The Evolution of Intellectual Property Protections in the People’s Republic of China: Is there an Enforcement Problem?

William McGuire, University of Washington - Tacoma Campus
Michael Wotherspoon, University of Washington - Tacoma Campus

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The Evolution of Intellectual Property Protections in the People’s Republic of China: Is there an Enforcement Problem?

Michael Wotherspoon†
William McGuire‡

Abstract: Since the opening of China’s economy in 1978, a near constant stream of intellectual property rights (IPRs) disputes have arisen between China and its major trading partners. As China has become the world’s largest exporter, and the developing world’s largest recipient of foreign direct investment (FDI), the protection of IPRs has become a topic of interest among scholars. Although on the books China’s IPR laws are on par with those found in the developed world, their enforcement of these laws has been lax and uneven. The literature commonly attributes China’s low IPR enforcement to weak institutions and frames it as a problem that has harmed China’s development. However, this paper takes an alternative view. It argues that, when choosing a level of IPR protection, Chinese policymakers have been responsive to three forces that all have a stake in China’s IPR policy. In order to formulate IPR policies that maximize China’s general welfare, policymakers must balance the desires of foreign governments, foreign firms, and domestic actors. Yet, these interests often conflict, and over the last thirty-five years the balance of power among these forces has shifted. As a result, Chinese policymakers have changed how responsive they were to each of these three forces, leading to changes in IPR policy. It is presumptuous to classify China’s low IPR enforcement as a problem, as so many have. Rather, it may be a delicate balancing act designed to bring the greatest benefit to China.

I: INTRODUCTION

The protection of intellectual property rights (IPRs) in China has been a topic of hot debate since the opening of China’s economy in 1978. IPRs have featured prominently in the often tense U.S. – China diplomatic negotiations, which had a tendency to result in exchanges of

† B.A. in Law and Policy expected 2014, University of Washington Tacoma. Michael Wotherspoon would like to thank Cory Black, Jerrod Arkins, and Mattias Leino for their input and editing expertise.
‡ William McGuire is an Assistant Professor of Economics at the University of Washington Tacoma.
It is often claimed that China has a problem with the protection of IPRs and that these “failed” IPR policies hurt Chinese and foreign citizens alike. However, this paper takes an alternative view. It recognizes that the aggregate level of enforcement in China is low; however, it argues that the current level of IPR protection represents an effort to maximize welfare as Chinese policymakers respond to several distinct sets of actors that all have a stake in IPR policy. Rather than poor enforcement being the result of weak institutions, it may be the result of policymakers striking a balance between the competing objectives of these multiple stakeholders. Recognizing the reasons behind China’s resistance to strong IPR protection can provide insight that negotiators in the U.S. can use to reformulate their strategies and promote enforcement of IPR in China more effectively.

Over the last thirty-five years, China has rapidly developed a framework for the protection of IPRs, ascended to many international IPR agreements, and engaged in diplomatic negotiations with foreign governments over IPRs. However, it has not exclusively been international forces that influenced IPR reform. For example, a growing number of domestic innovators began to call for stronger IPR protections, contrary to the desires of those working in China’s imitative industries. We can classify the interest groups attempting to influence China’s IPR laws into three broad categories: 1) foreign governments, 2) foreign firms, and 3) domestic actors. To varying degrees, these forces have exerted influence over the formulation of IPR policy and contributed to the rapid, but very uneven development of IPR protections in China.

Throughout China’s history of IPR reform, numerous events changed the influence these three forces have exerted over China’s IPR policy. Government efforts to attract more foreign direct investment (FDI), changes in industry-composition, their ascension to the World Trade

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Organization (WTO) in 2001, and the U.S. – China WTO dispute over IPR protections between 2007 and 2009 all changed how these forces interacted with each other. The course that IPR reforms in China have taken can be explained largely in terms of how responsive Chinese policymakers were to each of these three forces.

In section two, we explain how IPRs are an important policy instrument that can be used to produce economy-wide effects. In this section, we also explore the various channels through which these three forces can exert influence over IPR policy. In section three, we provide an overview of China’s current framework of IPR protections as well as the ways in which they have progressed over time. In section four, we take the history of IPR reform and put it into context, explaining how the three forces have influenced IPR reform in China and contributed to its uneven development. In section five, we conclude.

II: WHY ARE INTELLECTUAL PROPERTY RIGHTS IMPORTANT?

IPR policies provide the legal protections that are necessary to provide incentive for innovators to develop new technologies, for musicians to write their greatest hits, and multinational corporations (MNCs) to bring products and business expertise to new markets. The rationale behind protecting IPRs is simple: Without adequate protection, innovators will be unable to compete against imitators who can produce innovated goods without sinking the initial innovation costs. By granting innovators a temporary monopoly over their products, IPRs obstruct the entry of imitators, allowing innovators a chance to cover their development costs and earn a profit. This rationale is the cornerstone for the argument that a country should adopt a strong IPR regime. However, this rationale is not as applicable in the context of a globalized, integrated world, in which innovators participate in many different markets covered by myriad IPR regimes.

In an effort to harmonize IPR protections across the globe, the WTO adopted the agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPs), creating a minimum level of protections that WTO member countries must extend to intellectual property (IP). Yet, the heated discussions during the TRIPs negotiations between countries of the developed global North and countries of the developing global South illustrated that there was much controversy over whether or not setting a global standard for IPR protections was in the

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South’s best interests. Proponents of IPR reform in the North argue that greater IPR protection would facilitate faster technology transfer, more innovation, and greater investment in new and existing projects.\(^6\) However, economists have often challenged the claim that strong IPR protections are always optimal for the South.\(^7\) The issue is more complex than the global IPR proponents of the developed world have led us to believe. The South may enhance its own economic welfare by adopting an IPR regime that is less stringent than what the North demands. However, what actually constitutes a welfare enhancing policy is determined by the relative importance of each of the three forces mentioned in section one.

A. **Who Influences Intellectual Property Policy?**

Three main groups exist that exercise influence over the formulation of IPR policy in the South. First, Southern policy makers must consider the responses of *foreign governments*. Following the literature, we will categorize governments as either Southern or Northern in the following discussion. In response to a high degree of IPR protection in the South, Northern governments may provide greater subsidies to their firms, leading to an increase in research and development (R&D) expenditure. Alternatively, if IPR protections in the South are below what the North desires, Northern policymakers may threaten the use of tariffs and non-tariff barriers (NTBs) in order to persuade the South to adopt a higher level of IPR protections.

