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AI Standard Choices Under Geopolitical Competition

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I. Introduction

Amid the rapid advancement of AI technologies, nations are accelerating efforts for their development and adoption. As AI becomes a driving force for innovation across industries, governments are pursuing AI transformation—following digital transformation—to secure industrial competitiveness and foster economic growth. Beyond commercial applications, they also regard the integration of AI into military and security domains—to enhance defense capabilities—as an indispensable task for maintaining a strategic edge. Simultaneously, to manage the potential risks posed by AI, including misuse and abuse, personal-data leakage, hallucinations, harms from misinformation, and the prospect of an AI arms race, focus is shifting toward introducing new norms and regulatory frameworks.

AI standard-setting touches each of these concerns and bears on forecasts for the global AI ecosystem's evolution, bloc-formation prospects, and the emergence of cross-border barriers to AI services. Economic perspectives on standards hold that, for emergent technologies, standards fulfill several functions that contribute to technological progress: facilitating coordination among competing technologies based on superior performance; mitigating information asymmetries between users and technology sponsors; alleviating potential hold-up problems between sponsors and downstream firms concerning product development and technology adoption; and laying the groundwork for compatibility and interoperability. By doing so, standards can materially accelerate the pace of technological progress and diffusion. From this standpoint, identifying high-quality technologies that can positively influence industrial innovation and establishing AI standards that enable their development and deployment is of paramount importance. Especially given AI's characteristics—that services can be delivered across borders and that model performance and service quality improve through user-provided data and feedback—decisions made by influential standard-setting bodies can profoundly impact the entire global AI ecosystem.

The use of AI in military and security domains suggests that the standard-setting process may become fragmented along geopolitical lines. It is well known that, beginning under the previous U.S. administration, Washington adopted export controls on advanced semiconductors closely tied to AI development, aiming to impede China's efforts to secure a strategic advantage in AI. Since the inauguration of the Trump administration, America’s AI Action Plan released in July made the prospect of a U.S.–China separation in AI supply chains more explicit: *“The United States must meet global demand for AI by exporting its full AI technology stack—hardware, models, software, applications, and standards—to all countries willing to join America’s AI alliance. A failure to meet this demand would be an unforced error, causing these countries to turn to our rivals. The distribution and diffusion of American technology will stop our strategic rivals from making our allies dependent on foreign adversary technology.”*

If the two technological leaders build AI alliances anchored in geopolitical interests and exercise outsized influence over standards aligned with those alliances, third-country adopters seeking to use AI technologies from both sides may increasingly face binary choices shaped by economic benefits and international-political considerations.

Meanwhile, efforts to establish standards for the safe deployment and use of AI are actively progressing within supranational bodies, multilateral fora, and domestic institutions. ISO/IEC JTC 1/SC 42 is developing work on AI definitions and terminology, AI system operations and management, and lifecycle-based approaches to trustworthiness. Following the first AI Safety Summit in 2023, the creation of national AI Safety Institutes laid the foundation for international cooperation and joint research across areas including human-centric, trustworthy, and safe AI, risk identification, and developer responsibilities for non-harmful AI. At the regional and national levels, the European Union (EU) has advanced the most visible framework: the EU AI Act introduces a legal basis for risk-based AI governance, while CEN-CENELEC JTC 21 leads EU-level standardization across AI terminology, data, system trustworthiness, and risk management. These standardization efforts in AI governance and safety directly shape the types of AI development and services permitted within jurisdictions and provide a basis for curbing the diffusion of AI technologies deemed detrimental domestically.

In summary, the issue of AI standard-setting can be analyzed through multiple lenses: technological progress and diffusion, geopolitical competition, and technology-related trade barriers. Given AI's distinctive features as a general-purpose technology with substantial socio-economic spillovers, its dual-use potential with military applications, and pronounced scale and network effects in both production and use, the topic demands new analytical frameworks and insights. Among these dimensions, we foreground the geopolitical channel: tensions in the U.S.–China AI rivalry plausibly fragment standard adoption across jurisdictions by raising interoperability frictions and asymmetric adoption costs.

