AI, IPR, and Economic Development: Nascent Relationships*

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Abstract

The paper discusses the tradeoffs with IP protection and explains the case for differentiated IP protection between the Global North and South. It discusses how AI affects both the imitative risks and the innovative capacities of firms. With appropriate levels of IP protection, public support, and transfers of AI technology, the Global South can exploit AI to augment its innovation, employment, and production.

Keywords: Artificial Intelligence, Patents, Copyrights, Commercialization, Global South
JEL classification: O34, O33, O40, O10

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1 Motivation

Research on the impacts of AI on the economy and the appropriate role of intellectual property (IP) rights in an AI-driven economy is currently at a nascent stage. Technologies based on artificial intelligence will continue to permeate throughout society and further affect jobs, production, incomes, income distribution, and global trade. Existing IP laws and institutions, and policy and regulatory authorities, are tasked with overseeing AI developments.

This paper provides an international North-South perspective, and asks two questions:

- How does AI condition the optimal design of IP protection?
- How does AI condition the role of IP in the Global South?

I believe that answering these two questions will help explain how IP protection might best work to facilitate economic development amid continuing advances in artificial intelligence. I begin with a recap of what I think is the conventional view of the appropriate role of IP protection for generic technological innovation, and then discuss how the conventional view might be adjusted in the case of AI technologies. Next, I discuss the implications for policy and technology diffusion to the developing world.

2 Conventional View

The prevailing view is that IP protection has both costs and benefits for social welfare.[1] IP protection, whether it be copyright, trademark, or patent protection, confers some market power on the IP owner. This limits the availability of a good – or access to the good – since it is not apt to be competitively supplied. Prices are in general raised as a result of IP protection, and for some consumers or users, the good will be less affordable, or not affordable at all. Balanced against this cost is that IP protection can stimulate innovation and creative activity which enhances the quality of goods or expands the number or variety of goods.

More specifically, one can dive more deeply and argue that IP protection also affects the size

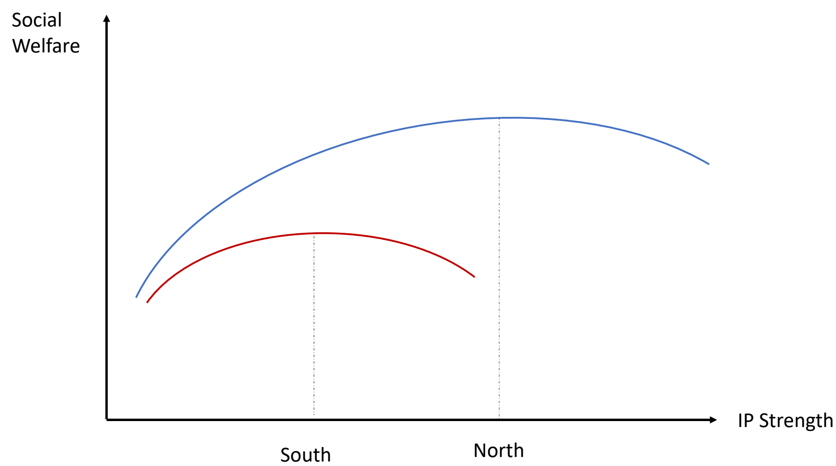
[1] See Park (2008) for a fuller treatment.

and frequency of innovations. If either the duration or scope of protection is too low, innovations will arise few and far between; and what little do occur will be of modest size, since innovators will not invest in large or ambitious research projects or creative endeavors if the protection is too weak to generate much sales and returns (due to piracy, imitation, or infringement). As protection increases, innovations can become more frequent and more radical. The greater market exclusivity and opportunities for greater returns create incentives for innovators to invest in larger breakthroughs. However, if protection is too stringent, innovators face less competition, less threat from having their innovations displaced, and therefore may introduce new innovations more slowly, ones that might even be incremental improvements over existing innovations. Thus, one can imagine an inverted-U relationship between the level of IP protection and innovation and ultimately social welfare. That means that there exists some optimal strength of IPR protection for purposes of maximizing social well-being.

