduits for transferring tacit knowledge and trade secrets. Accordingly, second, this Article also 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.[23] Basic investments in scientific, education, 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 has shown that patents can promote technology transfer. They primarily do so by reducing appropriation risk, thus enhancing the viability of patent-mediated transactions between separate entities in the marketplace. However, even where patents are strong, parties may still pursue organizational strategies—including forming bounded entities—to transfer tacit knowledge and prevent the leakage of trade secrets. Patents alone are primarily effective mechanisms 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

[23] Wesley M. Cohen & Daniel A. Levinthal, *Absorptive Capacity: A New Perspective on Learning and Innovation*, 35 ADMIN. SCI. Q. 128 (1990).

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 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 "closed" organizations provide a hospitable environment for transferring not only tacit knowledge but also trade secrets, which may be codified. 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 try to 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 patent-based, involuntary, and organizational transfer.

PART I. THE PATENT-BASED MODEL OF INTERNATIONAL TECHNOLOGY TRANSFER

Nations have long conferred intellectual property rights to induce the transfer of technologies and technical knowledge from abroad.[24] 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.[25] Similarly, the early British patent system offered exclusive rights to foreign artisans to induce them to immigrate and train British apprentices.[26] 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

[24] *See* Bronwyn H. Hall, *Patents, Innovation, and Development*, INT'L REV. APP. ECON. 1, 8 (2022).
[25] 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, 1273-74 (2012).
[26] *Id*. at 1270; ROBERT P. MERGES & JOHN F. DUFFY, PATENTS LAW AND POLICY 7 (7th ed. 2017).

inventor could patent an invention in multiple countries.[27] 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).[28] 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 patents 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 paradigm 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.[29] In the 1990s, the so-called Uruguay Round of negotiations resulted in the formation of the World Trade Organization (WTO). As part of establishing the WTO, member states also concluded the TRIPS Agreement, which established minimum standards for IP protection for all WTO members.

TRIPS has been characterized as "upward harmonization," and it establishes high minimum standards for IP protection.[30] 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.[31] Notably, before joining TRIPS, over forty low- and middle-income countries, including Brazil and India, did not grant product patents on pharmaceuticals.[32] 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.[33] While TRIPS permits compulsory licenses, it imposes requirements regarding negotiation and compensation that render granting them more burdensome.[34] Notably, TRIPS rules have real teeth. TRIPS provides for enforcing its provisions

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[27] Paris Convention for the Protection of Industrial Property, Mar. 20, 1883, 21 U.S.T. 1583, 828 U.N.T.S. 305. *See* L. Kamran Bilir et al., Do Treaties Encourage Technology Transfer? Evidence from the Paris Convention 3-4 (unpublished manuscript July 22, 2011).

[28] Agreement on Trade-Related Aspects of Intellectual Property Rights, Apr. 15, 1994, 1869 U.N.T.S. 299, 33 I.L.M. 1197 (1994) (TRIPS Agreement).

[29] Ian F. Fergusson, *The World Trade Organization: Background and Issues* 1, CONG. RES. SERV. REPORT FOR CONGRESS (May 9, 2007).

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

[31] TRIPS art. 27.1

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

[33] TRIPS art. 31.

[34] *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.*

through a Dispute Settlement Understanding, which has "been an important mechanism in transforming national intellectual property legislation worldwide."[35]

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.[36] 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.[37] Such "linkage bargaining" that tied greater market access to stronger IP standards helped convince developing countries to join the WTO.[38] 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.[39]

In its structure and framing, the TRIPS Agreement reflects the view that strong intellectual property rights foster international technology transfer.[40] Article 7 states that "The protection and enforcement of intellectual property rights should contribute to the promotion of technological innovation and the transfer and dissemination of technology."[41] TRIPS even creates an explicit obligation for developed countries to encourage technology transfer to least developed countries.[42]

In theory, stronger patents can promote international technology transfer in several ways.[43] First, strong patent protection can encourage greater international trade.[44] Innovators in developed countries may be more likely to export technological goods to developing countries offering strong patent protection, thereby reducing the risk of unauthorized copying of their

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[35] Ruth L. Okediji, *Public Welfare and the Role of the WTO: Reconsidering the TRIPS Agreement*, 17 EMORY INT'L L. REV. 819, 820 (2003).
[36] Ellen 'T Hoen, *Protecting Public Health through Technology Transfer: The Unfulfilled Promise of the TRIPS Agreement*, 24 HEALTH & HUM. RIGHTS J. 211, 211 (2022); Kal Raustiala, *Innovation in the Information Age: The United States, China, and the Struggle Over Intellectual Property in the 21st Century*, 58 COLUM. J. TRANS. L. 531, 542 (2020).
[37] Bello, *supra* note 8.
[38] Chon, *Development*, *supra* note 18, at 2832.
[39] *See, e.g.*, Maskus, *supra* note 18, at 222; 'T Hoen, *supra* note 36, at 211.
[40] 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. Maskus, *supra* note 26, at 224-25.
[41] TRIPS art. 7; *see* 'T Hoen, *supra* note 36, at 212.
[42] TRIPS art. 66.2; Jayashree Watal & Leticia Caminero, Least-Developed Countries, Transfer of Technology and the TRIPS Agreement, Staff Working Paper ERSD-2018-01 (Feb. 22, 2018); *see* Maskus, *Trading*, *supra* note 39, at 225 (noting that Article 66.2 is merely aspirational).
[43] *See* Hall, *supra* note 24, at 10; Nagesh Kumar, *Intellectual Property Rights, Technology and Economic Development*, ECON. & POL. WEEKLY 209, 210 (2003). 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 EC. LETTERS 110180, at 3 (2022).
[44] Maskus, *supra* note 39, at 230.

products.[45] Given that "[new] products embody novel ideas," international trade provides an important avenue for disseminating technical knowledge abroad.[46] Furthermore, trade promotes international technology transfer by allowing local entities to reverse engineer foreign products and by increasing access to new machinery and equipment.[47] Empirical research has found that increasing patent strength positively affects import volumes in many developing countries, particularly large ones.[48] Follow-up research similarly found that firms significantly increased exports to large and middle-income developing countries that strengthened patent protection.[49]

Second, strong patent protection in a receiving country can motivate greater cross-border licensing of inventions.[50] This is another form of international technology transfer involving granting the legal right to practice some invention in a foreign jurisdiction. Importantly, licensing may provide access to not only a technology but also the fundamental underlying technical knowledge to exploit it: "Contracts typically involve the purchase of production or distribution rights and the underlying technical information and know-how."[51] 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.[52] For example, a firm in one country may design and patent a technology, then license the patent to a foreign firm for manufacturing.[53] 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 licensing fees,[54] suggesting that when countries strengthen patents, licensing activity increases.

Third, strong patents can foster international technology transfer by spurring greater foreign direct investment (FDI).[55] 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. While FDI is certainly an important channel for international technology transfer,[56] the evidence that patents promote FDI

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[45] Kumar, *supra* note 43, at 212.
[46] Hoekman et al., *supra* note 15, at 1588.
[47] *Id*.
[48] Keith E. Maskus & Mohan Penubarti, *How Trade-Related are Intellectual Property Rights?*, 39 J. INT'L ECON. 227 (1995); *see* Kumar, *supra* note 43, at 212.
[49] Pamela J. Smith, *Are Weak Patent Rights a Barrier to U.S. Export?*, 48 J. INT'L ECON. 151 (1999). However, strengthening patents would not increase exports to least-developed countries, which have less capacity to copy technologies, or to richer OECD countries that already have strong patents. *Id*.
[50] Maskus, *supra* note 39, at 231.
[51] Hoekman et al., *supra* note 15, at 1589.
[52] Jonathan M. Barnett, *'Patent Tigers' and Global Innovation*, 42 REGULATION 14, 17-18 (Winter 2019-2020).
[53] *Id*. at 18 (describing a schematic example of an Israeli firm that designs semiconductors and licenses those designs to a Taiwanese foundry for manufacture).
[54] Guifang Yang & Keith E. Maskus, *Intellectual Property Rights and Licensing: An Econometric Investigation*, 137 WELTWIRTSCHAFTLICHES ARCHIV. 58 (2001); Lee G. Branstetter et al., *Do Stronger Intellectual Property Rights Increase International Technology Transfer? Empirical Evidence from U S. Firm-Level Panel Data*, Q. J. ECON. 321, 322-23 (2006).
[55] Maskus, *supra* note 39, at 230-31.
[56] Hoekman et al., *supra* note 15, at 1588; M. Blomstrom & A. Kokko, How Foreign Investment Affects Host Countries, World Bank PRD Working Paper No. 1745 (1997).

is somewhat mixed.[57] Some empirical research suggests that stronger patent laws exert a positive effect on inflows of FDI.[58] However, several studies have found that IP protection has little influence on inward FDI.[59] Additionally, stronger patents—which render licensing inventions to foreign entities more viable—may actually reduce the need for multinational corporations to directly transfer technologies using FDI.[60] One commentator has concluded: "the contention that stronger norms of IPR protection will facilitate greater inflows of FDI in the country is rather weak in either theoretical or empirical terms."[61] 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.[62]

Despite some mixed empirical evidence, in its structure and framing, the TRIPS Agreement reflects 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.[63] At a theoretical level, it is easy to see how patents can inhibit international technology transfer. Patents confer exclusive rights, thus providing the patentee with the ability to block any use (including transfer) of a proprietary technology. Notably, both the predominant narrative and this counternarrative focus on the centrality of patents—either their presence or absence—as gatekeepers to international technology transfer.