Against this backdrop, this article develops a simple theoretical model to analyze the choice problem of a third country that must decide whether to align its domestic standard with the U.S. AI standard or the Chinese AI standard once those standards already exist. Unlike ex-ante studies of how governance within standard-setting organizations (SSOs) affects standard selection (e.g., Simcoe 2012) or how technology sponsors choose among SSOs with different institutional features (Lerner and Tirole 2006, Chiao et al. 2007), this article analyzes the government's ex-post decision regarding standard adoption: given that the United States and China have established distinct AI standards and that firms embodying these standards enter the third country, which alignment (i.e., which external AI standard to harmonize with) maximizes the third country's welfare? Because the harmonization decision shapes the competitive interaction among foreign service providers operating domestically, our analysis is most closely related to Gandal and Shy (2001), who study standardization in a trade context. Gandal and Shy (2001) showed that with moderate conversion costs, two of three countries may form a "standards union" that excludes the third and eliminates conversion costs between them—an outcome akin to trade diversion that reduces global welfare. Conversely, when network effects arise from cross-country coordination of standards, mutual recognition across all three can emerge in equilibrium. Our model similarly assumes that U.S. and Chinese AI firms compete in a third-country market, and that the conversion costs vanish for the firm whose standard is recognized through alignment with the third country's chosen standard. However, regarding network effects, we assume they depend on the size of each firm's consumer base regardless of formal recognition. Here, the domestic consumer base is endogenously determined, while the global consumer base is taken as exogenous. The next section presents this model in detail.

II. Model and Results

Consider a world consisting of three countries—A, B, and C. Among them, countries A and B possess dominant AI technology capacities that are markedly superior to those of country C and their firms have achieved extensive commercialization in their domestic markets. Specifically, we assume that each hosts a single AI tech firm—firm a in country A and firm b in country B— and these firms offer AI services based on their own foundation AI models and are monopolists in their respective home markets.

AI technology has two key characteristics. First, firms with AI foundation model incur large upfront (fixed) costs, whereas the marginal cost of supplying additional services is comparatively low. This creates natural monopoly conditions through economies of scale. Second, user-provided data and feedback substantially improve model performance over time, creating network effects that attract more users and further enhance AI service quality. The former strengthens monopoly power on the production side, whereas the latter does so on the demand side. Hereafter, let n_A denote the number of users served by firm a and n_B the number of users served by firm b.

This study focuses on two cases in which firms a and b compete in the third country C. Our analysis distinguishes two possibilities. First, consider the case where, at the time firms a and b enter country C, no firm in C provides AI services or intermediates between users and AI services. Such a situation can arise when C is a developing economy with a relatively low capability of AI technology. In this case, once a and b enter C, they engage in a duopoly competition a la Hotelling model setting. Second, consider the case where, at the time firms a and b enter country C, although no domestic firm trains a competitive foundation AI model and provides quality AI services based on it, C can possess a platform firm c that occupies a unique downstream position and intermediates AI services built on foreign foundation models. For example, one may think of firm c as a smartphone manufacturer whose smartphone provides AI assistant application developed and operated by firm a and b. If country C is an advanced country with a high level of information and communications technology, it is more likely to fall into this second case. Under this case, when firms a and b enter country C, they engage in duopoly competition there, but we assume they must pay firm c an ad-valorem fee on the unit price they charge.

1. Network Effects in the AI Services Market and Standardization

As noted, the hallmark of AI technologies is that service performance continues to improve based on data and feedback provided by accumulated users. Performance gains raise users' utility from the service, creating a positive feedback loop that attracts additional users. Such network effects are called direct network effects and they are common in software markets. In the model, direct network effects are captured in each consumer's utility derived from a good or service which rises as the number of users increases.

In our setting, both global and local (within-country) direct network effects are present. We differentiate two types of direct network effects in terms of whether these effects are attributed to the total number of global market users or limited to the number of local market users.

On the one hand, as more people—regardless of location—contribute diverse data and feedback, the AI that learns from them becomes smarter, so network effects that span borders (global network effects) matter. On the other hand, local network effects within national markets are distinct: as the number of users of a given AI service grows within a country, that service better learns the country's language nuances, speakers' sentiment, and cultural context, making it easier to produce outputs tailored to local users and, in turn, stimulating further demand domestically. In this regard, our model incorporates both global and local network effects.

We now turn to how national standards affect AI services in the model. As mentioned earlier, we consider a setting in which countries A and B have established national AI standards, each grounded in the dominant domestic AI firm's technical properties. We assume that the services supplied by a and b are differentiated and, accordingly, that the national standards of A and B would differ. In our framework, "competition over standardization" degenerates to C's standard-setting problem. Prior to the entry of AI firms into C, country C chooses whether to adopt A's or B's technological standard as its own national standard. Under the premise that A and B cannot coerce C into adopting their respective standards, country C voluntarily establishes its domestic standard that maximizes its social welfare while coordinating the standard with one of the standards set up in the country A or B.