Second, Southern policymakers must consider how changes in IPR policy may alter the investment and trade behavior of *foreign firms* that do business with the South. Stronger protections can increase the product variety available to Southern consumers by skewing the range of innovated goods and services from Northern firms towards the preferences of Southern consumers.\(^8\) If IPRs are strong and the risk of imitation is low, Northern firms may license their technology to Southern firms and technology transfer will occur through commercial channels. Furthermore, if IPRs sufficiently reduce the risk of employees disseminating the trade secrets, know how, and technology from Northern firms to their Southern competitors, then Northern firms may find it attractive to engage in FDI by moving their production operations to the South.

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Yet, if the gains from imitation are particularly high, and its impact on Northern R&D expenditure is sufficiently low, the South may intentionally set IPRs low so that they can maximize imitation and absorb technology.

Finally, Southern policymakers must consider the effects that their policies will have on *domestic economic actors*. IPR policy can incentivize domestic innovation and stimulate domestic expenditures on R&D. It can also increase the range of products available to Southern consumers. Yet, raising the level of IPR protections can drive imitating enterprises out of business, which can reduce welfare for some Southern citizens. Furthermore, using IPR policy to attract FDI can provide cheaper products to Southern consumers, but it also puts competitive pressure on domestic firms and drives down their profit margins. Figure one summarizes the various ways through which these three forces exert influence over the formulation of IPR policy.

[Insert Figure One Here]

IPRs, both strong and weak, can be a powerful tool used to produce economy-wide effects. At the same time, globalization has made the determination of the optimal level of IPR protections more complex. While weak IPRs can make innovation unprofitable in one country, that same innovator may be able to earn sufficient profit in a different country to cover innovation costs. The complex dynamics of IPR protections in a global, integrated economy create a multitude of channels through which these three forces exert influence over IPR policy.

B. *Innovation*

It has been long been held that the South can strengthen their IPR protections in order to leverage more innovation out of the foreign firms from the North. A strengthening of IPR laws makes Northern firms more confident that their IP will be protected resulting in an increase in Northern R&D expenditure and with that, a higher likelihood of successful innovation. IPR policy can also alter the types of products that the North innovates. By strengthening IPR protections, the South can skew the range of goods and services innovated by Northern firms towards the preferences of Southern consumers as these firms now have a greater incentive to

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9 See, id. at 28, see generally also, Helpman, supra note 7.
serve the Southern market. More innovation in the North can lead to higher-quality products for Southern consumers as well as more efficient technologies for Southern firms. However, the South’s IPR policies do not only stimulate innovation in the North, they can stimulate innovation and investment in R&D from Southern economic actors as well.

Yet, stronger protections do not always incentivize more innovation. If the length of time that IPRs protect innovations is too long, then it will decrease competitive pressure and reduce innovation due to the fact that innovative firms are no longer constantly introducing new products to stay one step ahead of imitators. In order to maximize innovative activity, Southern policymakers must make sure that IPR policies are strong enough to allow innovators to earn a profit, but not so strong that they begin to reduce the incentive to innovate.

Innovation pushes the technological frontier and allows the South to advance technologically, but protecting innovation with IPRs subjects Southern consumers to monopoly pricing. IPRs grant innovators a temporary monopoly over their products, and prevent imitators from entering the market. Because imitators can provide innovated goods cheaper than the innovator can, there exists a tradeoff: short term consumer loss for a gain in product quality and variety. Welfare maximizing IPR policies must strike a balance between the gains from innovation and the losses from monopoly pricing. When the benefits generated by innovation outweigh the consumer loss from artificially higher prices, stronger IPR protections may be warranted. However, gains from innovation and losses from monopoly pricing are not the only factors that policymakers need to consider.

C: Technology Transfer

Technology transfer allows Southern countries to adopt the specialized knowledge and advanced technology utilized by Northern firms. Successfully transferring technology and knowledge has the potential to produce economy wide effects and is an important factor that Southern policymakers must consider when formulating smart IPR policies. Facilitating more technology transfer can lead to greater productivity for the South’s domestic firms and can

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11 Diwan & Rodrik, supra note 8, at 34.
12 Yongmin Chen & Thitima Puttitanun, Intellectual Property Rights and Innovation in Developing Countries 78 JOURNAL OF DEVELOPMENT ECON. 474, 482 (2005).
14 Deardorff, supra note 5, at 38.
enhance their technological capabilities. It can accelerate development and introduce consumers to previously unavailable goods. Technology transfer can take several forms, each one affected differently by IPR policies.

1. Reverse Engineering

Reverse engineering, i.e. imitation, is a common way that Southern firms can facilitate technology transfer but in doing so it creates a disincentive for Northern firms to innovate. In contrast to innovation, reverse engineering allows Southern firms to free-ride off of Northern firms, and increase their productivity by tapping into the knowledge and technology embodied in Northern products. Imitation increases the availability of cheaper products for Southern consumers, but it reduces the South’s share of production in innovative goods because more resources are devoted to imitation. Additionally, a certain degree of economic inefficiency is endemic to technology transfer through imitation. Northern firms will try to increase the cost of imitation by making their products increasingly difficult to imitate, allocating resources to the development of product masking techniques. In response, imitative firms in the South will allocate resources to try and unlock these products for imitation by overcoming these masking methods. Imitation can facilitate technology transfer, but in the process it misallocates valuable resources that could have been put to better use. When the gains from imitation outweigh the costs of misallocated resources and reduced innovation, Southern policymakers act appropriately in setting low IPR protections.

2. Foreign Direct Investment Spillovers

The term spillover refers to the various ways that MNCs engaging in FDI improve the competitiveness of Southern firms. FDI familiarizes Southern workers with new technologies, managerial processes and production expertise, all of which improve the South’s overall competitiveness; however, this transfer often occurs without the consent of the foreign firm

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15 See generally, e.g., Chen & Puttitanun, supra note 12.
18 Masking techniques raise the costs and difficulty of imitation. They consist of tangible methods such as encrypted coding and intangible methods such as a corporation’s legal branch that files imitation lawsuits.
19 Taylor, supra note 16, at 629.
operating in the South. Designing IPR policy to maximize spillovers is not as simple as trying to maximize technology transfer from reverse engineering. When encouraging FDI and maximizing spillovers, a delicate balance must be struck. If IPR protections are too low, spillovers will be too large and foreign firms will decide to export their goods instead of engaging in FDI. If IPR protections are too strong, then the potential for spillovers will be low, and foreign firms will choose to license their technology to Southern firms instead of partaking in FDI.