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.[64] Weak protection allowed these countries to rapidly assimilate and imitate foreign technologies.[65] The

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[57] *See, e.g.*, Branstetter et al., *supra* note 54, at 323 n.4.
[58] Juan S. Blyde & Cristina Acea, *The Effects of Intellectual Property Rights on Trade and FDI in Latin America*, InterAmerican Development Bank (2002); *see* Hall, *supra* note 24, at 11; *see also* Edwin Mansfield, Intellectual Property Protection, Foreign Direct Investment, and Technology Transfer, INT'L FIN. CORP. DISCUSSION PAPER 19 (suggesting that U.S. multinational corporations considered IP enforcement when locating facilities in major developing countries).
[59] *See* Kumar, *supra* note 43, at 212 (collecting sources).
[60] Hall, *supra* note 24, at 10; Kumar, *supra* note 43, at 212; Yang & Maskus, *supra* note 54, at 61.
[61] Kumar, *supra* note 43, at 213.
[62] *Id*.
[63] Hall, *supra* note 24, at 3 (noting reduced learning through imitation and technological spillovers with strong patent enforcement); Kumar, *supra* note 43, at 209.
[64] *Id*. at 214; Justin Hughes, *The Philosophy of Intellectual Property*, 77 GEO. L.J. 287, 293 (1988).
[65] *See* Kumar, *supra* note 43, at 211-12 (collecting and summarizing sources).

United States followed this pattern,[66] as have several Asian countries.[67] For example, during South Korea's industrialization, the "government tried to minimise IPR protection to help domestic firms use foreign intellectual property."[68] Taiwan employed a similar policy.[69] Japan adopted utility models—watered-down versions of patents for incremental inventions—that facilitated local modifications of foreign technologies.[70] The long absence of product patents on pharmaceuticals in India encouraged local manufacturing of medicines that were patented elsewhere.[71]

Even the TRIPS Agreement, which generally strengthens intellectual property standards, reflects the concern that overly strong intellectual property rights can hinder technology transfer. For example, least developed countries received prolonged transition periods (and subsequent extensions) before having to fully implement TRIPS provisions, particularly for pharmaceuticals.[72] 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."[73] As mentioned, Article 31 permits states to grant compulsory licenses.[74] Such licenses can also increase access to patented foreign technologies.[75]

The principle that curtailing patents can promote international technology transfer was crystalized a generation ago 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. In 1997, South Africa adopted legislation permitting compulsory licenses to manufacture generic versions of patented HIV/AIDS drugs.[76] 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

[66] Raustiala, *supra* note 36, at 555-58.
[67] Kumar, *supra* note 43, at 213.
[68] Won-Yong 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); Hoekman et al., *supra* note 15, at 1593.
[69] Kumar, *supra* note 43, at 215.
[70] *Id*. at 214; *see also* Hoekman et al., *supra* note 15, 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 Bhagwati ed., 1977); Alfred D. Chandler, *Organizational Capabilities and the Economic History of the Industrial Enterprise*, 6 J. ECON. PERSPS. 79, 84 (1992).
[71] Kumar, *supra* note 43, at 218.
[72] *See* J.H. Reichman, *The TRIPS Agreement Comes of Age: Conflict or Cooperation with the Developing Countries?*, CASE W. RES. J. INT'L L. 441, 444 (2000); *see, e.g.*, World Trade Organization, *Developing Countries' Transition Periods* (Sept. 2006), https://www.wto.org/english/tratop_e/trips_e/factsheet_pharm04_e.htm; World Trade Organization, *WTO Members Agree to Extend TRIPS Transition Period for LDS until 1 July 2034* (June 29, 2021), https://www.wto.org/english/news_e/news21_e/trip_30jun21_e.htm.
[73] TRIPS art. 8.2; *see* 'T Hoen, *supra* note 36, at 212.
[74] TRIPS art. 31; *see* Maskus, *supra* note 39, at 228.
[75] Subsequent amendments to the TRIPS Agreement more explicitly provide for the transfer of patented products between nations via compulsory licenses. TRIPS art. 31*bis*.
[76] Medicines and Related Substances Control Amendment Act No. 90 of 1997 § 22F(1)(a) (S. Afr.).

TRIPS Agreement.[77] After significant public backlash, the pharmaceutical companies withdrew the lawsuit.[78] 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 countries to issue compulsory licenses to increase access to patented technologies, including those from foreign countries.[79]

The link between weakening patents and promoting international technology transfer has renewed salience in the current COVID-19 pandemic. Many medical products necessary to fight the pandemic—from respirators to diagnostic tests to drugs—are patented.[80] Amid concerns that patents were inhibiting access to these technologies, in October 2020 India and South Africa proposed a temporary waiver of TRIPS obligations for technologies related to diagnosing, preventing, and treating COVID-19.[81] After protracted negotiations, in June 2022 the WTO adopted a narrow version of a TRIPS waiver limited to patented vaccines.[82] This Article will return to the TRIPS waiver below,[83] but for present purposes it illustrates the view that weakening patents can increase access to foreign technologies.

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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. 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

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[77] 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. GLOBAL LEG. STUD. 167, 183 (2011).
[78] *Id*. at 186.
[79] Shortly after the South African litigation, the TRIPS Council issued the Doha Declaration on the TRIPS Agreement and Public Health. World Trade Organization, *The DOHA Declaration on the TRIPS Agreement and Public Health,* ¶ 4, WT/MIN(01)/DEC/2 (Nov. 14, 2001). Among other provisions, the Doha Declaration reaffirmed flexibilities in the TRIPS Agreement, including member states' right to issue compulsory licenses and determine the circumstances that merited such licenses. *Id.* ¶ 5. A 2003 decision permitted countries to issue compulsory licenses to manufacture patented technologies for *export* to countries that could not manufacture them locally. WTO, *Amendment of the TRIPS Agreement*, WT/L/641 (Dec. 6, 2005), *available at* http://www.wto.org/english/tratop_e/trips_e/wtl641_e.htm. 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 explicitly promote international technology transfer.
[80] Susan Decker & Christopher Yasiejko, *World War II-Style Mobilization Order May Carry Risks*, BLOOMBERG (March 23, 2020).
[81] India & South Africa, Waiver from Certain Provisions of the TRIPS Agreement for the Prevention, Containment and Treatment of COVID-19 (IP/C/W/669), Council for Trade-Related Aspects of Intellectual Property Rights (2020).
[82] WORLD TRADE ORG., DRAFT MINISTERIAL DECISION, *supra* note 10.
[83] *See infra* Part IV.B.1.

an incomplete account of how parties often transfer technology and technical knowledge between nations.

PART 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 this analysis, this Part first explores the classic theory of the firm, which posits that transaction costs determine whether parties coordinate the production of goods (including 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 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 critical 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.[84] In its classic formulation by economist Ronald Coase, the theory of the firm explains why firms perform some functions "in-house" while completing others by transacting with outside parties in the market.[85] 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.[86] Sometimes, however, the transaction costs of market exchanges render market-based production less efficient than simply producing an asset in-house.[87] Market exchanges entail numerous transaction costs, including the expense of determining prices, delineating obligations, and

[84] There are in fact several theories of the firm. *See* Gorga & Halberstam, *supra* note 19, at 1129-30; Robert M. Grant, *Toward a Knowledge-based Theory of the Firm*, 17 STRAT. MGMT. J. 109, 109 (1966). This Part focuses on Coase's transaction-cost theory of the firm, which establishes a useful foundation for exploring the knowledge-based theory of the firm.
[85] *See generally* R.H. Coase, *The Nature of the Firm*, 4 ECONOMICA 386 (1937) (articulating the theory of the firm).
[86] *See id.* at 387-88.
[87] *See id.* at 392.

negotiating, monitoring, and enforcing contracts.[88] 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 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 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.[89] 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.[90] 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 transfer between separate parties. 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 appropriation, thus resolving Arrow's Information Paradox.[91] For their part, buyers can pay for

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[88] 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).

[89] 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 (Nat'l Bureau of Econ. Research ed., 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.

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

[91] *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-

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.[92] 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.[93] 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.[94]

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. Accordingly, all major patent jurisdictions, as well as the TRIPS Agreement, require that inventors disclose in their patents how to practice their inventions.[95] For example, under U.S. law, the enablement requirement mandates that a patent itself must teach a person of ordinary skill in the art how to make and use the claimed invention.[96]

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.[97] In describing tacit knowledge, philosopher and scientist Michael Polanyi famously observed, "*we can know more than we can tell*."[98] Tacit knowledge refers to personal, experiential knowledge that is not easily codified.[99] 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.[100] It includes "intangible

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).

[92] Lee, *Autonomy*, *supra* note 90, at 301.

[93] Dan L. Burk, *The Role of Patent Law in Knowledge Codification*, 23 BERKELEY TECH. L.J. 1009, 1011 (2008).

[94] *See supra* Part I.A.

[95] TRIPS art. 29.

[96] 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 – and accompanying text.

[97] 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.

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

[99] *See* Kogut & Zander, *Combinative Capabilities*, *supra* note 1, at 387.

[100] 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).

knowledge, such as rules of thumb, heuristics, and other 'tricks of the trade'."[101] Conventional information economics posits that information moves easily and is readily appropriable by receiving parties.[102] This intuition is captured by the aphorism that "information wants to be free."[103] However, rather than moving easily, tacit knowledge is "sticky" and difficult to transfer.[104]

In describing tacit knowledge, 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.[105] However, some tacit knowledge is "latent," meaning that it is technically codifiable but presently uncodified.[106] 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.[107] Third, tacit knowledge manifests in several different types of entities. While individuals certainly possess tacit knowledge,[108] organizations also develop tacit knowledge in the form of routines, processes, and even institutional cultures.[109] Finally, tacit knowledge from an inventor 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.[110] Commercializing an invention often presents novel technical challenges for which the tacit knowledge of the original inventor is very helpful to surmount.