But this optimal strength should vary by economy. In particular, for developing countries, it should typically be lower than that for developed countries. Typically, the Global South conducts less R&D, owns less of the world's IP assets, and has lower innovative capacities. A greater propensity for imitation and piracy exists in the developing world owing to the affordability issue under IP protection. Moreover, the market size of the Global North is much larger than that of the Global South. Because of this, most of the innovators recoup their returns in the developed country markets. This is one factor for why IP protection should be stronger in the developed world. And since the majority of innovating firms are based in the developed world, their profits add to the social welfare of the developed world and help offset losses to social welfare stemming from higher prices. The developed world, in other words, is better able to absorb the costs of IP protection. Hence, this is another factor for why IP protection should be stronger in the developed world.

Figure 1 shows a comparison of the optimal strength of IPR between North and South. In general, social welfare should be higher in the developed world than in the developing world for any level of IP protection; the former stands to gain more than the latter. This is why the social welfare curve of the developed world tends to be above that of the developing world. And the turning point occurs sooner for the developing world, as the point beyond which the costs of IP protection exceed the benefits therefrom occur sooner.

Figure 1: Optimal IPR, by Stage of Development



The optimal strength of IPR protection should also vary by industry, such as pharmaceuticals, transportation, computers, and electronics. The variation by industry is dependent on the technological characteristics. For example, hardware versus software. If hardware is especially capital-intensive, this intensity can be a natural barrier to imitation. Another feature is the complexity or discreteness of products. Discrete products such as drugs are relatively easier to imitate. Complex products, in contrast, which comprise multiple pieces are harder to reverse engineer because the components would not easily reveal the nature of the composite product. Whether industries produce goods with long or short product life cycles will also affect their dependence on IP protection. When product life is short, technological obsolescence may arise well before the product or underlying technology is imitated.[2] Thus, some industries are more dependent on IP protection than are others depending on the ease of imitation. Ideally, therefore, the strength of protection should vary by industry, being stronger in those sectors facing higher imitation risks. However, IP strength typically does not vary by industry but only by country or jurisdiction.

And even then, the WTO TRIPS agreement sets the same minimum standards of IP protection

[2]Product life cycles are relatively long for pharmaceuticals, metallurgy, and chemicals. They are shorter in semiconductors, TV, electronics, and computer graphics processing. See Lee (2013) for a study on how emerging economies that successfully caught up to the developed world tended to specialize in products with short life cycles. This enabled innovation to thrive in regions where IP protection levels were not very high and enabled firms to compete in markets where the Global North could not dominate as long as products underwent short life cycles.

for all member states, even though theoretically (as just discussed) protection levels should vary by stage of economic development. But in practice, there are ways in which the Global South can provide lower levels of IP protection. International rules allow for *flexibilities* in IP, such as parallel imports, compulsory licensing, fair use and other limitations and exceptions, and alternative means of protection (other than patents, such as plant variety protection) for agricultural innovations. Moreover, Article 66.2 of TRIPS puts conditions on governments in the developed world to "provide incentives to enterprises and institutions in their territories for the purpose of promoting and encouraging technology transfer to least developed country Members in order to enable them to create a sound and viable technological base." This is important. It is not only the developing world that is obliged to strengthen its IP regimes, which was premised on its being able to spur innovation and attract technology transfers. The developed world too has an obligation to support global technology transfers and the technological development of the developing world.

Another means by which the developing world has enhanced its innovation and innovative capacity in a world of stronger IP regimes is its participation in open innovation, such as open source, open education, and open biotechnology projects.[3] These projects provided greater access to knowledge and opportunities for learning by doing. Moreover, open access journals and books have enabled scholars in the developing world to access copyrighted works more easily.