3. Technology Licensing

Technology licensing is a market-facilitated way for Northern firms to transfer their technology to Southern firms. It has long been held that an increase in IPR protections induces more licensing of technology from Northern firms to Southern firms. There is a threshold level of IPR protections above which Northern firms will decide to license technology. Below this level, Northern firms will decide either to export or engage in FDI. If policymakers decide that technology licensing is the most appropriate form of technology transfer, then they must be sure that IPR protections are strong enough to deter imitation of the licensed technology in order to make Northern firms feel comfortable licensing it to Southern firms. Licensing deepens the international division of labor, making more Northern labor available to conduct R&D, an area where the North enjoys a comparative advantage over the South. Southern labor is then allocated to the production of goods produced using licensed technology, an area where the South enjoys a comparative advantage over the North. Because technology licensing requires the strongest IPR protections out of the three forms of technology transfer, the gains from imitation must be lower than the gains from technology licensing before policymakers should tailor IPR policies to promote more licensing.

1 Alireza Naghavi, Strategic Intellectual Property Rights Policy and North – South Trade 143 REVIEW OF WORLD ECON. 55, 63 (2007).
22 See id. at 75.
24 See, Naghavi, supra note 21 at 75.
25 See generally id.
D: Policy Negotiations

The response of Northern governments to the IPR policies adopted by the South is another factor that Southern policymakers must always be mindful of. Through numerous channels, policy negotiations between the governments of Northern and Southern countries can exert considerable influence over the South’s IPR policies. The South can increase IPR protection in order to induce Northern governments to increase the amount of subsidies that Northern firms receive, resulting in greater expenditures on R&D and greater productivity enhancements from technology transfer. Alternatively, if Southern policymakers set IPR protections too low, then the North may impose tariffs and NTBs on Southern goods as a way to pressure the South into increasing their level of protection.

TRIPs was adopted with the conclusion of the Uruguay Round of WTO negotiations, mandating a minimum level of IPR protections for all WTO member states. In many cases, this mandated minimum level of protection is above the level that lower and middle-income countries would have preferred to set independently. Yet, the widespread acceptance of TRIPs by the South poses an interesting question: why did the South adopt TRIPs in the first place? Recall that when the optimal level of IPR protection in the South is low, the North can sweeten the deal by providing concessions to the South to entice them to adopt stronger IPRs. This is exactly what occurred, and the adoption of TRIPs hinged on the North offering greater market access and technology transfer for Southern producers. It is unlikely that the North would ever have convinced the South to adopt TRIPs without these concessions.

Southern countries who seek WTO membership post-Uruguay Round face a trade-off. On the one hand, WTO membership requires them to abide by TRIPs which can potentially require them to adopt a level of IPR protection that is otherwise above their optimum. On the other hand, WTO membership increases trade flows for the Southern country because it grants them access to the world market through reciprocal trade liberalization. This translates into lower tariffs on

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domestic exports and cheaper goods for Southern consumers due to an increase in imports. Given the increasing representation of the global South in the WTO, many Southern governments have clearly found that the latter effect of access to the world market sufficiently compensates for the costs of increasing IPR protections.

A multitude of channels exist through which IPR policy can bring benefits to the South. Yet, these benefits are not always greater with stronger IPR protections. Economic benefit can be derived from weak IPR protections as well. In order to formulate smart policy, Southern policymakers must consider all of the various channels through which IPR policy facilitates welfare gains. These channels originate from three main groups. Foreign governments, foreign firms, and domestic economic actors all exert influence over the formulation of IPR policy. Yet, all these groups have different interests which can often conflict with each other. Some may want strong protections, while others may prefer weak protections. Southern policymakers are left to perform a delicate balancing act: Whatever IPR policy the South adopts reflects the relative strengths of the influences that these three groups exert on Southern policy makers.

III: CHINA’S INTELLECTUAL PROPERTY PROTECTIONS

We can use the theoretical framework outlined in section two to understand the evolution of China’s IPR laws. Following the opening of their economy in 1978, China began to rapidly develop a modern framework of IPR protections. China acceded to a plethora of international IPR agreements, promulgated legislation regarding all the major types of IP, and supplemented these with regulations to expedite their implementation. Today, China’s IPR protections, as they stand on the books, are on par with those of developed countries. This is due, in no small part, to the fact that China modeled their IPR legislation after the rules and norms found in the international IPR agreements they ascended to. Indeed, the problem that IP holders run into in China today is not with the substance or coverage of their laws, but instead with their enforcement.

Trademarks, patents, copyrights, and trade secrets are all a form of intellectual property, and represent valuable intangible assets for firms. Trademarks represent a signal of quality to

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31 See CHOW, *supra* note 1, at 424.
32 See Yang, *supra* note, 3 at 138.
33 See CHOW, *supra* note 1, at 424.
consumers, distinguishing brands and producers from one another. Patents represent ownership of some new innovative process or technology, while copyrights represent some form of artistic or literary work. Trade secrets encompass any confidential business information that can confer a competitive advantage to those who possess it. IPRs embody ownership of knowledge, and firms and governments accumulate these forms of intangible capital in order to achieve certain economic objectives.

A: Trademark Protections

China’s first IPR legislation was the Trademark Law of the People’s Republic of China (hereinafter China’s Trademark Law), which came into force in 1982, accompanied by regulations for its implementation in 1983. In China, trademark holders are entitled to the exclusive use of their trademark, allowing solely them to determine how their trademark is used. Protection of this exclusive right lasts for a period of ten years, and includes the ability to renew status as a trademark for an additional ten years following the expiration of the initial protection period. China’s Trademark Law includes an appeals process. Decisions regarding trademark applications are made by the Trademark Review and Adjudication Board; however, if an applicant is unsatisfied with a decision by the board, they may file a suit with a People’s Court. The law was amended in 1993, tightening protections of trademarks, raising administrative fines that can be levied on infringers, and allowing judges to order infringers to pay damages to IP holders. The law was further amended in 2001, explicitly providing

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38 CHOW, supra note 1, at 422.
40 Id. at Art. 37 – 38.
41 Id. at Art. 32.
protection for well-known trademarks not registered in China, producing the trademark legislation that reigns in China today.\textsuperscript{43}