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[101] 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 (1988) ("[K]now-how is the accumulated practical skill or expertise that allows me to do something smoothly and efficiently.").

[102] *See generally* Arrow, *supra* note 89, at 614–16.

[103] *See* STEWART BRAND, THE MEDIA LAB 202, 211 (1987).

[104] *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 in Copyright*, 2011 WIS. L. REV. 177, 180; Gorga & Halberstam, *supra* note 19, 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; Agrawal, *Engaging the Inventor*, *supra* note 122, at 64; Howells, *supra* note 100, at 93.

[105] *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).

[106] *See* Ajay Agrawal, *Engaging the Inventor: Exploring Licensing Strategies for University Inventions and the Role of Latent Knowledge*, 27 STRATEGIC MGMT. J. 63 (2006).

[107] *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 CAL. 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 the 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*].

[108] *See* NELSON & WINTER, *supra* note 105, at 72-73 (noting that "skills" inhere in individuals).

[109] *Id.*; Robin Cowan & Dominique Foray, *The Economics of Codification and the Diffusion of Knowledge*, 6 INDUS. & CORP. CHANGE 595, 596 (1997); Robert Gibbons & Laurence Prusak, *Knowledge, Stories, and Culture in Organizations*, 110 AEA PAPERS & PROCEEDINGS 187, 187 (2020); Kogut & Zander, *Combinative Capabilities*, *supra* note 1, at 383; *cf.* Gorga & Halberstam, *supra* note 19, at 1141-42 (observing that knowledge can reside in physical assets, organizations, or individuals).

[110] Lee, *Transcending*, *supra* note 107, at 1529.

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.[111] This disclosure requirement encourages patentees to codify some knowledge that would otherwise remain tacit.[112] 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 codify. Importantly, patentees have significant incentive to disclose as little information as possible while appearing to satisfy the disclosure requirements of patentability. In this manner, they can retain significant private knowledge—tacit and otherwise—for themselves.[113] Furthermore, it is exceedingly difficult for the PTO or courts to know whether patentees possess some relevant tacit knowledge that they should disclose. Finally, patent law's disclosure obligations generally focus on disclosing some basic version of an invention.[114] As such, patentees may refrain from disclosing additional knowledge (including tacit knowledge) related to developing and commercializing an invention.[115]

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.[116] Codified disclosures, after all, cannot easily capture all the nuances of how inventors actually create and use complex biological macromolecules. Beyond being helpful to producing a biologic compound in a laboratory, tacit knowledge of inventors is especially helpful to ramping up the mass manufacture of such compounds. 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."[117]

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 knowledge to practice

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[111] *See supra* notes - and accompanying text.
[112] *See* Burk, *supra* note 112, at 1013 ("[C]odification results in commodification of knowledge, allowing it to be treated more as an object of trade or exchange.").
[113] *See* Brenner v. Manson, 383 U.S. 519, 534 (1966) (acknowledging "the 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, 634–36 (2010); Jeanne Fromer, *Patent Disclosure*, 94 IOWA L. REV. 552 (2009).
[114] *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 "reduced to practice"). As discussed below, the best mode requirement could require disclosure of additional information for practicing an invention, but it is rarely enforced. *See infra* notes – and accompanying text.
[115] *In re* Gay, 309 F.2d 769, 774 (C.C.P.A. 1962) (observing that patents are not intended to be product specifications).
[116] *Cf.* OFFICE FOR TECHNOLOGY ASSESSMENT, COMMERCIAL BIOTECHNOLOGY—AN INTERNATIONAL ANALYSIS 368 (1984).
[117] W. Nicholson Price II & Arti K. Rai, *Manufacturing Barriers to Biologics Competition and Innovation*, 101 IOWA L. REV. 1023, 1028 (2016).

an invention.[118] However, such transfers typically do not unfold as quick, one-off market exchanges, and they require intensive, longer-term interactions between inventors and adopters. 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.[119] As Bruce Kogut and Udo Zander note, "The teaching of know-how and information requires frequent interaction within small groups, often through the development of a unique language or code."[120] Similarly, economist Joanne Oxley observes that tacit knowledge "is extremely difficult to transfer without intimate personal contact, involving teaching, demonstration, and participation."[121]

A shared organizational environment can facilitate the common context and repeat interactions necessary to transfer tacit knowledge.[122] 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.[123] Put differently, the

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[118] Ashish Arora, *Licensing Tacit Knowledge: Intellectual Property Rights and the Market for Know-How*, 4 ECON. INNOV. NEW TECH. 41, 42 (1995) [hereinafter Arora, *Licensing*]; Hoekman et al., *supra* note 15, at 1589.
[119] Arora, *Contracting*, *supra* note 101, at 235; Arora, *Licensing*, *supra* note 118, at 43; Howells, *supra* note 104, 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."); *see* Lynn 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 hand-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.").
[120] Kogut & Zander, *Combinative Capabilities*, *supra* note 1, at 398.
[121] Joanne E. Oxley, *Appropriability Hazards and Governance in Strategic Alliances: A Transaction Cost Approach*, 13 J.L. ECON. & ORG. 387, 393 (1997).
[122] Nickerson & Zenger, *supra* note 19, at 626; Grant, *supra* note 84, at 115-16.
[123] *See* Harold Demsetz, *The Theory of the Firm Revisited*, 4 J.L. ECON. & ORG. 141, 141 (1988); Gorga & Halberstam, *supra* note 19, at 1124; *but see* Nickerson & Zenger, *supra* note 19, at 617-18 (articulating tensions between competing knowledge based-theories of the firm).

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.[124]

In the knowledge-based theory of the firm, much of the value and competitive advantage of firms come from efficiencies in generating, transferring, and exploiting knowledge.[125] As Erika Gorga and Michael Halberstam argue, "Knowledge-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."[126] Similarly, as Bruce Kogut and Udo Zander argue, "In our view, firms are efficient means by which knowledge is created and transferred."[127] These knowledge-transfer efficiencies are particularly salient for tacit knowledge, which is intrinsically difficult to convey.[128] 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.[129] Economist David Teece's influential empirical analysis of 26 international technology transfer projects revealed that transfer costs comprised 19% of total project costs.[130] Such transfers entail particularly high information costs. Economists have long recognized that international technology transfer requires innovators to transfer tacit knowledge along with more formal and codified elements of technology.[131] The tacit nature of this knowledge renders it "slow and costly to transmit,"[132] even for technologies that inventors have disclosed in patents. The physical distance between technology inventors and adopters burdens international tacit knowledge transfer.[133] Additionally, difficulties of facilitating interpersonal interactions and differences in language, culture, educational backgrounds, and even measurement units all

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[124] 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 19, at 1133.
[125] Gorga & Halberstam, *supra* note 19, at 1125; *cf*. Demsetz, *supra* note 123, at 148; Grant, *supra* note 84, at 111.
[126] Gorga & Halberstam, *supra* note 19, at 1126-27.
[127] Bruce Kogut & Udo Zander, *Knowledge of the Firm and the Evolutionary Theory of the Multinational Corporation*, 24 J. INT. BUS. STUD. 625, 631 (1993) [hereinafter Kogut & Zander, *Multinational*]; *see* Nickerson & Zenger, *supra* note 19, at 623.
[128] Gorga & Halberstam, *supra* note 19, at 1145.
[129] Teece, *Technology Transfer*, *supra* note 107, at 242-43; Kogut & Zander, *Multinational*, *supra* note 127, 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.").
[130] Teece, *Technology Transfer*, *supra* note 107, at 247.
[131] Arora, *Contracting*, *supra* note 101, at 234; Teece, *Technology Transfer*, *supra* note 107, at 245.
[132] David J. Teece, T*he Market for Know-How and the Efficient International Transfer of Technology*, 458 ANNALS AAPSS 81, 83 (Nov. 1981) [hereinafter Teece, *Know-How*].
[133] *See* Gorga & Halberstam, *supra* note 19, at 1146 ("The transmission of tacit knowledge both within and between firms is facilitated by geographical proximity.").

complicate international technology transfer.[134] Technology transfer is particularly difficult from developed to developing countries, where transferees may require substantial tacit knowledge to assimilate a new technology.[135] In short, transferring tacit knowledge represents a major challenge of international technology transfer.[136]

The knowledge-based theory of the multinational firm posits that multinational corporations enjoy significant efficiencies in transferring tacit knowledge internationally.[137] 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.[138] Having technical personnel on the ground at foreign sites is particularly helpful to solve unexpected problems and adapt transferred technology.[139] Multinational corporations facilitate the shared context and repeat interactions that accelerate international tacit knowledge transfer.[140] Importantly, this may constitute "internal" transfer within a multinational firm that straddles national borders. As Teece notes, "the arm's 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."[141] 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.