3 Role of AI

Artificial intelligence technologies should influence the optimal levels and design of intellectual property protection in diverse ways. They tend to raise *both* imitative and innovative capacities. First, AI raises imitation risks since the technologies make it easier to produce copies of IP works, mimic original creations, and engage in reverse engineering. These risks may require a more stringent enforcement of IP to the degree that they discourage or pre-empt innovation. On the other hand, AI can enhance the productivity of research and production, and improve the ability of developing economies to catch up technologically. For example, AI aids immensely in recognizing

[3] In the case of OpenAI, while it was founded as a non-profit research organization, it is presently a for-profit enterprise with *Microsoft* as a corporate investor.

and analyzing patterns in large datasets and seeking solutions to complex problems more speedily. AI may generate its own creations or innovations endogenously. Like plant variety innovations, which carry the seeds for further innovations and reuse, AI has the ability to create (or be programmed to self-create) original technologies beyond what the human programmer/creator might have intended or imagined to result. High valued AI innovations may also require sufficiently secure IP protection to motivate their creations but the ease of innovation due to AI may call for a relaxation of stringent levels of protection.

Compounding the issue of the appropriate design of IP protection is that AI has both hardware and software features. Software includes the algorithms and the data, while the hardware includes the supercomputers with vast numbers of GPU's, the robots, chips, solid state drives, the tensor processing units. Software is typically easier to reproduce but the codes border very closely to being material of mathematical nature that is unpatentable in many jurisdictions, unless some legal requirements as to "technical effect" are demonstrated.[4] Hardware, as was pointed out earlier, may inherently be harder to imitate if it is capital-intensive and complex, and thereby associated with high setup costs. Having both hardware and software components make calibrating levels of IP rights around AI innovations uniquely challenging.

From a North-South perspective, the Global North is likely to widen its technological lead over the Global South, given that most of the AI innovations occur and are owned by firms in developed countries, such as the U.S. While China, from the developing world, is offering a formidable challenge to the U.S., other developing economies are likely to see an increase in their technological balance of payments deficit to the developed world. As Table 1 shows, more IP from the developed world is licensed than IP from the developing world. The table shows the exports of licensed innovations based on receipts of fees and royalties. Over the period 2005 - 2022, the gap in technologies licensed had shrunk. In 2005, the developed world earned 68 times more licensing fees and royalties than the developing world had; but by 2022, this ratio fell to 11. However, developments in AI (and any stronger IP protection for AI) may well turn the trend back up, worsen the terms of trade for the Global South, and widen the skills gap between the South and North unless AI knowledge, training, and computer science skills are transferred or diffused widely

[4]Of course, software codes are of copyrightable material.

Table 1: Licensing Exports, by select years

Country Group	2005	2010	2015	2020	2022
A. Developed	209.4	273.2	323.6	348.8	346.9
B. Developing	3.1	5.4	17.7	25.4	31.8
Ratio A/B	68	51	18	14	11

Billions of real 2017 US dollars. Source: UNCTAD Data Center
Data are based on charges for the use of intellectual property.

around the world, and unless IP rights on AI are well-balanced.

A balancing of the costs and benefits of IP protection for AI should take into consideration a number of factors. First, the value and efficacy of AI as a tool for creativity and innovation depend on AI systems having full access to data – that is, the training data. Withdrawing information or material from the training dataset because copyright owners refuse to let their works enter the knowledge base, unless they receive compensation, will make AI less effective as a resource.

Second, an anti-commons effect also threatens the efficacy of AI. While there are legitimate concerns about privacy, ethics, and safety, AI tools and innovations are likely to be underutilized if policymakers over-regulate. Appel et al. (2023) have identified a number of important concerns and legal risks with AI. But methods to mitigate the risks, such as permitting artists to opt out of image generators, developing audit trails (to source the provenance of AI-generated content and the platform with which it was developed), disclosures, agreements, and generative AI check lists, must not be such as to be burdensome and raise the transactions costs of deploying AI.