Specifically, let the national standards of countries A and B be denoted by α and β, respectively. Depending on whether country C adopts α or β, the effects are as follows. If C adopts α, then firm a can export to C the AI services without modification. By contrast, when firm b enters C, it must adapt its AI services—originally built to comply with β—to the α standard, incurring modification costs. We assume that when a firm enters a country with a different national standard, the per-unit variable cost of producing its AI service increases by $k(> 0)$.

Building on these assumptions, we examine the standard-choice problem for (i) a developing country and (ii) an advanced country, respectively. In both cases, the game proceeds as follows. First, country C chooses one of the two standards, α or β. Second, given C's chosen national AI standard, firms a and b enter country C and compete as in the standard Hotelling model. Equilibrium is analyzed as a subgame-perfect Nash equilibrium (SPNE) that satisfies consumers' rational expectations a la Katz and Shapiro (1985). That is, consumers rationally expect the exact number of users for both firms and implied network effects which affect the value of the services they would choose.

2. Standard Choice of a Developing Country

Following the standard approach of the Hotelling setting, suppose consumers in country C—whose total population is normalized to 1—are located at each point $x \in [0,1]$ with locations distributed according to a uniform distribution. Assume every consumer uses at most one AI service—either firm a's or firm b's—or chooses not to use any service at all. In other words, demand is inelastic. The utility function of a consumer located at x is given by:

$$u(x) = \begin{cases} v + g\,n_A + l n_a - t\,x - p_a & if\ buy\ "a" \\ v + g\,n_B + l n_b - t\,(1-x) - p_b & if\ buy\ "b" \end{cases}$$

The first line in the expression denotes the utility obtained when a consumer (user) located at x purchases firm a's service, while the second line denotes the utility obtained when purchasing firm b's service, instead. In the expression, v represents the standalone utility a consumer derives from using an AI service. The term g captures the global network effect on consumer utility, where g is a coefficient reflecting the technical characteristics of AI learning, and is the number of consumers using the AI service in country A (B). In other words, the global network effect grows the more widely firm a's AI service is used outside country C, and the parameter g governs the extent to which existing users improve AI performance. Next, the term l measures the local network effect. Local network effects arise within country C from consumers who use service a (b). Here, l is the coefficient reflecting the technical features of AI learning, and denotes the number of consumers within C who use service a (b).

As noted earlier, we distinguish g from l for the following reason. In general, AI performance improves as the user base expands; however, for certain AI technologies, the information provided by local consumers can be particularly consequential for improvement. For example, when image recognition is central to the service, performance tends to improve as more images are provided by users regardless of region. By contrast, for AI services where natural interaction in a particular language is crucial, performance improves as more users of that language use the AI. In our model, the relative magnitudes of g and l determine whether global user counts or in-market user counts matter more for learning—an aspect that depends on the technological characteristics of the AI service.

The terms tx and $t(1-x)$ represent taste heterogeneity: a consumer located at x incurs a disutility of tx when purchasing from firm a, and a disutility of $t(1-x)$ when purchasing from firm b. Under this assumption, consumers located closer to 0 tend to prefer service a, while those closer to 1 tend to prefer service b. A larger t is typically interpreted as the two services being more differentiated. For convenience, we will refer to tx and $t(1-x)$ as "transportation costs." Finally, p_a and p_b denote the prices paid when purchasing service from a and b, respectively.

To derive the equilibrium of the two-stage game, we use backward induction. Given country C's choice of either α or β, the two firms then compete. We normalize the marginal cost of producing one unit of AI service for both firms to zero. Let k denote the additional marginal cost that firm a (b) must bear to supply services in C when C does not choose as its standard. For example, if α is not chosen as the standard in C, then the total marginal cost for a, denoted by c_a, is k and the total marginal cost for b, denoted by c_b, is 0. We assume that v is large enough to ensure that every consumer purchases either a's or b's service. For simplicity, we denote $v + gn_A$ by V_a and $v + gn_B$ by V_b.