PART 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

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[134] *See* Teece, *Technology Transfer*, *supra* note 107, at 255.
[135] Arora, *Licensing Tacit Knowledge*, *supra* note 118, 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").
[136] Martin & Salomon, *supra* note 129, at 360.
[137] *Cf*. *id*. at 367 ("Tacitness still places a premium on tight coordination between recipient and source, and beyond some point discourages knowledge transfer.").
[138] Teece, *Know-How*, *supra* note 132, 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 107, at 246.
[139] Teece, *Technology Transfer*, *supra* note 107, at 246.
[140] *See* Sazali Abdul Wahab et al., *Exploring the Technology Transfer Mechanisms by Multinational Corporations: A Literature Review*, 8 ASIAN SOC. SCI. 142, 144 (2012); Teece, *Know-How*, *supra* note 132, at 87 ("An 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 70, at 318 ("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 127, at 636 ("[F]irms specialize in the transfer of knowledge that is difficult to understand and codify.").
[141] Teece, *Know-How*, *supra* note 132, at 95.

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 coins 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. In sum, bounded entities solve two problems with respect to 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 protect 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.[142] Notably, patentees may "disclose" their inventions in a patent yet deliberately withhold invention-related trade secrets to maintain commercial advantage.[143] 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. 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 easily appropriable, codified information. 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 knowledge as trade secrets.[144] Trade secrets, however, encompass a much wider range of private information, including codified knowledge, such as confidential instructional manuals, experimental protocols, and manufacturing specifications. Unlike tacit knowledge, codified trade secrets are "sticky" not because they are intrinsically difficult to communicate. Rather, they are "sticky" because an innovator deliberately tries to keep 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 tacit knowledge. For ease of exposition, this discussion will focus on trade secrets

[142] *See* UNIF. TRADE SECRETS ACT §1(4); Defend Trade Secrets Act, 18 U.S.C. § 1839(3).
[143] Branstetter et al., *supra* note 54, at 324.
[144] 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 §1(4)(i).

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, thus eliminating its value.[145] 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.[146]

It is possible, of course, for a firm to license trade secrets to external entities via market exchanges.[147] In this sense, strong legal protection for trade secrets (like strong patent protection) can promote technology transfer.[148] However, constraining information leakage through internal physical and managerial controls is generally more effective than relying on trade secret law 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[149]—or third parties who may gain access to the information. In the language of the theory of the firm, this increased risk of misappropriation represents a transaction cost that imperils 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.[150]

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 featuring firm-like properties, including integrated firms, joint ventures, and "thick," long-term contractual relationships.[151] The defining characteristic of bounded entities is that participants are organizationally "bound" in some fashion—such as by permanent

[145] 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.
[146] Of course, internally transferred trade secrets are also susceptible to misappropriation, for instance by departing employees. Branstetter et al., *supra* note 54, at 324-25.
[147] *See, e.g.*, Metallurgical Indus. Inc. v. Fourtek Inc., 790 F.2d 1195 (5th Cir. 1986) ("We conclude that a holder may divulge information to a limited extent without destroying its status as a trade secret.").
[148] *See* James Pooley, *Trade Secrets: The Other IP Right*, WIPO MAGAZINE (June 2013), https://www.wipo.int/wipo_magazine/en/2013/03/article_0001.html.
[149] *See* Smith v. Dravo, 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).
[150] Gorga & Halberstam, *supra* note 19, at 1169 (noting that integrating production in-house rather than coordinating production through market transactions can prevent information spillovers).
[151] Oxley, *supra* note 121, at 388.

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

Beyond integrated firms, other forms of bounded entities also facilitate the transfer of tacit knowledge.[152] 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."[153] For example, joint ventures between two distinct entities also enjoy efficiencies in tacit knowledge transfer.[154] Furthermore, "thick" contractual relationships between long-term partners promote transferring tacit knowledge.[155] For example, "relational" contracts between long-term partners can facilitate significant interaction and organizational interpenetration.[156] Relatedly, networks—which may be structured by contracts—also facilitate significant tacit knowledge sharing.[157]

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 prevent spillovers to external parties.[158] 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.[159] "Thick," long-term contractual relationships, moreover, provide additional safeguards against knowledge leakage. Among other considerations, such organizational meshing increases each partner's ability to monitor the other's handling of confidential information.[160] Furthermore, dense relationships can contribute to a collective identity and align financial incentives, both of which motivate partners to share trade secrets with each other while discouraging leaking trade secrets to outside parties.[161]

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[152] 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.

[153] 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).

[154] Gorga & Halberstam, *supra* note 19, at 1203; Oxley, *supra* note 121, at 388.

[155] Naomi Lamoreaux et al., *Beyond Markets and Hierarchies: Towards a New Synthesis of American Business History*, 108 AM. HIST. REV. 404, 408 (2003).

[156] *See* Charles J. Goetz & Robert E. Scott, *Principles of Relational Contracts*, 67 VA. L. REV. 1089, 1091 (1981) (defining relational contracts as broad legal arrangements establishing a framework for business transactions without delineating all details); *id.* at 1093 (noting that relational contracts may allow principals to directly monitor and supervise agents' activities).

[157] *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 (1996); Jeffrey H. Dyer & Kentaro Nobeoka, *Creating and Managing a High-Performance Knowledge-Sharing Network: The Toyota Case*, 21 STRAT. MGMT. J. 345 (2000).

[158] *See supra* Part II.C.-D.

[159] Gorga & Halberstam, *supra* note 19, at 1149; Teece, *Know-How*, *supra* note 132, at 89.

[160] *Cf.* Goetz & Scott, *supra* note 156, at 1093.

[161] *See* Dyer & Nobeoka, *supra* note 157, at 351-52 (discussing Toyota's formation of a "network identity" among its suppliers and its ability sanction partners that do not share information); DOUGLASS C. NORTH, INSTITUTIONS, INSTITUTIONAL CHANGE, AND ECONOMIC PERFORMANCE 55 (1990); *cf.* ROBERT C. ELLICKSON, ORDER WITHOUT LAW: HOW NEIGHBORS SETTLE DISPUTES 184-206 (1991) (arguing that efficient norms, such as norms against

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.[162] In articulating this view, this Article reflects the influential (though contested) conception of the firm as a nexus of contracts.[163] Firms are a nexus 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.[164] 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.[165] Separate units within a bounded entity may actively conceal both tacit knowledge and trade secrets from each other due to internal competition.[166] Finally, internally transferred tacit knowledge and trade secrets may still be misappropriated, such as by departing employees.[167] 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 solve two problems with respect to transferring two 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 featuring intensive internal interactions and limited external interactions with outside parties.[168] 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

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breaching agreements, are most likely to arise in communities that are "close-knit" and in which members interact repeatedly).

[162] Lamoreaux et al., *supra* note 155, at 405.

[163] *See* 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 firm as a nexus of contracts).

[164] Pisano et al., *supra* note 153, at 195 ("On the surface, it can be difficult to distinguish arms-length and collaborative relationships.").

[165] Morten T. Hansen, *The Search-Transfer Problem: The Role of Weak Ties in Sharing Knowledge across Organization Subunits*, 82 ADMI. SCI. Q. 44 (1999).

[166] Anthony M. Marino & Ján Zábojník, *Internal Competition for Corporate Resources and Incentives in Teams*, 35 RAND J. Econ. 710, 711 (2004).

[167] *See* Branstetter et al., *supra* note 54, 324-25.

[168] *See* Simon, *supra* note 22; Smith, *supra* note 22, at 1761-66.

licensing their patents often form bounded entities to transfer tacit knowledge.[169] Licensee firms often hire faculty inventors as long-term consultants or bring them "in-house" as permanent scientific advisors.[170] Although patents themselves are supposed 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.[171] 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 leakage to competitors.[172] 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."[173] In sum, tight organizational linkages facilitate the transfer of both tacit knowledge and trade secrets between academic and industrial entities, even for inventions ostensibly disclosed in patents.

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 inventions to separate pharmaceutical companies.[174] Frequently, however, parties achieve such transfer through establishing a variety of bounded entities. One form of bounded entity involves vertical integration of biotech and pharmaceutical firms, thus combining invention and commercialization under one roof.[175] For example, biotech firms have integrated forward into drug manufacturing,[176] and large pharmaceutical companies routinely integrate backward by acquiring small biotech firms.[177] Among other advantages,[178] integration accelerates tacit knowledge transfer across the research-commercialization interface. Other types

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[169] 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)
[170] Lee, *Transcending*, *supra* note 107, at 1551-52
[171] *Id*. at 1549-51.
[172] *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. USA 12709, 12709-10, 12712 (1996); *id*. at 12714 ("[S]tar scientists embodying the break-through technology are the 'gold deposits' around which new firms are created or existing firms transformed.").
[173] *Id*. at 12709.
[174] Ashish Arora & Robert P. Merges, *Specialized Supply Firms, Property Rights and Firm Boundaries*, 13 INDUS. & CORP. CHANGE 451 (2004); Pisano et al., *supra* note 153, at 194.
[175] *Id*. at 194, 199-200 ("The organizational problems of transferring know-how can be overcome by vertical integration between R&D and manufacturing.").
[176] *Id*. at 197-98.
[177] *See* Peter Lee, *Innovation and the Firm: A New Synthesis*, 70 STAN. L. REV. 1431, 1455-66 (2018) [hereinafter Lee, *Innovation and the Firm*].
[178] *See id*. at 1462-63.

of bounded entities in the biopharmaceutical industry that similarly transfer tacit knowledge include joint ventures,[179] long-term contracts, and networks.[180]

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.[181] 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."[182]

PART IV. MULTINATIONAL BOUNDED ENTITIES AND INTERNATIONAL TECHNOLOGY TRANSFER

A. A Knowledge-based Theory of Multinational Bounded Entities

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.[183] This Article adds the dual insights 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.