Third, AI challenges the non-obviousness standard of patentable innovations.[5] If AI assisted human innovation, how much credit should the human inventor receive and what was the investment cost of the innovation if AI facilitated it?[6] Moreover, what might seem complex and nonobvious to a human inventor might seem obvious to a supercomputer that can better discover emergent patterns.

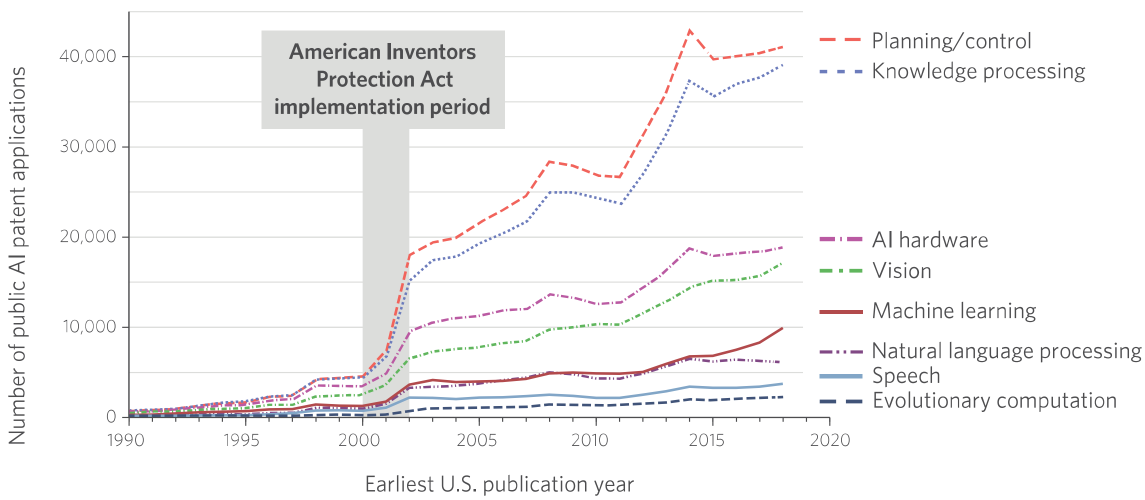
Regardless of any changes to the costs and benefits of IP protection brought about by AI, the

[5]See Shemtov and Gabison (2022) for a fuller treatment.

[6]For example, a major cost component of pharmaceutical R&D cost are the clinical trials. If AI can prevent multiple failed trials, the upfront fixed cost of R&D can be lowered significantly.

patenting of AI innovations has proceeded quite rapidly. Figure 2 shows the filings of patents on AI by type of AI innovation. According to the U.S. Patent and Trademark Office (2020), annual AI

Figure 2: Number of AI Patent Filings by AI Component



Source: USPTO, 2022.

patent applications have doubled during a 16 year period. AI innovations are pervasive, as more than 42% of technology subclasses contain at least one AI patent. The leading AI components are planning and control, which are processes for executing activities to achieve specified goals, and knowledge processing, which involves inputting information into automated systems. The top 10 leading patentees are IBM, Microsoft, Google, Hewlett-Packward, Intel, AT&T, Oracle, Amazon, Apple, and General Electric.

Researchers have also already begun compiling evidence on the economic impacts of AI. Czarnitski et al. (2023) regard AI as a general-purpose technology (GPT), much like the steam engine and the internet. Using German firm data and output measures such as sales and value-added, the study finds that AI usage and the intensity with which firms utilize AI have positive effects on firm productivity. The study also controls for reverse causality whereby firm productivity determines AI adoption.[7] Cockburn et al. (2019) focus on the impact of AI on innovation, using *Web of Science* data to analyze the effects of AI on the publication of scientific and technical articles. The

[7]Corrado et al. (2021) also examine the effects of AI on firm productivity, focusing on measured and unmeasured intangibles associated with AI.

study finds that the onset of deep learning neural networks led to a sharp rise in AI publications, particularly in application-oriented outlets.