\textbf{B: Patent Protections}

In 1984, China followed the Trademark Law with the adoption of its first act of patent legislation, the Patent Law of the People’s Republic of China (hereinafter China’s Patent Law). The law distinguishes between three types of patents: \textit{invention patents}, which are new technical solutions or processes for a new or existing product, \textit{utility patents}, which are new technical solutions or processes for the shape or structure of an existing product, and \textit{design patents}, which are alterations to the shape, design, color or any combination of these to an existing product that are designed to improve aesthetic appeal.\textsuperscript{44} The length of protection for an invention patent lasts twenty years, whereas the length of protection for utility and design patents lasts ten years.\textsuperscript{45} The Patent Law also provides guidelines for situations that warrant the issuance of compulsory licenses including, \textit{inter alia}, in situations of national emergency, public health, or when the economic importance of the patented technology is particularly high.\textsuperscript{46} Despite claims that the scope of compulsory licensing is a glaring blemish on China’s patent protections,\textsuperscript{47} it should be noted that TRIPs allows member nations to adopt compulsory licensing requirements,\textsuperscript{48} and that since China enacted their patent law in 1984, they have never granted a compulsory license.\textsuperscript{49}

Starting in 1992, the Patent Law underwent a series of amendments that expanded and strengthened patent protection. The first round of amendments extended patent coverage to pharmaceuticals, products derived from chemical processes, as well as food, beverages, and flavorings.\textsuperscript{50} In addition, it extended the length of protection for invention patents from fifteen years to twenty years and the length for utility and design patents from five years with a potential

\begin{footnotesize}
\textsuperscript{45} Id. at Art. 42.
\textsuperscript{46} Id. at Art. 49 – 51.
\textsuperscript{47} Gabrielle, \textit{supra} note 2, at 337.
\textsuperscript{49} China Allows Compulsory Licensing, MILLER-CANFIELD, Dec., 2012, at 1.
\textsuperscript{50} Yu, \textit{supra} note 42, at 141 – 142.
\end{footnotesize}
three year extension to a single ten year term. The second round of patent amendments took place in 2000 and enhanced judicial and administrative protection for patents, clarified application procedures – especially for foreign applicants – and simplified enforcement procedures. The most recent round of patent amendments was completed in 2008 and centered primarily on improving deterrents to infringement. It increased monetary damages that infringers could be ordered to pay to IP holders, in addition, it improved existing and created new administrative and judicial tools that IP holders could use to target infringers.

C: Copyright Protections

China passed its first act of copyright legislation, the Copyright Law of the People’s Republic of China (hereinafter China’s Copyright Law), in 1991. Included under copyright protection are, *inter alia*, oral and written works, sketches, software, and other forms of literary, artistic, or graphic works. Copyright protection lasts the duration of the author’s life, plus an additional fifty years following the death of the author. During the duration of the period of protection, the author enjoys exclusive ownership rights except in several situations: Unauthorized use of a copyrighted work is permitted for, *inter alia*, news reporting, research, and personal, non-commercial purposes. In response to the change in the legal landscape that the internet era prompted, China amended the Copyright Law and promulgated new regulations for its implementation in 2001 to better address online issues and bolster software protection. Since 2001, no further copyright amendments have been made.

Coinciding with their adoption of the copyright law, China also ascended to numerous international copyright conventions. Between 1992 and 1993, China ratified the Berne Convention for the Protection of Literary and Artistic Works, the Universal Copyright Convention, and the Geneva Phonograms Convention. In addition to joining these international conventions, Chinese IPR officials also promulgated the International Copyright Treaties
Implementation Rules designed to bring China’s copyright practices into conformity with the international agreements they recently ratified. Interestingly, these regulations biased copyright protection in favor of foreign copyright holders over domestic ones.

D: Trade Secrets

Legal protection for trade secrets was absent in China prior to a landmark ruling in 1992. Broadly, that ruling interpreted the application of criminal law and practice as they pertain to theft. Most notably, the interpretations from the Supreme People’s Court found that stealing intangible property, such as trade secrets, constituted an act of theft and subjected violators to China’s criminal codes. Shortly after the Supreme People’s Court ruling, China adopted the Anti-Unfair Competition Law which explicitly banned various unfair business practices. As the law pertains to trade secrets, it banned obtaining trade secrets through unfair means, disclosing unfairly obtained trade secrets, or using trade secrets that were obtained unfairly by a third party.

E: Criminal Penalties

In anticipation of WTO ascension, China amended the Criminal Law of the People’s Republic of China (hereinafter China’s Criminal Law) to provide penalties for serious misuse of all the major types of IP. Depending on severity, trademark infringement can be punishable by up to three years imprisonment or criminal detention, three to seven years imprisonment, or three to seven years imprisonment and a concurrent fine. Patent infringement provides for weaker punishments, including imprisonment up to three years, criminal detention, and fines.

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59 Id. at 143.
60 Id. at 143.
61 See Yu, supra note 42, at 145.
63 Id. at Art. 10 ¶ 1 – 3.
66 Id. at Art. 213 – 215.
which may be combined with imprisonment, criminal detention, or imposed independently.\textsuperscript{67} When serious enough, publishing, reproducing or distributing copyrighted work or faking the signature of an author is punishable by fines, criminal detention, imprisonment up to three years or imprisonment between three and seven years as well as fines that can run concurrent with imprisonment.\textsuperscript{68}

Yet, one glaring issue with China’s criminal penalties for IP infringement has been that the legal statutes contained ambiguous language. They often contained phrases such as “of a serious nature,” “of an especially serious nature,” “fairly large amount,” and “relatively huge amount.”\textsuperscript{69} However, following interpretations issued by China’s Supreme People’s Court and the Supreme People’s Procuratorate in 2000, explicit definitions were given to these ambiguous terms. These interpretations explicitly defined what illegal income amounts, business values, and thresholds of produced pieces of IP infringing goods were needed to constitute different levels of IPR infringement provided for in China’s Criminal Law.\textsuperscript{70} A second interpretation was issued in April of 2007 that reduced, by half, the amount of IP-infringing pieces someone would need to produce in order to violate the criminal codes.\textsuperscript{71} Criminal punishments for trademark, patent, and copyright infringement originate from articles 213 to 217 of China’s Criminal Law as well as the 2004 and 2007 interpretations by China’s judiciary.