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.[184] 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 secrecy agreements 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.[185]

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 subsidiary. Multinational firms also prevent

[179] Pisano et al., *supra* note 153, at 195.
[180] *Id*. at 200; Powell et al., *supra* note 157.
[181] Pisano et al., *supra* note 153, at 195-96.
[182] *Id*. at 195.
[183] *See supra* Part III.C.
[184] 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 129, at 360.
[185] Magee, *supra* note 70, at 333.

knowledge leakage and safeguard the sharing of trade secrets to foreign units.[186] Although subject to some limitations,[187] international joint ventures also facilitate the transfer of tacit knowledge and trade secrets across borders.[188] Additionally, "thick" cross-border contractual relationships, particularly between long-term partners, are multinational bounded entities that facilitate tacit knowledge exchange. Furthermore, organizational interpenetration often allows participants to monitor their partners' handling of sensitive information and align their financial interests, 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.[189] 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 entities.[190] A 2019 empirical examination of 160 multinational enterprises in 14 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.[191] International joint ventures were third, with 304 linkages.[192] International equity investments were fourth, with 205 linkages.[193] 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.[194] 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.[195] To provide a more textured account of multinational bounded entities, the next section turns to case studies of these entities operating in real-world contexts.

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[186] 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.
[187] Kogut & Zander, *Multinational*, *supra* note 127 , at 635.
[188] *See* Wahab et al., *supra* note 140, at 146.
[189] Edwin Mansfield & Anthony Romeo, *Technology Transfer to Overseas Subsidiaries by U.S.-Based Firms*, 95 Q. J. ECON. 737 (1980); Teece, *Know-How*, *supra* note 132, at 93; Kogut & Zander, *Multinational*, *supra* note 127, at 639.
[190] *See* UNCTAD, *supra* note 2, at 10 ("The bulk of technological dissemination is undertaken through internalized channels within the networks of [transnational corporations].").
[191] Andrea Andrenelli et al., International Technology Transfer Policies, OECD Trade Policy Papers, at 26 (2019).
[192] *Id*.
[193] *Id*.
[194] *Id*.
[195] *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.").

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, and affiliates.[196] This Article highlights the underappreciated fact that bounded entities are critical to transferring technical knowledge even for technologies that inventors have ostensibly disclosed in patents. Even more striking, bounded entities facilitate technology transfer even where 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[197] and patented the technologies underlying these vaccines around the world.[198] While these vaccines have saved countless lives, limited access to these essential resources has been highly controversial.[199] While vaccine access has improved considerably over the past two years, developing countries still have virtually no access to (patented) mRNA vaccines,[200] which are the most effective vaccines against the newest 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 international technology transfer, thus highlighting the role of 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.[201] The Biden administration took the surprising move of supporting a narrower version of the TRIPS waiver limited to patented COVID-19 vaccines.[202]

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[196] *See, e.g.*, Jeffrey H. Dyer & Kentaro Nobeoka, *Creating and Managing a High-Performance Knowledge-Sharing Network: The Toyota Case*, 21 STRAT. MGMT. J. 345 (2000); Jeoung Yul Lee et al., *Technological Knowledge Transfer within Chaebols after the 1997-98 Crisis*, 43 LONG RANGE PLANNING 585 (2010); Ramon Padilla-Perez, *A Regional Approach to Study Technology Transfer through Foreign Direct Investment: The Electronics Industry in Two Mexican Regions*, 37 RES. POL'Y 849 (2008).

[197] *See* Peter Lee, *Patents and the Pandemic: Intellectual Property, Social Contracts, and Access to Vaccines*, 17 WASH. J. L. TECH. & ARTS 193 (2022) [hereinafter Lee, *Pandemic*].

[198] Martin & Lowery, *supra* note 6, at 57.

[199] *See supra* notes 8-9 and accompanying text.

[200] Prabhala, *supra* note 9.

[201] India & South Africa, *supra* note 81.

[202] Katherine Tai, Statement from Ambassador Tai on the Covid-19 Trips Waiver, May 5, 2021; Thomas Kaplan et al., *Taking 'Extraordinary Measures,' Biden Backs Suspending Patents on Vaccines*, N.Y. TIMES (May 5, 2021).

After protracted negotiations, the WTO adopted such a limited waiver in June 2022.[203] Connecting to an earlier discussion, 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.[204]

Biopharmaceutical companies steadfastly opposed the TRIPS waiver, and in so doing they reveal the knowledge-based limitations of the patent-centric model of international technology transfer. Among various objections, vaccine patentees asserted that even if governments temporarily weakened patents, unauthorized manufacturers would be unable to produce COVID-19 vaccines without tacit knowledge and trade secrets from vaccine developers themselves.[205] Although vaccine developers have ostensibly disclosed their technologies in patents, significant tacit knowledge and trade secrets remained 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.[206] Before subsequently reneging on that pledge, it could (for a time) argue that its patents were not preventing generic manufacturing of its vaccine.[207] However, Moderna has refused to widely share its tacit knowledge and trade secrets for manufacturing its vaccine,[208] without which third parties have been unable to produce its vaccines in industrial quantities.

Tacit knowledge and trade secrets play an important role in the international transfer of patented COVID-19 vaccines.[209] 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."[210] Similarly, vaccine expert Alain Alsalhani from Doctors without Borders observed, "You need someone to share 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. This is why it's not just about a recipe, it's about an active and full

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[203] WORLD TRADE ORG., DRAFT MINISTERIAL DECISION, *supra* note 10.
[204] *See supra* Part I.B.
[205] 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; Stephanie Nolen, *Here's Why Developing Countries Can Make mRNA Covid Vaccines*, N.Y. TIMES (Oct. 22, 2021). Opponents of compulsory licenses have previously made this argument as well. *See* Delegation of the United States of America, Patents and Health: A Proposal by the Delegation of the United States of America 1 (Dec. 7, 2011), SCP 17/11.
[206] Moderna, Statement by Moderna on Intellectual Property Matters during the COVID-19 Pandemic (Oct. 8. 2020).
[207] Moderna, Moderna's Updated Patent Pledge (March 7, 2022), https://investors.modernatx.com/Statements--Perspectives/Statements--Perspectives-Details/2022/Modernas-Updated-Patent-Pledge/default.aspx; s*ee* Rebecca Robbins & Jenny Gross, *Moderna Sues Pfizer and BioNTech Over Covid Vaccine Technolog*y, N.Y. TIMES (Aug. 26, 2022).
[208] *See* Stephanie Nolen & Sheryl Gay Stolberg, *Pressure Grows on U.S. Companies to Share Covid Vaccine Technology*, N.Y. TIMES (Sept. 22, 2021) (detailing the Biden administration's frustration with Moderna for not transferring its technology widely to other vaccine manufacturers).
[209] Kaplan et al., *supra* note 202.
[210] W. Nicholson Price II et al., *Knowledge Transfer for Large-scale Vaccine Manufacturing*, 369 SCIENCE 912, 912 (2020).

tech transfer."[211] Transfer of private information—including tacit knowledge and trade secrets—is critical to the manufacture of patented COVID-19 vaccines.

Vaccine patentees decried the difficulty of transferring technical knowledge as a reason to oppose the TRIPS waiver. 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.

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.[212] 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. It also establishes a "closed" organizational environment that helps prevent leakage of trade secrets to outside parties.

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.[213] The agreement involved establishing manufacturing facilities at Lonza's sites, and it provided that technology transfer would start in June 2020.[214] 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."[215] In September 2021, Moderna announced a multi-year agreement with Canadian firm National Resilience, which will produce mRNA for Moderna's COVID-19 vaccine.[216] Similarly, this long-term partnership will facilitate significant tacit knowledge and trade secret exchange between its partners.

Pfizer and its partner BioNTech have also established multinational bounded entities in the form of thick contractual relationships to transfer mRNA vaccine technology abroad. 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

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[211] Nolen & Stolberg, *supra* note 211 (quoting Alain Alsalhani, Doctors without Borders).
[212] *See* Moderna, Moderna to Build State-of-the-Art mRNA Facility in Africa to Manufacture up to 500 Million Doses Per Year (Oct. 7, 2021); Moderna, Moderna and Australia Announce Collaboration to Bring mRNA Manufacturing to Australia (Dec. 13. 2021); Moderna, Moderna and Canada Announce Collaboration to Bring mRNA Manufacturing to Canada (Aug. 10, 2021).
[213] Moderna, Moderna and Lonza Announce Worldwide Strategic Collaboration to Manufacture Moderna's Vaccine (mRNA-1273) Against Novel Coronavirus (May 1, 2020) [hereinafter Moderna, Lonza]; Sydney Lupkin, *How Will Moderna Meet The Demand For Its COVID-19 Vaccine?*, NPR (Dec. 17, 2020).
[214] *See* Moderna, Lonza, *supra* note 213.
[215] Pisano et al., *supra* note 153, at 200.
[216] Moderna, Resilience to Manufacture mRNA for Moderna's COVID-19 Vaccine (Sept. 8, 2021); Matthew Herper, *Moderna Turns to Biotech Startup to Ramp up Covid Vaccine Manufacturing*, STAT (Sept. 8, 2021).