In view of the potential economic benefits of AI-related innovations, the debate over IP might center upon the commercialization costs – of delivering these benefits to end users. Even if the innovation is less costly to create due to AI's assistance or generation, or the innovation is less non-obvious from the vantage point of an AI model, the commercialization of it may require large investments. The question then is whether a period of market exclusivity is necessary for the investors to recoup those upfront costs. This is a question that resembles the conventional rationale for IP protection, but focused on the introduction of the technology into the marketplace. Exclusivity is especially needed if the imitation and infringement risks are on balance greater for AI-related innovations.

A close eye on levels of industry concentration is needed as the key players involved in commercialization acquire market exclusivity. Currently, the market is oligopolistic with companies such as Microsoft and NVIDIA possessing significant market shares of AI-related products. In the spirit of the inverted-U relationship depicted in Figure 1, a *Goldilocks* rule should govern the temporary market exclusivity: not too strict as to diminish the drive to innovate when competition is limited and not too weak as to dissipate the returns needed to recoup the upfront costs. Non-exclusive licensing to enable other participants to market the AI-based products will no doubt mitigate concerns about concentration.

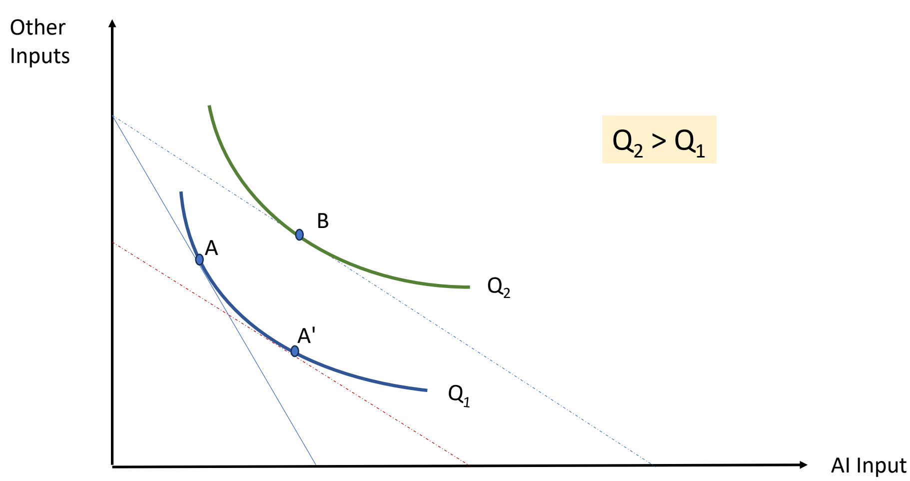
4 Implications for the Global South

The AI technologies should also not be concentrated in the North. The means by which technologies are transferred to the South include licensing, trade, foreign direct investment, and joint ventures. To date, no formal evidence has been gathered on the extent to which AI technologies have diffused to developing countries, nor on the extent of indigenous AI innovation in the Global South. For sure, the Global South is heterogenous. Some are still agricultural-based and exhibit innovative capacities in that arena, such as GMOs. Others with experience in electronics and computers are part of the global value chain and make value added contributions to AI development.

IP protection should be appropriate for providing multinational and other companies incentives to establish facilities in the South – to run the supercomputers, create global knowledge networks and research labs. IP and other policies should also create incentives for local firms and workers to invest in the skills needed. A strong motivation for human capital investment in AI-related skills would be the availability of high-value added jobs. The Global South can be participants in producing the intermediate inputs that go into AI manufacture. With labor cost advantages, the region can be a draw for outsourcing or offshoring. To the extent that AI-enabled supply chains help reduce firm costs, the savings can be used for innovation.

As AI inputs become cheaper through technological progress or outsourcing to the developing world, the scale of production can expand. Figure 3 illustrates the effect. The curve (isoquant) labeled Q_1 shows combinations of AI and other inputs that can produce a given quantity of output denoted by Q_1.[8] Point A is the current point of cost minimization where the firm's budget is given by the triangle formed by the solid blue line; the slope of the blue line is the ratio of the price of the AI input price to that of other inputs.