As previously noted, in 1992, China formally recognized stealing trade secrets and other forms of intangible assets as theft. Since then, China has incorporated statutes into its Criminal Law that specifically deal with trade secrets. Acquiring, revealing, or allowing the use of trade secrets through improper means, when it causes serious harm to the owner of such secrets is punishable by up to three years imprisonment or three to seven years imprisonment, as well as fines that can run concurrently with prison sentences depending on the severity of the offence.\textsuperscript{72}

\textsuperscript{67} \textit{Id.} at Art. 216.
\textsuperscript{68} \textit{Id.} at Art. 217 – 218.
\textsuperscript{71} Harris, \textit{supra} note 69, at 124.
\textsuperscript{72} Criminal Law, \textit{supra} note 65, at Art. 219 – 220.
On the books, China provides IPR protections on par with those of developed countries. Due to the influence that international IPR agreements had on the policymakers drafting China’s IPR legislation, the wording in their IPR statutes mirrors that of those found in the developed world. Since 1982, China’s framework for IPR protections has developed rapidly, but certain types of IPR were given more attention than others.

IV: THE PROCESS OF INTELLECTUAL PROPERTY REFORM IN CHINA

If one were to summarize the history of China’s IPR reform in one word, that word would have to be uneven. During the course of reform, there was much variation in the development of different types of IPR laws as well as variation in the pace reform took. Rather than institutional disarray, sparse finances, or lack of trained professionals causing this uneven development, we can explain the unevenness using the model described in section two. In order to maximize the gains from IPR policy, Chinese policy makers have been responsive to foreign governments, foreign firms, and domestic economic actors to varying degrees over the course of reform.

A. Uneven Development of Trademark, Patent, and Copyright Protections

Different types of IPRs are important to different industries, and as industry composition changed over time in China, so did the relative importance of each type of IPR. As their importance changed, Chinese policymakers altered the amount of resources that they devoted to the development of trademark, patent, and copyright protections. The result of this was a very uneven history of the development of different types of IPRs.

Trademarks have traditionally been the most developed type of IPR in China. The Trademark Law of the PRC was the first act of IPR legislation that China drafted, and the early U.S. – China IPR agreements were not concerned with bolstering trademark protection. Trademarks are also seen as the most effectively enforced type of IPR in China. A Chinese IPR official was famously quoted as saying that 90 per cent of the IPR infringement cases he was reviewing were filed under trademark infringement, and 10 per cent were filed under patent infringement. See generally, Dexi Qiao, A Survey of Intellectual Property Issues in China – U.S. Trade Negotiations Under the Special 301 Provisions 2 PAC. RIM L. & POL’Y J. 259 (1993), see generally also, A Brief Chronology of China’s Intellectual Property Protections, AMERICAN UNIVERSITY, http://www1.american.edu/ted/hpages/ipr/cheng.htm (Last accessed Oct. 10, 2013).
infringement; however, according to him 60 per cent of the trademark infringement cases he dealt with could have alternatively been filed as patent infringement cases.\textsuperscript{74} Victims of IPR violations find trademark enforcement more effective than copyright or patent enforcement because it has enjoyed the most development and consistent enforcement in China.

It is unsurprising how developed trademark protection is in China given its importance to the industries that dominated China’s emerging market economy. Throughout the 1980s and the first half of the 1990s, China’s exports were dominated by low-tech manufacturing including textiles, miscellaneous manufactured goods, and other light consumer goods with MNCs accounting for the bulk of production in these industries.\textsuperscript{75} During this same time, domestic producers, such as China’s economically crucial township and village enterprises, were growing in economic importance and were primarily concentrated in textiles and other light consumer goods.\textsuperscript{76} These industries are trademark-intensive meaning that they rely heavily on trademark ownership for their business operations.\textsuperscript{77} Additionally, an increasing amount of internationally recognized Chinese brands such as Lenovo, Haier, and Huawei, were establishing themselves in international markets during this period.\textsuperscript{78} Trademarks have been a fundamental part of China’s export-driven economy, and its protection was important for a growing number of domestic trademark holders as well as the MNCs operating in China. As a result, it is unsurprising that more attention was devoted to the development of trademarks than was devoted to other types of IPRs.

However, as China opened their economy, industries outside of light consumer goods were becoming increasingly important. Their international competitiveness in machinery and equipment manufacturing as well as finished goods manufacturing was increasing by leaps and bounds.\textsuperscript{79} Starting in the 1990s, China’s high-tech manufacturing industries, such as electronics, transport equipment, machinery, and computer hardware grew steadily, eventually dominating

\textsuperscript{74} See Maskus et al., supra note 4, at 310.
\textsuperscript{76} See BARRY NAUGHTON, THE CHINESE ECONOMY: TRANSITIONS AND GROWTH, 276 (MIT Press, 2009).
\textsuperscript{79} Changjun Yue & Ping Hua, Does Comparative Advantage Explain Export Patterns in China? 13 CHINA ECONOMIC REVIEW 276, 279 (2002).
half of China’s total manufactured goods.\textsuperscript{80} This trend of increasing international competitiveness in high-tech industries was inextricably linked to the accumulation of necessary resources as well as the removal of administrative roadblocks. Throughout the 1990s, an increasing number of patent applications were being filed in China, illustrating a growing number of domestic innovators.\textsuperscript{81} Additionally, China experienced truly remarkable growth in FDI inflows in the 1990s, allowing them to accumulate more technology through spillover.\textsuperscript{82} Finally, the Company Law of 1994 removed many outdated legal restrictions on privately owned enterprises and raised the protection of foreign invested enterprises that had historically been under-protected.\textsuperscript{83} The accumulation of domestic innovators and technology as well as reforming China’s outdated corporate laws allowed high-tech industries to grow and operate more effectively.

All of these high-tech industries, as well as others such as telecommunications, rely heavily on patent ownership and have been classified as patent-intensive industries.\textsuperscript{84} Globally competitive high-tech Chinese companies, such as Lenovo in computer hardware, TCL in consumer electronics, and Huawei in telecommunications, were becoming increasingly relevant in international markets.\textsuperscript{85} FDI into these industries soared as well, reaching more than double the amount of FDI inflows into the light consumer industries by the late 1990s.\textsuperscript{86} Chinese policy makers responded to these trends with patent reform in order to protect the interests of China’s growing domestic high-tech innovators and the foreign firms who competed in these industries.