COVID-19 vaccine.[217] This collaboration features significant knowledge sharing between the two firms. Blurring the organizational boundaries between the two companies, Pfizer has taken a sizable equity stake in BioNTech.[218]

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.[219] 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 for injection to filling it into vials, labeling the vials, packaging them, and distributing them around the world.[220]

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.[221]

While, in theory, vaccine patentees have publicly disclosed their technologies, multinational bounded entities are crucial for transferring patented-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 distribution of easily appropriable trade secrets, such as codified vaccine recipes.[222]

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

[217] Pfizer and BioNTech Announce Further Details on Collaboration to Accelerate Global COVID-19 Vaccine Development, Bus. Wire (Apr. 9, 2020).
[218] *Id*.
[219] Pfizer, Shot of a Lifetime: How Pfizer is Partnering with CMOs to Increase COVID-19 Vaccine Production and Reach More People.
[220] *Id.*
[221] *Id.*
[222] Transfers within multinational bounded entities also prevent leakage of tacit knowledge. While tacit knowledge is to some extent naturally excludable, it is still capable of unauthorized appropriation. Such appropriation, moreover, is quite costly given the high value of tacit knowledge. Martin & Salomon, *supra* note 129, at 360.

The importance of multinational bounded entities to transferring technical knowledge abroad is also evident in the long-running U.S-China trade war.[223] 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,[224] this section 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 example of the centrality of multinational bounded 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."[225] This section 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.[226] 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."[227] Such "mandatory" JVs comprise one of the "most important sources" of forced technology transfer.[228]

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 embody cutting-edge technologies.[229] The high-speed rail industry illustrates the success of mandatory JVs in transferring leading technologies to China.[230] In 2004, China's Ministry of Railways tendered bids to produce high-speed train sets.[231] The Ministry required successful bidders to enter into JVs with China South Rail (CSR) and China

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[223] *See* Qin, *supra* note 13, at 743; Sykes, *supra* note 13, at 128; United States Trade Representative, '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', (22 March 2018) ('Section 301 Report'), https://ustr.gov/sites/default/"les/Section%20301%20FINAL.PDF.
[224] *See infra* note 289-296 and accompanying text.
[225] White House Office of Trade & Mfg. Policy, How China's Economic Aggression Threatens the Technologies and Intellectual Property of the United States and the World 5 (2018).
[226] *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); Qin, *supra* note 13, at 747; Hoekman et al., *supra* note 15, at 1591.
[227] Lee, *Forced*, *supra* note 14, at 332.
[228] The European Commission, WTO–EU's Proposals on WTO Modernization (July 5, 2018), http://src.bna.com/Aoe; Sykes, *supra* note 13, at 128; *see* Lee, *Forced*, *supra* note 14, at 331 ("[China's] most well-known FTT policy is to use foreign ownership restrictions to facilitate de facto technology transfer from foreign companies to their Chinese partners."). 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 226, at 150-52; Qin, *supra* note 13, at 745. 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.
[229] Prud'homme et al., *supra* note 226, at 150.
[230] Qin, *supra* note 13, at 751.
[231] Prud'homme et al., *supra* note 226, at 158, 165.

North Rail (CNR) and to transfer significant technology to them.[232] Three foreign-Chinese joint ventures won parts of the bid. A Japanese consortium led by Kawasaki partnered with Chinese firm Sifang to transfer technologies to subsidiaries of CSR.[233] Bombardier's German subsidiary also partnered with Sifang and transferred technologies to CSR.[234] Alstom, a French company, partnered with Chinese firm Changchun to transfer technology to CNR.[235] Illustrating the effectiveness of such technology 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."[236]

The inner workings of foreign-domestic JVs reveal their high capacity to transfer tacit knowledge and trade secrets.[237] 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.[238] While the first three trains were constructed at Siemens' German plant, the remaining 57 were built at CNR's Tangshan Locomotive and Rolling Stock Works plant in Hebei. As part of the JV, CNR sent over 1,000 technical staff members for training at Siemens' facilities in Germany.[239] Such in-person interactions are well suited for intensive transfer of private knowledge.

Mandatory JVs have also facilitated technical knowledge transfer in the alternative-energy automotive industry. In 2009, China promulgated Admittance Rules for New Energy Auto Manufacturing Companies and Products. These rules required that foreign firms seeking manufacturing licenses, government procurement deals, and public subsidies "must first 'master' 'core' [New Energy Vehicle] technologies with a JV with a local Chinese firm."[240] 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."[241]

In examining mandatory JVs in China, it is important to put these policies in context.[242] In some cases, foreign companies try to facially comply with mandatory JV rules while not transferring their leading technologies.[243] In the high-speed rail industry, for example, Alstom did not transfer its frontier rail technology to its Chinese partner.[244] Similarly, China has long

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[232] *Id*. at 165.
[233] *Id*. at 158.
[234] *Id*.
[235] *Id*.
[236] *Id*.
[237] 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 13, at 160.
[238] Prud'homme et al., *supra* note 226, at 158.
[239] *Id.*
[240] *Id.* at 153.
[241] *Id.* at 159.
[242] Qin, *supra* note 13, at 749 (noting that China has long pursued "market for technology" policies); Lee, *Forced*, *supra* note 14, at 330 (recounting how the United States has accused China of forced technology transfer for several decades).
[243] Prud'homme et al., *supra* note 226, at 160.
[244] *Id*. at 166.

required foreign-domestic JVs in the (traditional) automobile industry, but foreign companies have complied with these requirements while not transferring their most advanced technologies.[245] Finally, China has signaled a commitment to end some of its "forced technology transfer" policies, though critics are skeptical of reforms.[246]

Notably, multinational bounded entities such as foreign-domestic joint ventures transfer technology even when innovators try to 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 indefinitely.[247] The regulations also stipulated that technology transfer agreements involving joint ventures were limited to ten years.[248] So, for example, if a U.S. firm transferred a patented technology to a Chinese firm as part of a mandatory joint venture, 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, 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 joint ventures are organizational vehicles for transferring confidential information that foreign innovators would ordinarily protect as trade secrets.[249] 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.[250] To be sure, this dynamic represents a departure 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 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 joint ventures 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.

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[245] Qin, *supra* note 13, at 751.
[246] Lee, *Forced*, *supra* note 14, at 335-40; Keith Bradsher, *How China Obtains American Trade Secrets*, N.Y. TIMES (Jan. 15, 2020). For example, China's new Foreign Investment Law prohibits administrative entities from disclosing trade secrets of foreign investors. Qin, *supra* note 13, at 746. Critics argue, however, that these "prohibition" will simply allow these practices to persist in different form. Sykes, *supra* note 13, at 162.
[247] Regulations for the Implementation of the Law of the People's Republic of China on Sino-Foreign Equity Joint Ventures (promulgated by the State Council, Sept. 20, 1983, amended July 22, 2001, effective July 22, 2001), english.mofcom.gov.cn/article/lawsdata/chineselaw/200301/20030100064563.shtml.
[248] Office of the United States Trade Representative, Executive Office 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 54 (March. 22, 2018); Joint Venture Regulations, Art. 43(3).
[249] *See, e.g.*, Bradsher, *supra* note 246.
[250] Office of the United States Trade Representative, Executive Office of the President, *supra* note 248, at 28.

PART 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. However, where an invention requires significant private knowledge (including tacit knowledge and 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.

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,[251] 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.[252] In this context, patents can substitute for multinational bounded entities to transfer technologies. Under these conditions, for instance, older technologies or those that are relatively simple are well suited for patent-based transfer.[253]

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

[251] Kumar, *supra* note 43, at 212.
[252] *Cf. id*.; Hoekman, *supra* note 15, 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).
[253] Indeed, innovators are likely to patent particular inventions precisely because they are difficult to protect through secrecy. Arti Kaur Rai, *Regulating Scientific Research: Intellectual Property Rights and the Norms of Science*, 94 NW. U. L. REV. 77, 118 (1999).

bounded entities. Strong patent protection in the receiving country reduces the risk of unauthorized copying and will likely induce patent licensing by innovators. However, patent licensing alone will not be enough to transfer the technology. 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.[254] Relatedly, economists have shown how patentees can bundle together licenses for patents and patent-related tacit knowledge.[255] 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.[256] Such long-term, information-intensive exchanges represent another kind of multinational bounded entity.

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. However, to transfer patent-related trade secrets, an innovator may create a wholly owned subsidiary or joint venture with a foreign technology adopter.[257] 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.[258] 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, and it would also align the financial interests of the adopter to maintain secrecy. This, too, represents 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-term contractual relationship that facilitates the sharing of both tacit knowledge and trade secrets with its foreign partner.[259]

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 innovator seeking to transfer technologies abroad

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[254] *See* Wahab et al., *supra* note 140, at 145.
[255] Arora, *Licensing*, *supra* note 118, at 42; Hoekman et al., *supra* note 15, at 1589.
[256] 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.").
[257] Transfer within an organizational channel helps curb the leakage of not only codified trade secrets but also tacit knowledge. *See* Baranson, *supra* note 135, at 437 (observing that firms prefer direct investment when they fear that licensing will lead to the loss of valuable know-how).
[258] 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.
[259] *See* Lonza, Global Long Term Agreement (Sept. 4, 2020); *supra* notes – and accompanying text.

with the greatest risk of unauthorized appropriation. Weak patent protection[260] and the inability of an innovator to extract value from tacit knowledge or trade secrets may discourage it from transferring the technology at all. 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.[261]

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.[262] Although South Africa had adopted the TRIPS Agreement, it authorized generic manufacturing and parallel imports, thus creating a weak patent regime.[263] Furthermore, due to the public 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.[264] 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.[265]

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.[266] 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 of 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

[260] *See, e.g.*, Prud'homme et al., *supra* note 226, at 158 ("China's weak IP regime has discouraged transfer of frontier foreign technology to domestic firms.").
[261] *Cf*. Minyuan Zhao, *Conducting R&D in Countries with Weak Intellectual Property Rights Protection*, 52 MGMT. SCI. 1185, 1197 (2006).
[262] *See supra* notes – and accompanying text.
[263] *See supra* notes – and accompanying text.
[264] Jeffrey L. Fox, *Antivirals Become a Broader Enterprise*, 25 NAT. BIOTECH. 1395, 1396 (2007).
[265] *See supra* notes – and accompanying text.
[266] *Cf*. Prud'homme et al., *supra* note 226, at 153; Hoekman et al., *supra* note 15, 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").