Figure 3: Decrease in AI Input Price



When the price of the AI input falls, holding other factors constant, effectively the firm's budget

[8]The convexity of the curve is due to the diminishing marginal productivity of inputs.

expands and the new point of cost minimization is B. A higher level of output, Q_2, is attained and more of all inputs are employed or deployed. Point A$'$ is the hypothetical point which shows the pure substitution effect: had the price ratio been the dashed blue line initially, the firm would be operating with a higher mix of AI inputs relative to other inputs. The figure shows that there will be some job or input displacement due to artificial intelligence or automation, but that with an increased scale of production, employment levels could be higher. This is important for the South where automation or AI can relieve workers of tedious, manual labor and redirect their employment, with appropriate training.

Other potential ways in which AI could benefit the Global South are that several middle-income economies have presence in the ICT industries and, with licensing or joint ventures, can access new AI innovations and in turn become exporters of AI technologies. AI can also help with climate change mitigation and agricultural crop research, or with searches for vaccines, particularly for neglected tropical diseases, or resource management for minerals in Africa (such as cobalt, nickel, lithium). As in the developed world, AI and digital platforms can offer workers in low-income countries work flexibility, such as remote or hybrid work, and consumers access to a more connected global, online marketplace.

5 Extensions

More analysis is needed on technology standards and the role of standard essential patents. As AI-related innovations expand, and if incumbent firms continue their market dominance, there is a risk of locking into established technology standards which could be harmful if markets lock into inefficient standards.

Developing economies acquire much knowledge through their participation in open innovation. High licensing fees are avoided. Researchers benefit from knowledge sharing and can freely adapt innovations to local needs. Open source AI should enable developers in the developing world to continue their scientific progress. However, as Tozzi (2023) points out, open source communities generally do not have the resources to train generative AI algorithms. This requires "massive amounts of computing power," which only large corporations thus far have the wherewithal to fund. This entry barrier for open source AI projects could be overcome if governments can sponsor them.

As AI diffuses within the Global South – and labor markets are restructured due to automation – social safety nets, unemployment insurance, and retraining will play an important role (see Freund, 2023). These policies seem imperative if the Global South is to share in the benefits of AI transformation. Some income redistribution schemes, via the tax system, could be implemented whereby the gainers can compensate the losers.

Lastly, a related direction for future research is to analyze the demand for automation. This demand is likely to be endogenous; that is, respond to job shortages or demand for leisure time. For example, automation does relieve workers in poor countries the burden of difficult (and in some cases, unsafe) work.[9] Understanding the sources of demand for automation and AI should yield better context for their diffusion in society.

[9]As an analogy, few regret the introduction of laundry machines which freed people from backbreaking labor. College educators benefit from digital learning management systems, like McGraw-Hill's *Connect*, which free them from onerous homework grading.

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AI, IPR, and Economic Development:

Nascent Relationships

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Sciences Po, Paris Workshop on "Kicking Away the Innovation Ladder? Intellectual Property Perspectives on AI Development", Dec. 11, 2023

Motivation

- Many benefits (and risks) with AI – economic, social, and others
- Economics literature focuses on effects on productivity, thus far
- Gaps:
  - Little attention to IPRs among economists, considering that IPRs govern the innovation regime behind AI innovations and usage
  - What changes, if any, are needed in IP regimes?
  - How does this affect the Global (North-South) divide?

