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Technological Power and Persistent Dependency in Latin America: China, the US, and the Regional Patent Network (2013–2023)

Poder tecnológico y dependencia persistente en América Latina: China, Estados Unidos y la red regional de patentes (2013–2023)

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Abstract

China's expanding technological footprint in Latin America challenges traditional dependency patterns dominated by the United States. Applying Social Network Analysis to foreign patent registrations (2013–2023), this article examines technological power dynamics through centrality and concentration metrics. Despite China's growing influence, the findings reveal that the core–periphery structure remains intact: technological dependency continues to revolve primarily around the United States, with China's rise producing diversification rather than structural transformation.

Keywords: Technological power; patent networks; China in Latin America; technological dependency; global value chains; social network analysis.

Resumen

La creciente huella tecnológica de China en América Latina desafía los patrones tradicionales de dependencia dominados por Estados Unidos. Mediante el Análisis de Redes Sociales aplicado a patentes extranjeras registradas entre 2013 y 2023, este artículo examina las dinámicas de poder tecnológico a través de métricas de centralidad y concentración. Pese al aumento de la influencia china, los resultados revelan que la estructura centro–periferia se mantiene: la dependencia tecnológica sigue girando principalmente en torno a Estados Unidos, y el ascenso de China genera diversificación sin transformación estructural.

Palabras clave: Poder tecnológico; redes de patentes; China en América Latina; dependencia tecnológica; cadenas globales de valor; análisis de redes sociales.

JEL Classification / Clasificación JEL: F13, F54, O34, O38, O54.

1. Introduction

The Fourth Industrial Revolution and China's accelerated ascent as a technological power are reshaping the global distribution of power and reconfiguring traditional hierarchies of influence (Rikap & Lundvall, 2021). Within this context, Latin America (LA) has gained strategic relevance as a geopolitical space where China's expanding presence increasingly challenges the long-standing technological and political dominance of the United States (US). Shifts in US foreign policy have heightened tensions in the region, as Washington seeks to reaffirm its role amid growing Chinese influence (Sanahuja, 2025), positioning technological leadership as a central dimension of this strategic competition.

This geopolitical realignment is reflected in the strategic frameworks articulated by both powers. US strategy positions the Western Hemisphere as a priority region where reasserting preeminence requires controlling critical supply chains, securing access to strategic resources, and preventing foreign ownership of vital infrastructure—objectives directly linked to technological leadership, advanced manufacturing, and the protection of intellectual property (The White House, 2025). Concurrently, Chinese strategy emphasizes deepening science and technology cooperation with LA, promoting joint research in artificial intelligence and digital infrastructure, advancing standards-setting in emerging sectors, and fostering high-technology partnerships framed in explicitly non-confrontational and mutually beneficial terms (Ministry of Foreign Affairs of the People's Republic of China, 2025). These parallel yet divergent articulations reveal how technological capabilities—and the governance of intangible assets that underpin them—have become instruments through which both powers seek to consolidate influence, secure preferential access, and shape the region's integration into competing global innovation ecosystems.

Against this backdrop, technological power in the 21st century is not only material but also deeply embedded in the control of intangible assets within global value chains (GVCs), especially intellectual property rights (IPRs). In particular, patents are strategic instruments through which countries consolidate influence in high-value-added sectors and shape global technological standards (Schwartz, 2017; Rikap, 2021; Vázquez & Visintin, 2024). Understanding how these assets flow across borders is essential to analyzing structural asymmetries in innovation and dependence.

China's engagement with LA offers a revealing case. While initial interactions focused on trade and infrastructure, recent initiatives have increasingly targeted digital connectivity, artificial intelligence, and renewable energy (Ellis, 2022). This shift raises new questions about the region's external technological dependencies, and the role China plays in potentially reconfiguring them.

Although existing literature has extensively examined China's trade, investment, and diplomatic strategies in LA (Ding et al., 2021; Ellis, 2022; Melguizo et al., 2024), fewer studies have explored how technological influence is structurally embedded across the region through formal IPRs mechanisms. In particular, the role of transnational IPRs flows—especially foreign patent registrations—remains understudied despite offering a crucial lens into the mechanisms of technological power projection (Yang et al., 2019).