"bounded" nature of multinational bounded entities can help safeguard the transfer of trade secrets abroad.[267]

While this analysis has focused on voluntary transfer, one variant of the "weak IP and significant private knowledge" scenario involves so-called forced technology transfer. This includes, for example, China's policy of mandatory JVs between foreign and domestic firms.[268] 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. A summary of the role of patent strength and the nature of knowledge to be transferred in determining international technology transfer channels appears in Figure 1.

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

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.[269] 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.[270] 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.[271] Additionally, firms also consider political risk and the availability of low-cost, high-skilled labor in determining whether and how to transfer technologies abroad.[272] Relatedly, another important consideration, which this Article will address below, is the absorptive capacity of receiving nations to assimilate foreign technologies.[273] 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.

[267] *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 it is easier to monitor and control the activities of partners in such arrangements than via arms-length contracts.").
[268] *See supra* notes – and accompanying text.
[269] Hoekman et al., *supra* note 15, at 1589; Watal & Caminero, supra note , at 5.
[270] Conversely, even if a jurisdiction has strong patent protection, firms may not transfer technologies there if the market is too small.
[271] Prud'homme et al., *supra* note 226, at 153.
[272] Hall, *supra* note 39, at 12.
[273] *See infra* Part VII.

PART VI. NORMATIVE ASSESSMENTS AND PRESCRIPTIONS FOR IMPROVING INTERNATIONAL TECHNOLOGY TRANSFER

This Article has augmented the dominant patent-based model of international technology transfer by exploring the underappreciated role of multinational bounded entities in effectuating such transfer. 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 determine 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

From the perspective of private parties, multinational bounded entities represent a valuable, if costly, alternative (or, sometimes, complement) to patent-based technology transfer. In some respects, multinational bounded entities fill important gaps in the patent system, which is ill-suited to directly transfer tacit knowledge and trade secrets between separate entities. Bounded entities enjoy significant efficiencies in transferring such private technical knowledge, particularly abroad. However, these gains must be weighed against efficiency losses from decreased specialization and the costs of managing large organizational complexes.[274] Returning to the classic theory of the firm, low transaction costs enable firms to disaggregate production among various actors via market-based transfers. This enables firms to specialize in particular functions, such as invention or manufacturing, in creating technological products.[275] However, multinational bounded entities, particularly those which are highly integrated, lose some of these benefits of specialization. Furthermore, while bounded entities economize on external transfer costs, they incur higher internal management costs. After all, administering large bureaucracies, coordinating joint ventures, and monitoring "thick" contractual relationships are all costly endeavors.[276] 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 informational 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.[277] 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.[278]

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[274] Pisano et al., *supra* note 153, at 202.
[275] *See supra* Part III.A.
[276] *Cf.* Coase, *supra* note 85, at 395 (discussing "diminishing returns to management" in large firms).
[277] *See generally* Brett M. Frischmann & Mark A. Lemley, *Spillovers*, 107 COLUMBIA L. REV. 257 (2007).
[278] Vrendenburg & Garcia, *supra* note 2, at 144; UNCTAD, *supra* note 2, at 15 (discussing "'islands of excellence' that do not contribute to the host country innovation system").

This critique of multinational bounded entities, however, is subject to two qualifications. First, due to appropriation risk, 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 outside parties in a receiving country. For example, FDI, which is one form of multinational bounded entity, generates positive externalities for receiving countries through "demonstration effects" and forcing local subcontractors to keep up with the latest foreign technologies.[279] In some ways, information really does want to be free. Employees of wholly owned subsidiaries move to local competitors and bring private knowledge with them,[280] foreign subsidiaries share knowledge with local vendors and distributors,[281] and foreign competitors eventually reverse engineer trade secrets. In the long run, the presence of multinational bounded entities promises to enrich the technical capacity of receiving countries.

In some cases, however, long-term diffusion of tacit knowledge and trade secrets takes longer than countries can 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.[282] However, these efforts would have occurred much earlier if researchers had direct access to Moderna's or Pfizer's tacit knowledge and trade secrets.[283] As discussed further below, governments can use other policy mechanisms, such as leveraging public R&D funds or even compulsorily licensing trade secrets, to unlock such private technical knowledge.[284]

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. As indicated above, market size is a significant factor in determining where such corporations transfer technologies.[285] Evidence suggests that among developing countries, multinational corporations focus transfer efforts on a handful of large countries, such as China, India, and

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[279] *See* Wahab et al., *supra* note 140, at 144-45; Hoekman et al., *supra* note 15, at 1588-89 (collecting and summarizing studies); M. Blomstrom & A. Kokko, How Foreign Investment Affects Host Countries, World Bank PRD Working Paper No. 1745 (1997); UNCTAD, *supra* note 2, at 12, 15.

[280] *See* Hoekman et al., *supra* note 15, at 1588 (discussing spillovers from local labor turnover); Sykes, *supra* note 13, at 146.

[281] Hoekman et al., *supra* note 15, at 1588-89.

[282] World Health Organization, Toward Africa's First mRNA Vaccines Technology Transfer Hub, Sept. 17, 2021, https://www.afro.who.int/news/towards-africas-first-mrna-vaccine-technology-transfer-hub; Amy Maxmen, *South African Scientists Copy Moderna COVID Vaccine*, 602 NATURE 372, 372 (2022).

[283] 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). However, widespread diffusion of tacit knowledge and trade secrets and 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.

[284] *See infra* notes – and accompanying text.

[285] *See supra* notes 269-271 and accompanying text.

Brazil.[286] Furthermore, the world's largest R&D spenders are concentrated in a few industries, notably IT hardware, automobiles, pharmaceuticals, and biotechnology.[287] From a social perspective, the benefits of multinational bounded entities are limited by geography and industry as opposed 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. While they drive significant wealth generation and knowledge transfer, they can also contribute to economic concentration, social inequality, and environmental degradation.[288] This Article focuses on just one dimension of multinational bounded entities' multifaceted impact on global welfare.

At this point, it 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.[289] This Article does not evaluate the legality of this policy, though at least one comprehensive analysis concludes that it does not clearly violate China's legal obligations.[290] Rather, it focuses on the welfare effects of so-called "forced technology transfer." Though U.S. firms complain about losing tacit knowledge and trade secrets, they continue to participate in joint ventures with Chinese partners, suggesting that doing so enhances their individual welfare.[291] More broadly, 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 interests), and the U.S. government strongly opposes China's policy.[292] On the other side of the ledger, individual Chinese firms gain considerably from appropriating foreign technologies through joint ventures. More broadly, China benefits as well—as long as such "restrictions" do not reduce foreign investment to an extent that outweighs their benefits.[293] As legal scholar Alan Sykes suggests, the global welfare effects are indeterminate. It is likely that "forced" technology transfer simply transfers surplus between firms and countries without diminishing overall welfare, and it may even increase overall efficiency.[294]

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[286] UNCTAD, *supra* note 2, at 11.
[287] *Id*. at 6.
[288] *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., 2019).
[289] *See infra* Part IV.B.2.
[290] Sykes, *supra* note 13, 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.
[291] Sykes, *supra* note 13, at 130; Hoekman et al., *supra* note 15, at 1591 (noting that overly strict investment restrictions will prevent foreign investment).
[292] Sykes, *supra* note 13, at 142-48. Even if China abandoned this policy, China could (legally) restrict foreign investment in other ways, such as taxes or fees for licenses to invest, which could also harm foreign investors. *Id*. at 142-42.
[293] *See id*. at 130; Hoekman et al., *supra* note 15, at 1591.
[294] Sykes, *supra* note 13, at 131, 154-55.

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. It bears emphasizing that developing countries routinely utilize foreign ownership restrictions or mandatory joint venture requirements for foreign investment.[295] 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.[296]

B. Prescriptions for Improving International Technology Transfer

While this Article primarily aims to describe and analyze the role of bounded entities in international technology transfer, this examination also suggests several policy reforms for improving such transfer. Enhancing technology transfer implicates dozens of policy levers, ranging from increasing immigration to reforming antitrust laws,[297] a full exposition of which far exceeds the scope of this Article. 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 patent-based transfer and involuntary compulsory licensing in times of significant public need. 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 the need to invest in the capacity of receiving countries to absorb foreign technology and technical knowledge.

1. Enhancing Patent Disclosure and Bolstering Patent-based and Involuntary Transfers

One of the implications of this study is 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.[298] To help remedy this state of affairs, this Part first suggests raising the disclosure requirements of patentability. Increased disclosure would enhance the effectiveness of both voluntary and involuntary patent-based transfer.

The patent system is often characterized as a quid pro quo in which inventors disclose novel technologies in exchange for exclusive rights.[299] Indeed, one of the key functions of patent law is to incentivize the codification of private knowledge, including tacit knowledge and trade

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[295] Teece, *Know-How*, *supra* note 132, at 88; *see also* Qin, *supra* note 13, at 752; Lee, *Forced*, *supra* note 14, at 341-42 (noting that developing countries have used "trade-technology-for-market" policies since the 1970s).
[296] *See supra* notes 37-39 and accompanying text.
[297] *See generally* Hoekman et al., *supra* note 15.
[298] *Cf.* Wahab et al., *supra* note 140, 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. 76 (1995) (suggesting that licensing is the more appropriate transfer mode for less complex technologies).
[299] *See, e.g.*, Universal Oil Prods. Co. v. Globe Oil & Refining Co., 322 U.S. 471, 484 (1944).

secrets.[300] 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.[301] As patents on COVID-19 vaccines illustrate, however, an inventor can patent a technology while not disclosing valuable tacit knowledge and trade secrets.[302] Such nondisclosure offends the quid pro quo at the heart of the patent system,[303] and it undermines the adequacy of patents themselves (along with general information sources) to convey the technical information necessary to practice patented inventions.