Conventional View

- Appropriation
  - Let €F = sunk cost (innovation)
  - P = price per unit
  - C = cost per unit
  - π = profit per unit
  - Q = quantity sold
  - Recouping requires $\pi Q \geq F$

Where IPR often matters

Conventional View

- Optimal IP (non-linear)

- Case for differentiation of IP strength by
  - Level of Economic Development
  - Industry
  - Type of Product

- Role of AI and how it affects the conventional framework:
  - Imitation risks and innovation boost
  - Hardware and software
  - Introduces new **debates** (not necessarily new solutions)

Debates

AI and Copyrights

- Training Datasets
- AI generated creations

AI and Patents

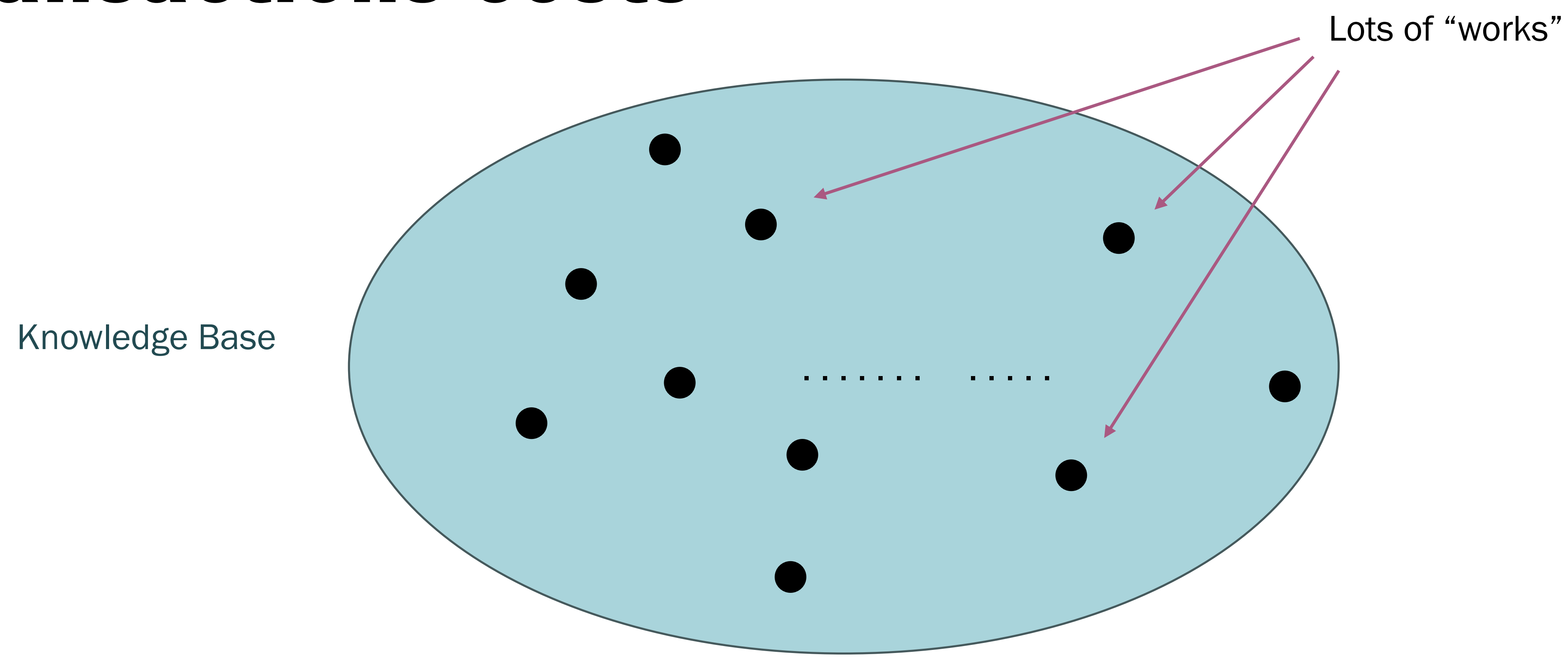
- Non-obviousness standard
- Patent eligibility & costs of innovation

Common questions

- AI as inventor (output perspective)
- AI training datasets (input perspective)

- Either way, I prefer the answer to be "NO" for both
  - No patent/copyright protection for autonomously or endogenously created innovations or works. Pure economic rent.
  - No additional fees/royalties for works in the training dataset.