In equilibrium, prices set by firm a and firm b are

$$p_a^* = (t - l) + \frac{1}{3}(V_a - V_b + 2c_a + c_b)$$

$$p_b^* = (t - l) + \frac{1}{3}(V_b - V_a + c_a + 2c_b).$$

And the demand in C for firm a's service and firm b's service are

$$n_a^* = \frac{1}{2} + \frac{1}{2(t-l)}\left\{\frac{1}{3}(V_a - V_b) - \frac{1}{3}(c_a - c_b)\right\}$$

$$n_b^* = \frac{1}{2} + \frac{1}{2(t-l)}\left\{\frac{1}{3}(V_b - V_a) - \frac{1}{3}(c_b - c_a)\right\}.$$

We now turn to country C's standard-setting problem. To choose the standard that maximizes domestic consumer welfare, country C considers the following welfare function.

$$W(c_a, c_b) = \{(V_a - p_a^*)n_a^* + (V_b - p_b^*)n_b^*\}$$

$$-\frac{t}{2}\{(n_a^*)^2 + (n_b^*)^2\}$$

$$+l\{(n_a^*)^2 + (n_b^*)^2\}$$

On the right-hand side of the equation, the first term represents the net utility that individual consumers obtain from transacting with firm a or firm b, attributable to global network effects and prices. The second term captures the average transportation costs borne by consumers. Finally, the third term measures the total magnitude of local network effects generated by transactions with the two firms.

If country C is a developing economy that does not host firms supplying AI services, social welfare is computed solely from consumer welfare. It follows that social welfare rises when (i) the net utility per consumer from transacting with an AI service is larger, (ii) transportation costs are lower, and (iii) local network effects are stronger.

Notably, the transportation cost parameter t and the local network effects parameter l offset each other from a welfare perspective. When many infra-marginal consumers value the service more highly than the marginal consumer does, the strong local network effects induced enable the marginal consumer to purchase even at a high transportation cost.

Without loss of generality, we consider the case where $n_A > n_B$. To maximize the welfare, country C chooses $\alpha(where\ c_a = 0, c_b = k)$ or $\beta(where\ c_a = k, c_b = 0)$ as its standard.

In the welfare function expression, the global network effects are captured in the first term. It is notable that $\{(V_a - p_a^*)n_a^* + (V_b - p_b^*)n_b^*\} \propto -\frac{2g}{9(t-l)}(n_A c_a + n_B c_b)$. That is, the consumers' net utility obtained from standalone value and global network effects of AI service is maximized when standard α is chosen. However, in that case the average price paid by consumers—that is, the overall price level for AI services—also rises when α is selected (price effect).

Comparing the global network effect with the price effect, the welfare gain from the increase in the global network effect is larger. Hence, if we consider only these two effects, choosing α is desirable. This shows that although selecting the dominant firm (with larger global network effects)'s standard softens price competition between a and b—thereby raising the average price—the global network benefits to consumers more than offsets the price increase.

Next, consider how the choice of standard affects transportation costs captured in the second term. Because transport costs reduce consumer welfare, it is desirable to minimize them. As $\{(n_a^*)^2 + (n_b^*)^2\} \propto -\left(\frac{2g}{9(t-l)^2}\right)(n_A c_a + n_B c_b)$ holds, in the welfare perspective, transportation costs can be reduced by choosing standard β. This is because when the market-share gap between the two services widens, more consumers end up paying relatively high transportation costs to choose the high–market-share service. As noted above, when the global network advantage widens the gap in consumer choices between the two AI services, selecting the disadvantaged firm b's standard helps mitigate this dispersion and thus lowers average transportation costs.

By contrast, the local network effect—captured by the third term—is maximized by choosing α. The larger the market-share gap, the greater the network benefits enjoyed by those who choose the high–market-share service, and the larger the mass of such consumers. Consequently, the average local network effect in the market increases overall.

Putting the pieces together: global and local network effects favor choosing the dominant firm's standard, whereas the price effect and the transportation costs effect favor choosing the disadvantaged firm's standard because tougher head-to-head competition tends to be welfare-improving. Aggregating all of the above effects yields the following relationship in the welfare expression.

$$W(c_a, c_b) \propto -\left(\frac{gt}{9(t-l)^2}\right)(n_A c_a + n_B c_b)$$

This result shows that network effects always dominate the price and transportation cost effects. It also confirms that the larger the global and local network effects, the greater the improvement in social welfare when choosing dominant firm's AI standard. For a developing country C, there is thus an incentive to choose, before entry, the standard of the firm with the relatively stronger global network effect as its national standard.