Occurring roughly simultaneously with the rise of patent-intensive industries was the rise of China’s domestic software industry. Prior to the copyright amendments, China saw huge growth in their domestic software industry. Between 1995 and 1997, the size of the local software industry, as a percentage of GDP, grew by 45.7 per cent.\textsuperscript{87} Copyright protection was crucial for the operation of China’s software companies because software is a copyright-

\begin{footnotesize}
\begin{itemize}
\item \textsuperscript{80} Liu & Daly, supra note 75, at 22.
\item \textsuperscript{82} Shang-Jin Wei, Foreign Direct Investment in China: Sources and Consequences, in FINANCIAL DEREGULATION AND INTEGRATION IN EAST ASIA 77, 79 (Takatoshi Ito & Anne O. Krueger eds., Univ. of Chi. Press 1996).
\item \textsuperscript{84} See Blank & Kappos, supra note 77, at 36.
\item \textsuperscript{85} See, Silk & Malish, supra note 78 at 107 – 108.
\item \textsuperscript{87} See Yu, supra note 2, at 194.
\end{itemize}
\end{footnotesize}
intensive industry.\textsuperscript{88} Prior to this time period, Chinese policymakers had been averse to improving copyright protection; however, protecting an important domestic industry provided a compelling reason for reform. Enforcement of copyrights had become important for protecting the interests of the growing number of domestic innovators, and copyright protections improved as a result.

\textit{B: U.S. Diplomatic Pressure: 1979 – 2001}

At the same time that domestic economic conditions were evolving, China also faced growing international pressure over how high their level of IPR protection should be. The 1979 Sino – U.S. Trade Agreement marked the beginnings of both China’s modern IPR reforms and the beginning of the tumultuous history of U.S – China IPR negotiations. The 1979 agreement provided for reciprocal IPR protections and led China to introduce their first acts of legislation protecting trademarks and patents.\textsuperscript{89} During these negotiations, the U.S. pressured reform in various areas of IPRs, which played a role in guiding the development of IPRs in China. U.S. pressures initially focused on establishing an IPR legislative framework and creating modern IPR legal protections. Yet, China’s commitment to the 1979 agreement did not satisfy the U.S. Over the next twelve years, China and the U.S. agreed upon two IPR agreements, known as memorandums of understanding (MOUs), one in 1989 and one in 1992.\textsuperscript{90}

The 1989 MOU reaffirmed China’s commitment to IPR protection and helped, alongside other forces, to bring about the passage of China’s first copyright law.\textsuperscript{91} However, it failed to address all of the U.S. – China IPR issues and further tense negotiations took place.\textsuperscript{92} Following threats of retaliatory tariffs and trade sanctions, China and the U.S. agreed on the 1992 MOU which helped to facilitate amendments to China’s copyright and patent laws, their ratification of the Berne Convention, and their passage of the Anti-Unfair Competition Law.\textsuperscript{93}

The 1992 MOU also marks the beginning of a shift in the focus of IPR reform. While the focus had been on drafting legislation and joining international agreements, enforcement of these laws would soon become the central issue. While the U.S. had raised concerns about China’s

\textsuperscript{88} See Blank & Kappos, \textit{supra} note 77, at 31.  
\textsuperscript{89} CHOW, \textit{supra} note 1, at 418.  
\textsuperscript{90} \textit{Id.} at 419.  
\textsuperscript{91} \textit{Id.} at 419.  
\textsuperscript{92} \textit{Id.} at 420.  
enforcement of IPR prior to 1992, the 1992 MOU was the first bilateral agreement that explicitly stated China’s commitment to enforcement reform.\textsuperscript{94} This shift illustrated a shift in focus from the simple provision of legal protections for IPR to the more complex enforcement of these protections.

Shortly after China agreed to commit to IPR enforcement reform in the 1992 MOU, the U.S. decided they were not satisfied with the enforcement reforms that China had adopted. Two further IPR agreements, in 1995 and 1996, were negotiated with the aim of bolstering China’s IPR enforcement. The 1995 agreement saw China draft an action plan that included the creation of new enforcement task forces and expanded IPR enforcement in certain vulnerable industries.\textsuperscript{95} However, by 1996, the U.S still felt that China was not taking enforcement reform seriously, and threatened tariffs and NTBs if they did not begin to make meaningful change.\textsuperscript{96} In order to avoid the disastrous results of U.S. trade sanctions, Chinese policymakers had to be responsive to the demands of U.S. negotiators. As discussed in section 3, China rapidly developed and amended all of their IPR laws to satisfy these demands. However, a radical change in the dynamics between U.S. and China was looming on the horizon.

\textbf{C: \hspace{1em} The Role of the World Trade Organization}

After the mid-1990s, Chinese policymakers became increasingly unresponsive to the demands of U.S. negotiators. Some scholars have attributed this shift in responsiveness to the U.S. overusing trade threats, diminishing their effectiveness.\textsuperscript{97} This may explain part of China’s unresponsiveness, especially prior to WTO ascension, but it does not accurately capture the dynamics at play after China’s accession to the WTO. Joining the WTO would make China accountable to TRIPs and subject to the jurisdiction of the Dispute Settlement Body (DSB), an organ of the WTO that handles, \textit{inter alia}, IPR disputes between member countries. If this were to happen, the U.S. would become significantly more restricted in their ability to impose trade sanctions due to the fact that they would first need to convince the DSB that China’s IPR policies violated their TRIPs obligations. This buffer provided China with an incentive to accelerate its IPR reforms.

\textsuperscript{94} See Qiao, supra note 73, at 275.
\textsuperscript{95} See \textsc{Chow}, supra note 1, at 421.
\textsuperscript{96} \textit{See id.} at 421.
Joining the WTO required China to bring their laws into conformity with the minimum level of protections mandated by TRIPs. China created criminal penalties for commercial scale IPR infringement bringing their IPR laws into conformity with article 61 of the TRIPs Agreement, which explicitly requires such penalties.98 Additionally, recall that the 2000 Patent Law amendments improved and clarified administrative procedures and penalties for infringement. It is no coincidence that these amendments occurred just a year before China’s accession to the WTO. Ambiguity about what the new IPR laws actually meant would have cast doubt on China’s compliance with TRIPs, and Chinese policymakers were eager to avoid U.S. opposition to China’s WTO membership.99

Following China’s accession to the WTO, it became much more difficult for the U.S. to credibly threaten trade sanctions in IPR disputes, due to the fact that the DSB would need to authorize retaliatory sanctions. Cases from the DSB had almost exclusively focused on the failure to enforce laws rather than the failure to effectively enforce laws.100 Additionally, section III and IV of TRIPs, the sections discussing IPR enforcement obligations, were written with vague terminology making it difficult to successfully argue that a country was not effectively enforcing IPRs.101 Recognizing this ambiguity, Chinese policymakers became less responsive to the demands of foreign governments.