Transactions costs



For AI to be effective/accurate, it should be trained on complete knowledge

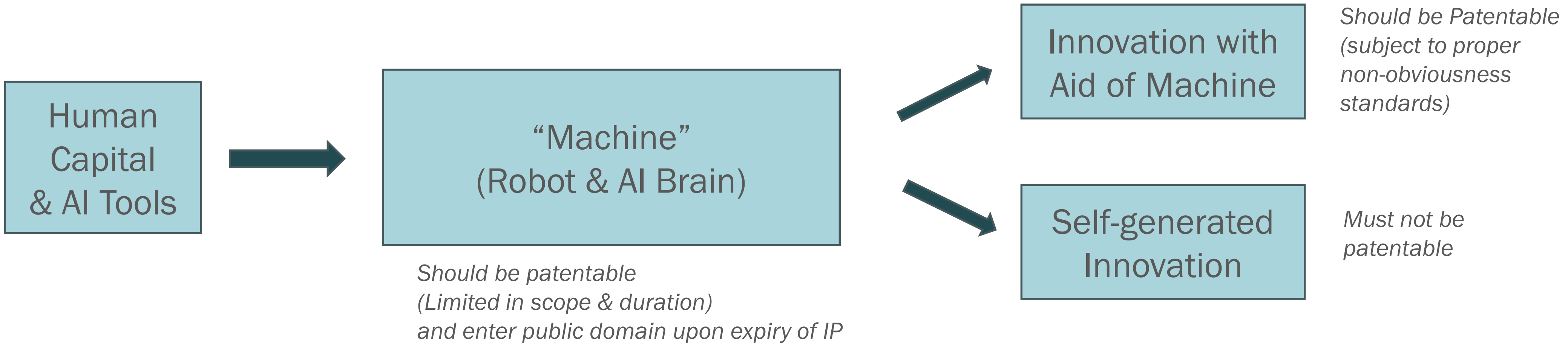
Case for Public Domain

- Compare to how patent disclosure works
  - In exchange for exclusive rights, owner reveals knowledge
  - That knowledge becomes part of the public domain (the big **circle** in the previous slide)
  - Patent right protects only the product or technology based on the knowledge, not the knowledge itself. *(The patented invention is an excludable good, but the underlying knowledge remains non-rival and non excludable).*

- Where is the copyright infringement?
  - Is the work in the training dataset being exploited commercially? Is it a work of authorship (see C. Craig's writings)? Or simply a source of information? Is the training dataset unlawfully using 'expressions' thereby?

Other issues: i. obviousness & ii. AI as inventor

- AI will likely make new innovations more ‘**obvious**’
  - Raises bar for patentability
  - Reduces €F. Obviates need for strong patents for purposes of appropriability.
- Autonomous Innovation



- Futurist outlook: possibility of many (similar or exact) independent innovations. Smart AI will search for best & few “bests” exist.

Impact on Economic Development

IP Licensing Receipts of Fees & Royalties (Exports)

Country Group	2005	2010	2015	2020	2022
A. Developed	209.4	273.2	323.6	348.8	346.9
B. Developing	3.1	5.4	17.7	25.4	31.8
Ratio A/B	68	51	18	14	11

- Technological gap will widen, at least temporarily, if not permanently unless AI benefits and tools diffuse globally. AI models, tools, platforms, assets, innovations, firms, research universities, IP rights holders mostly concentrated in N. Think about competition policy and standards setting.
- Skills gap between N & S in AI will likely widen too. Focus on education and labor market policies.
- How to get S participation: value chains, open-source projects, tech transfers, joint ventures, access to knowledge (A2K).
    - What works for the South: reduce trade/investment barriers, keep training datasets as part of public domain (or exempt from copyright assertion). Publicly support generative AI training in open innovation communities. Encourage AI innovations for S needs and provide clarity on IP eligibility and rights.