This raises a critical question: to what extent is China's rising technological presence reshaping—or reinforcing—the region's historical patterns of technological dependency dominated by the US? This article addresses this gap by analyzing the evolution of LA's foreign patent network between 2013 and 2023. It applies Social Network Analysis (SNA) to evaluate the structural positions of China and the US as emitters of technological influence. Using weighted centrality measures and the Herfindahl–Hirschman Index (HHI) to assess concentration patterns, the study examines the extent to which China's growing role may be reshaping—or reinforcing—existing hierarchies of technological dependency.

The results show that although China has significantly expanded its presence in the regional patent network, it has significantly lower levels of network centrality than the United States. Brazil and Mexico function as regional hubs of technological absorption, yet the core–periphery architecture of LA's technological network persists. Rather than displacing US technological dominance, China's rise appears to redistribute influence without fundamentally transforming the network's underlying hierarchy.

These findings contribute to the broader debates on technological power, structural dependency, and global network hierarchies by providing new empirical evidence from LA. Through the application of SNA to transnational patent flows, this study reveals how emerging actors such as China integrate into existing technological structures without fundamentally altering the core–periphery configuration. In doing so, it nuances prevailing narratives about the transformative potential of China's rise, highlighting instead the resilience of hierarchical technological dependencies. The results also offer insights into regional policy strategies, emphasizing the need to address external vulnerabilities not only through economic diversification but also by strengthening autonomous technological capabilities in an increasingly contested global order.

The remainder of this article is structured as follows: Section 2 reviews the theoretical and empirical literature on global value chains, intellectual property rights, and structural power in international networks. Section 3 examines the evolution of China's technological engagement in LA. Section 4 describes the data sources and methodological approach. Section 5 presents empirical results; Section 6 discusses their broader implications. Section 7 concludes the article.

2. GVCs and IPRs: the geoeconomics of technological dominance and power asymmetry

Latin American structuralist and dependency scholars developed some of the earliest and most influential analyses of how technological asymmetries sustain the region's subordinate position in the international economy. Prebisch (1950) argued that technical progress diffuses unevenly, with innovation generated in the center and absorbed only partially and belatedly in the periphery. Dos Santos (1970) conceptualized dependency as a structural relationship in which external control over capital goods, machinery and technology constrains local learning and reproduces underdevelopment. Marini (1973) emphasized that the adoption of foreign technologies imposes productivity and profitability patterns aligned with core interests, deepening exploitation rather than correcting structural imbalances. Pinto (1970) highlighted the pronounced structural heterogeneity of LA, characterized by enclaves of modern industry embedded within low-productivity sectors unable to internalize imported innovations. Sunkel (1973) showed how the transnationalization of production entrenched external technological paradigms within domestic institutions. Fajnzylber (1983) later deepened this analysis by documenting how persistent technological dependency reproduced cycles of modernization without structural transformation. Together, these authors conceptualized dependency as a condition rooted in the external origin of technological change and in the asymmetric diffusion of knowledge.

From the late twentieth century onward, these classical insights were extended as new mechanisms of technological power emerged. World-system theorists such as Wallerstein (1974), Arrighi (1994) and Amin (1974) stressed that monopolies over innovation and knowledge organize the world-economy into a durable technological hierarchy. Pérez (2004) argues that each technological revolution unfolds through phases in which learning, experimentation and institutional adaptation concentrate overwhelmingly in a small group of early-moving economies. During the "installation" period of a new paradigm, financial and productive restructuring reinforce the advantages accumulated by leading countries, allowing them to institutionalize technological dominance as the paradigm transitions into its "deployment" phase. This framework explains why technological power tends to remain path dependent and geographically clustered, even when emerging economies expand their industrial capacity.