To increase patent disclosure, this Article proposes rehabilitating the "best mode" requirement of patentability in U.S. patent law. This requirement mandates that a patent applicant disclose any specific techniques and instrumentalities known to the applicant as the best way of practicing an invention.[304] 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.[305] For example, if an inventor seeking to patent a COVID-19 vaccine knew of the best way to manufacture that vaccine, the best mode requirement would compel disclosure of this knowledge.

Ironically, the best mode requirement is currently a requirement of patentability in the United States, but it is rarely enforced.[306] Concerns that the best mode requirement increased the cost and complexity of patent litigation motivated legislative reforms that render it largely toothless.[307] However, these concerns are likely overstated, and requiring disclosure of a best mode may actually decrease the cost and complexity of litigation in some cases.[308] 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.[309] However, such a reform would be unnecessary given that patentees worldwide routinely secure U.S. patent protection for commercially significant inventions. A strengthened best mode requirement in U.S. patent law would help compel patentees to publicly disclose tacit knowledge and trade secrets for most effectively practicing their inventions.[310]

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[300] Burk, *supra* note 112, at 1012.
[301] 35 U.S.C. § 112.
[302] *See supra* Part IV.B.2; *see supra* note 113.
[303] *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.").
[304] Chemcast Corp. v. Arco Indus., 913 F.2d 923 (Fed. Cir. 1990).
[305] 35 U.S.C. § 112.
[306] *Id.*
[307] Love & Seaman, *supra* note 303, 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 unenforceable a patent. 35 U.S.C. § 282(b)(3)(A).
[308] Love & Seaman, *supra* note 303, at 16-18.
[309] Importantly, the TRIPS Agreement allows countries to require disclosure of a best mode. TRIPS art. 29.
[310] *Cf.* Application of Gay, 309 F.2d 769, 772 (C.C.P.A. 1962) ("[The] 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").

Of course, purely tacit knowledge is not capable of codification and would presumably fall outside the scope of a rehabilitated best mode requirement. Furthermore, an overly stringent best mode requirement may force inventors to engage in costly and unnecessary disclosures or cause them to forego patenting altogether in favor of trade secrecy.[311] 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,[312] but they have not publicly disclosed that information in patents. Under this proposal, if they possessed such knowledge at the time of patent filing, they would be compelled to disclose it.[313]

Enhanced patent disclosure would increase the efficacy of patent-based technology transfer.[314] 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.[315]

Importantly, enhanced patent disclosure would also increase the efficacy of involuntary technology transfer. As noted, TRIPS provides for flexibilities that allow countries to weaken patents in times of urgent need.[316] 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.[317] Critics contend that compulsory licenses are difficult to grant and may result in political backlash from powerful players.[318] 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.[319] This dynamic is painfully evident in the controversy over the

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[311] Lee, *Transcending*, *supra* note 107, at 1559-60.
[312] Price II et al., *supra* note 210, at 913.
[313] The current best mode requirement applies as of the date of filing a patent application. However, inventors gain much knowledge about their inventions throughout patent prosecution and commercialization. Jeanne C. Fromer, *Dynamic Patent Disclosure*, 69 VAND. L. REV. 1715, 1718 (2016). 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. 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.
[314] Bingbin Lu, *Best Mode Disclosure for Patent Applications: An International and Comparative Perspective*, 16 J. INTELL. PROP. RIGHTS 409, 415 (2011) (noting that a robust best mode requirement would ensure that developing countries access patented technologies from developed countries "with sufficient and valuable information).
[315] *See* Carolyn C. Cooper, *Nineteenth-Century American Patent Management as an Invisible College of Technology*, *in* LEARNING AND TECHNOLOGICAL CHANGE 40, 40 (Russ Thompson ed., 1993); MERGES & DUFFY, *supra* note 26, at 247.
[316] *See supra* notes – and accompanying text.
[317] *See supra* notes – and accompanying text.
[318] Public Citizen, Existing TRIPS "Flexibilities" Unworkable for Necessary Scale Up of COVID-19 Medicines Production 4 (2021).
[319] Maskus, *supra* note 39, 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").

TRIPS waiver for patented COVID-19 vaccines.[320] However, greater codification of tacit knowledge and trade secrets in publicly accessible patents 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

In some cases, however, multinational bounded entities will remain necessary or preferred vehicles for international technology transfer. 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 leakage of valuable trade secrets. It bears emphasizing that increasing the disclosure obligations of patentability may shunt some innovators into protecting more of their patentable technologies as trade secrets instead. Accordingly, this section explores various policy levers to increase the effectiveness of multinational bounded entities.

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.[321] 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.[322]

While receiving countries clearly benefit from incoming technology transfer, transferor countries sometimes seek to increase outgoing transfer. For instance, early in the COVID-19 pandemic, President Biden committed the United States to serving as the "arsenal of vaccines" for the world.[323] 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. The government can leverage 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.[324] 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

[320] *See supra* notes – and accompanying text.
[321] Hoekman et al., *supra* note 15, at 1590-91, 1594.
[322] UNCTAD, *supra* note 2, at 18-20.
[323] Joseph R. Biden, Jr., 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/; *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 (March 3, 2022).
[324] Stephanie Baker & Cynthia Koons, *Inside Operation Warp Speed's $18 Billion Spring for a Vaccine*, BLOOMBERG BUSINESSWEEK (Oct. 29, 2020).

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.

On a related note, governments should also have greater flexibility to access private knowledge held by multinational bounded entities in times of public need.[325] Existing law recognizes that exigent circumstances can justify compulsorily licensing patents. In similar fashion, this Article argues that exigent circumstances should justify public disclosure of certain forms of private knowledge. While compulsory licensing of purely tacit knowledge is unworkable because of the need for direct interpersonal interaction, the same is not true 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.[326] Furthermore, scholars have suggested that compulsory licensing of trade secrets is not prohibited under international law, including TRIPS.[327] While multinational bounded entities serve a valuable function in guarding trade secrets, sometimes national imperatives justify at least limited forms of disclosure.

Beyond providing funding, national and international authorities can directly establish multinational entities to 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.[328] Rather than being a passive repository of information, C-TAP facilitates active interactions between technology generators and adopters. One of the implementing elements of C-TAP, the Tech Access Partnership "facilitates connections between experienced manufacturers and local manufacturers in developing countries to share key data, knowledge and other relevant support through a coordinated network."[329] Additionally, as noted, the WHO, COVAX, and a consortium of African countries have established a technology transfer hub for mRNA vaccines based in South Africa.[330] Currently, this hub is actively transferring technical know-how to manufacture mRNA vaccines to six African countries.[331]

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

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[325] *See supra* notes 74-75 and accompanying text.
[326] *See, e.g.*, Christopher Morten, Publicizing Corporate Secrets for the Public Good (forthcoming U. Pa. L. Rev.); Christopher 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 (2021).
[327] 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, 1249-51 (2021).
[328] World Health Organization, WHO COVID-19 Technology Access Pool. https://www.who.int/initiatives/covid-19-technology-access-pool.
[329] United Nations, Tech Access Partnership, https://www.un.org/technologybank/tech-access-partnership.
[330] World Health Organization, Toward Africa's First mRNA Vaccines Technology Transfer Hub, Sept. 17, 2021, https://www.afro.who.int/news/towards-africas-first-mrna-vaccine-technology-transfer-hub.
[331] Roelf Wendell & Alexander Winning, *African Countries to Get mRNA Vaccine Technology in WHO Project*, REUTERS.COM (Feb. 18, 2022).

foreign entities to receive it. 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.[332] Absorptive capacity, however, is a broad concept that can apply to an individual, firm, or even an entire country. 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."[333] Enhancing the absorptive capacity of receiving countries (and firms in those countries) is a complex policy task involving shoring up domestic R&D programs, educational systems, and the technical training of local scientists and engineers.[334]

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.[335] 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. Strengthening patents serves their own interests, but developed countries also argue that strong patents promote international technology transfer and benefit developing countries as well. 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. 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 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.[336] 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 indigenous innovations. 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.

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[332] Cohen & Levinthal, *supra* note 23.
[333] Hoekman et al., *supra* note 15, at 1588; UNCTAD, *supra* note 2, at 18; *see also* Baranson, *supra* note 135, at 435.
[334] Hoekman et al., *supra* note 15, at 1588, 1590.
[335] *See supra* Part I.
[336] *Cf.* Vrendenburg & Garcia, *supra* note 2, at 143 ("There is no doubt that most developing countries lack capacity withing their educational institutions to absorb the transfer of technology.").

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, 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—compared to transferring such knowledge to external parties. It has expanded upon the knowledge-based theory of the firm in two ways to articulate a broader knowledge-based theory of bounded entities. First, it has argued that firms also promote the transfer of trade secrets by preventing the external leakage of secret information. 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 "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 private or public nature of knowledge to be transferred help determine preferred transfer channels. In some cases, patents and bounded entities are substitutes, and 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 voluntary and involuntary technology transfer 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 to foster the conditions most conducive to robust international technology transfer.