3. Standard Choice of a Developed Country

We now consider the case in which, at the time when firms a and b enter country C, there already exists a platform firm c that provides intermediation services within C. Before a and b enter, country C can choose either α or β as its national standard; accordingly, firm c operates its platform in a manner suited to onboarding AI services that comply with the chosen standard.

The key difference between the developing-country setting analyzed earlier and the advanced-country setting considered here lies in how the platform firm c earns profit. For tractability, we assume that c takes as a fee a fraction $s \in (0,1)$ of the profits that firms a and b obtain from the transactions conducted via c's platform. This modification of the model does not affect the equilibrium pricing derived earlier as the only difference here is that firms share their profits proportionally with the platform firm c.

Country C's social-welfare function now adds platform c's profits. If the government places weight $\rho(> 0)$ on the domestic platform's profit in the welfare consideration, it will consider the following social-welfare objective function when choosing the standard: $W(c_a, c_b) + \rho s\{\pi_a(c_a, c_b) + \pi_b(c_a, c_b)\}$.

Now the following holds:

$$W(c_a, c_b) + \rho s\{\pi_a(c_a, c_b) + \pi_b(c_a, c_b)\} \propto -\left(\frac{gt}{9(t-l)^2}\right)\left(t + 4\rho s(t-l)\right)(n_A c_a + n_B c_b).$$

Assuming $n_A > n_B$, we can verify—just as in the developing-country case—that country C will choose α as its national standard. Moreover, the incentive to choose α is even stronger than in the developing-country setting. This incentive grows (i) the higher the platform fee rate s captured by firm c, and (ii) the greater the weight the government places on firm c's profits in social welfare.

The outcome is straightforward: platform profits rise when price competition between a and b is softened. By setting the standard in favor of the firm with the stronger global network effect, the policy grants the advantaged firm greater market power, which in turn raises the platform's take. Furthermore, even without an intermediary, our earlier analysis shows that network effects dominate both the price effect and the transportation cost effect; with a platform in place, it is therefore even more clear in an advanced economy that the standard of the competitively advantaged firm will be chosen.

III. Policy Implications

We have examined a third country's national AI standard–setting problem when two firms from different countries—each owning a world-leading foundation AI model— compete in its domestic market. In equilibrium, our model firstly shows that for both advanced and developing countries, they are inclined to adopt the AI standard aligned with the AI technology which is employed by the firm exhibiting strong global externalities in its service. This result holds regardless of the relative importance of local network effects. In short, the pivotal variable in standards competition is how decisively superior one foundation model's pre-entry performance is relative to its rival in other countries.

The United States and China already possess cutting-edge AI capabilities, and the outcome of standards competition between them will be closely tied to the performance of their commercialized foundation models. Given the learning characteristics of AI, obtaining global user data through global tech firms' services premises to win the race, which in turn expands access to training resources and improves performance—thereby further increasing the likelihood of prevailing in standards competition.

A second implication of our analysis is that fragmentation in AI standards across competing countries can intensify standards competition in the third country. This rests on the premise that divergence in national AI standards amplifies service differentiation (larger t) across firms. Value-centric AI norms—e.g., those emphasizing democracy and freedom of speech—may deepen the divergence in standards and in the associated services between countries that endorse such norms and those that do not. As service differentiation intensifies, the welfare gap between the two standard choices shrinks, rendering a country's choice more indifferent between two standards. In this case, non-economic factors such as economic security and geo-political considerations may play a larger role in determining domestic AI standards. This also implies that when one country does not possess overwhelming technological leadership, the other country may still find a room to promote the adoption of its standard in third countries by transferring some of the potential benefits from its firm's expanding global user base to these countries.

Finally, the third implication concerns the bargaining power of the third country's platform firm that intermediates AI services. If the platform's bargaining power is large enough that a larger share of AI firms' profits is transferred as fees, the welfare gap associated with the choice of standard widens, which in turn increases the likelihood that the standard of the technologically advantaged firm will be adopted. For example, suppose a U.S. AI firm holds a decisive technological lead, and this firm partners with a monopolistic platform that intermediates its AI service in the third country. In this scenario, the probability that the country adopts a standardization policy aligned with the U.S. firm's technology becomes substantial. KIEP

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