On April 10, 2007, the U.S. filed a formal complaint with the DSB alleging that elements of China’s IPR laws, as well as their enforcement of these laws did not satisfy their TRIPs obligations. The complaint alleged China had failed to meet their TRIPs obligations in three ways:

1. China failed to provide copyright protection for works that had not been authorized for distribution in China.102

98 See TRIPs Agreement, supra note 48, at Art. 61.
99 See Michaela Eglin, China’s Entry into the WTO with a Little Help from the EU 73 INT’L AFFAIRS 489, 496 (1997).
100 See Yu, supra note 57, at 931.
2. The methods Chinese Customs used to dispose of seized IPR infringing goods resulted in their reemergence into commercial channels.\footnote{See id. at ¶ 7.193.}

3. China’s criminal thresholds for copyright and trademark violations were too high and did not provide an effective deterrent to infringement on a commercial scale.\footnote{See id. at ¶ 7.396.}

The most important claim in this complaint alleged that China’s criminal thresholds were an \textit{ineffective} deterrent to infringement on a \textit{commercial scale}. The DSB was venturing out into relatively uncharted waters. After all, up until this point the vast majority of DSB cases dealt with the failure to enforce laws rather than the failure to effectively enforce laws. How the DSB ruled in this case was sure to influence the dynamics of China’s IPR reforms in the years to come.

On January 26, 2009 the DSB issued their decisions on the complaints lodged by the U.S. They agreed with the U.S. that China failed to provide adequate copyright protections for work that had not received authorization for distribution in China. Although the DSB did not contest China’s right to restrict the circulation and exhibition of works,\footnote{See id. at ¶ 7.132.} it did find that China still must protect these works from copyright violations.\footnote{Id. at ¶ 7.139.} At best, this was a minor victory for the U.S., as copyright holders gain little from copyright protections if their works were not authorized for distribution.\footnote{Daniel Gervais, China – Measures Affecting the Protection and Enforcement of Intellectual Property Rights - WT/DS362/R 103 AM, J. INT’L L. 549, 553 (2009).}

The U.S. also partially won its second complaint, that Chinese Customs’ disposal methods were inconsistent with TRIPs. There were two disposal methods that the U.S. was objecting to: 1) donation to charitable organizations, and 2) auctioning after all IPR infringing marks were removed.\footnote{U.S. – China IPR Dispute, supra note 102, at ¶ 7.254.} In order for the U.S. to win this claim they needed to show that these disposal methods resulted in IP-infringing goods finding their way into commercial channels. If they could prove this, they could show that China was not in compliance with article 46 of TRIPs which forbids disposal of IP-infringing goods into commercial channels in all but extreme circumstances.\footnote{TRIPs Agreement, supra note 48, at Art. 46.}
The DSB found that the safeguards China had in place to ensure that donations to charitable organizations did not ultimately end up in commercial channels were sufficient. However, they agreed with the U.S. that auctioning of seized goods was not consistent with China’s TRIPs obligations. Article 46 of TRIPs states that “the simple removal of... unlawfully affixed [trademarks] shall not be sufficient, other than in exceptional cases, to permit release of the goods into the channels of commerce.” The DSB found that even though auctioning made up a mere 0.87% of goods disposed of by Chinese Customs, these situations were not exceptional, and the simple removal of trademark infringing marks was not sufficient to allow their release back into commercial channels. Again the U.S. achieved a shallow victory. They had successfully forced China to stop using a disposal method that applied to less than one percent of IP-infringing material.

The final issue that the DSB ruled on came down to what exactly constitutes infringement on a commercial scale. Article 61 of the TRIPs agreement requires that member nations provide criminal punishments for IPR infringement on a commercial scale. The U.S. argued that the criminal thresholds found in China’s Criminal Law were too high, allowing IPR infringement on a commercial scale. The DSB did not find that China’s criminal thresholds were inconsistent with TRIPs. However, they made this conclusion on the basis that the U.S. failed to put together a prima facie case, rather than affirming that China’s criminal thresholds were consistent with TRIPs. The U.S. lost the most important point of their complaint, but the defeat was not a rout. The fact that the DSB found that the U.S. failed to present sufficient evidence to prove China’s thresholds were too high means that the U.S. could, hypothetically, find sufficient evidence and win their point in a later case. Yet, this case highlights what Chinese policymakers have been capitalizing on for years: it is very difficult to prove to the DSB that a country is ineffectively enforcing their IPR protections.

110 See U.S. – China IPR Dispute, supra note 102, at ¶ 7.322.
111 TRIPs Agreement, supra note 48, at Art. 46.
112 Id. at ¶ 7.349.
113 See id. at ¶ 7.392.
114 See Gervais, supra note 103, at 552.
115 TRIPs Agreement, supra note 48, at Art. 61.
116 See U.S. – China IPR Dispute, supra note 102, at ¶ 2.2.
117 See id. at ¶ 7.669.
118 Id. at ¶ 7.632.
This decision also altered the dynamics of how the three forces shaping China’s IPR reforms interacted with each other, contributing to China’s low-level of IPR enforcement. Foreign governments had lost some of their ability to bargain over IPR reform with market access. According to our model, this would reduce China’s optimal level of IPR protections, \textit{ceteris peribus}.

The outcome of the U.S. – China IPR dispute resulted in a reduction in China’s responsiveness to the demands of foreign governments. This muted a voice that had, in the past, exerted upward pressure on China’s level of IPR protections. The removal of this voice increased the likelihood that IPR protections would remain low. Rather than accrediting low IPR protections to weak institutions, in this case it can be explained by institutions fulfilling their intended function. The DSB weighed the evidence and made a ruling, and China rationally altered their IPR policies in response.

\textit{D: Variation in Enforcement Across Provinces}

Critics of China’s IPR regime often point to the substantial variation in IPR protection across provinces as evidence of weak institutions or failed leadership.\textsuperscript{119} Many explanations for inadequate enforcement have been advanced. It has been blamed on Confucian and communist values that have historically characterized Chinese culture.\textsuperscript{120} Corruption and local protectionism is another explanation.\textsuperscript{121} It has even been blamed on the lack of political will in the U.S. to put IPRs at the head of the U.S. – China diplomatic agenda.\textsuperscript{122} However, one of the most compelling explanations has been the decentralized nature of China’s IPR enforcement regime.\textsuperscript{123} Decentralization is an interesting explanation because rather than culture, corruption or the actions of foreign governments, decentralization represents a policy choice by the Chinese government. Interestingly, IPR enforcement has remained decentralized despite a trend toward recentralization of political power over the Chinese economy. In the late 1990s, China’s premier, Zhu Rongji, pursued economic policies that lead to the recentralization of state decision making

\textsuperscript{119} See Wei, \textit{supra} note 2, at 464.

\textsuperscript{120} See generally, WILLIAM P. ALFORD, TO STEAL A BOOK IS AN ELEGANT OFFENCE (Stan. Univ. Press, 1995).

\textsuperscript{121} Harris, \textit{supra} note 69, at 103, see also, Andrew Evans, \textit{Taming the Counterfeit Dragon: The WTO, TRIPs, and Chinese Amendments to Intellectual Property Laws} 31 GA. J. INT’L & COMP. L. 587, 590 (2003).


\textsuperscript{123} See Wei, \textit{supra} note 2, at 464.
power in many economic issues. Yet despite this, China has maintained a decentralized bureaucracy for the enforcement of IPR laws. This gives rise to an obvious question: why is IPR an exception?

Decentralization gives IPR officials a wide degree of latitude in how rigorously they enforce IPRs. In China, IPR enforcement across provinces is not homogenous. Figure 2 illustrates the variation in IPR enforcement using the percentage of IP infringement cases won by the plaintiff as a measure. On the books, IPR protections are uniform across China, but a law is only as good as its enforcement. Decentralization has allowed the de facto level of IPR protections in China to vary considerably across provinces.

China has been referred to as “a country of countries.” Each province can be thought of as a separate country in that they exhibit wide variation in their endowments of natural resources, labor, and human as well as physical capital. Variation in these characteristics across provinces means it is likely there is also variation in provinces’ optimal level of IPRs. Imitation is a profitable industry, especially in rural and inland provinces where imitating enterprises account for large shares of employment and tax revenue for the local governments. Rather than an enforcement problem endemic to decentralization, the variation in IPR enforcement across provinces could potentially be a strategic choice by the Chinese government to allow poorer provinces to adopt a lower level of IPR protections that is more suitable for their economic realities.

As we have argued, the role of U.S. pressure in guiding China’s IPR reforms is commonly overstated. And while China has relied heavily on MNCs for spillovers and technology transfer, domestic economic actors in China have also exerted considerable influence over Chinese IPR policy. Many domestic actors in China, particularly in the poorer rural provinces, were opposed to a strengthening of IPR protections. In order to maximize welfare, Chinese policymakers must be responsive to many voices, some that wanted stronger protections and some that wanted weaker protections. It would be presumptuous to characterize the resulting

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124 See Naughton, supra note 76, at 91.
125 See Yu, supra note 2, at 206.
126 Yu, supra note 57 at 963.
128 See id. at 60.
uneven levels of protection as a *problem* in need of fixing because ultimately, it may represent a balance between the desires of all the different forces at play, a balance that policymakers calculated would maximize economic welfare for China.

V: CONCLUSION

Three major forces have been driving IPR reform in China over the last thirty-five years. In that time, key events altered the dynamics governing China’s IPR policy choices in ways we can understand through the lens of the literature on innovation, trade, and development. Chinese policymakers have been responsive to foreign governments, foreign firms, and domestic economic actors. Yet, this balance has shifted overtime. The composition of industry in China has changed, along with the demands of domestic innovators. This has changed which industries have more sway over IPR policy. Ascension to the WTO in 2001, and the conclusion of the U.S. – China IPR dispute in 2009 both drastically changed how responsive Chinese policymakers were to the demands of the U.S. and the rest of the international community.

A recurring characteristic of reform that we see in China is that IPR has developed unevenly. Trademark, patent, and copyright legislation developed at different paces depending on how important they were to the three main forces. Foreign governments, primarily of the developed global North, have constantly pushed for more harmonized protection of the different types of IPRs. However, foreign firms and domestic actors put more emphasis on some types of IPRs over others depending on their relative importance to the dominant industries in China at the time. Enforcement of IPR protections has also been very uneven across provinces in China. Poorer provinces often rely on IPR-infringing industries as large shares of employment and revenue while richer provinces rely on IPR-intensive industries. Decentralized enforcement power has resulted in each province enforcing IPRs to different degrees. On the books, IPR protection is equal across China, but a law is only as good as its enforcement. Strategic under-enforcement in certain provinces leads the *de facto* level of IPR protection in China to vary widely.

China’s rapid but uneven development of IPR protections has caused friction with China’s trading partners but it is presumptuous to characterize their low level of enforcement as a failure of policy. Instead, it might be best understood as a delicate balancing act that China’s policymakers continue to perform. The future of IPR policy in China will continue to be
influenced by the same three forces as in the past. As policymakers maintain their unresponsiveness to the demands of foreign governments, and the number of Chinese innovators continues to grow, it is likely that the future of IPR protections will be driven by the interests of China’s domestic actors. The growth of IP-intensive industry in China will gradually increase IPR enforcement in the coming years, albeit at a pace slower than what the global North would prefer.


**Figure 1: The Determinants of Intellectual Property Policy**

- **The “Carrot”**
  - Stronger IPRs rewarded with:
    - Preferential trade policies
    - Subsidies

- **The “Stick”**
  - Weaker IPRs punished with:
    - Tariffs
    - Non-tariff barriers

- **Foreign Direct Investment**
  - Stronger IPRs:
    - Increase spillovers
      - managerial expertise
      - tech transfer

- **Technology Licensing**
  - Stronger IPRs:
    - Increase licensing
    - Improve domestic tech. capacity

- **Innovators**
  - Stronger IPRs:
    - Promote innovation
    - Raise profits

- **Imitators**
  - Stronger IPRs:
    - Raise production cost
    - Lower profits

- **Consumers**
  - Want to maximize quality and minimize cost

- **Foreign Governments**
- **Foreign Firms**
- **Domestic Actors**
Figure 2: Variation in IPR Enforcement Across Chinese Provinces

The Percentage of IP Infringement Cases Won by the Plaintiff. 2001 - 2005

- 0.8 or more
- 0.67 to 0.80
- 0.50 to 0.67
- 0.25 to 0.50

129 James Ang et al., Does Enforcement of Intellectual Property Rights Matter in China? Evidence from Financing and Investment Choices in the High-Tech Industry REV. ECON. & STATS. (forthcoming, date to be determined). This figure has been edited for visual clarity.