More recent work underscores how dependency has shifted toward intangible assets, data infrastructures and IPRs. Scholars describe this configuration as "intellectual-monopoly capitalism," in which patents, algorithms and platforms operate as central vehicles of power and value extraction (Rikap & Lundvall, 2021). Studies of Industry 4.0 show that the convergence of digital and manufacturing technologies heightens global hierarchies by limiting latecomer upgrading (Flacher et al., 2024). Regional analyses reveal that digital platforms centralize algorithmic learning and data governance outside LA, creating new forms of technological dependency (Franco et al., 2024). Network research confirms that despite the rising presence of actors such as China, technological centrality remains highly concentrated in core economies (Vázquez, 2024; Vázquez Rojo & Visintin, 2024; Winecoff, 2020). These developments constitute a new dependency: updated mechanisms of subordination based no longer primarily on machinery or industrial goods, but increasingly on intangibles, standards, IPRs and digital infrastructures.

GVCs and IPRs lie at the core of these contemporary asymmetries. As organizational structures for production and mechanisms for value appropriation, they reinforce technological hierarchies and configure the global distribution of power. The fragmentation and transnationalization of production are often portrayed as opportunities for upgrading, yet in practice they sustain a stratified architecture: core economies retain high-value functions such as R&D, design and marketing, while peripheral countries specialize in resource-based, low-skill or assembly-intensive tasks (Gracia Santos et al., 2024; Rikap, 2021; Rísquez, 2022). Baldwin and Ito (2022) show that value has increasingly shifted toward intangible activities—a dynamic captured by the "smile curve"—which deepens technological asymmetries by reinforcing the concentration of high-value segments in core economies.

This configuration systematically benefits actors capable of controlling intangible assets and technological capabilities. Within global innovation networks, centrality becomes a form of structural power: the ability to shape standards, norms and technological trajectories without direct coercion (Schwartz, 2019). IPRs regimes institutionalize these dynamics by enclosing knowledge and converting it into exclusive economic assets. Patents transform non-rival knowledge into club goods that generate monopoly rents (Schwartz, 2017), anchoring what Rikap and Lundvall (2021) describe as an economy organized around intellectual monopolies.

The distribution of firms across the global economy mirrors this hierarchical structure. Firms in core economies command frontier technologies, human capital and extensive IPRs portfolios; semi-peripheral firms occupy intermediate positions, often in capital-intensive segments; and peripheral economies specialize in labor-intensive activities with limited scope for technological upgrading (Borja Reis & Pinto, 2022; Xing et al., 2021). Leading technology companies such as Apple, Google and Qualcomm epitomize this hierarchical configuration: by securing exclusive rights over key innovations, they extract rents from suppliers and partners integrated into GVCs (Durand & Milberg, 2020). These dynamics are particularly pronounced in pharmaceuticals, electronics and digital platforms, where IPRs regimes heighten bargaining asymmetries and institutionalize dependency.

For developing countries, the implications are profound. Peripheral economies are typically allocated tasks with low knowledge intensity (Nathan, 2020), which curtails opportunities for value capture, skill formation and wage growth. Barriers to upgrading are reinforced by the concentration of IPR protections in core economies. As intellectual monopolies consolidate, incumbent firms evolve from innovators into rentiers that entrench their dominance through reinvestment in R&D (Rikap, 2023), exacerbating global inequalities in knowledge production and appropriation.

This evolving landscape provides critical context for interpreting contemporary US–China technological rivalry. Pérez's (2004) analysis shows that each technological revolution opens a narrow "window of opportunity" during which countries may reposition themselves, but only if they rapidly align institutions and capabilities with the emerging paradigm. Because such alignment concentrates overwhelmingly in early-moving economies—those where experimentation, finance and regulatory adaptation converge—these windows tend to reinforce rather than disrupt existing technological hierarchies. In the current intangible-intensive paradigm, this concentration is amplified by digital infrastructures, IPRs regimes and data governance systems that operate as levers of structural power (Franco et al., 2024; Vázquez Rojo & Visintin, 2024). Also, emerging AI systems have become a strategic layer of great-power competition, as the US and China increasingly treat algorithms, data infrastructures and compute capacity as elements of techno-nationalist rivalry and instruments of economic security (Kotarski et al., 2025). These dynamics underscore how GVCs, IPRs and transnational patent flows reproduce long-standing patterns of dependency even as the geography of technological rivalry evolves.

Geoeconomic asymmetries are increasingly intertwined with geopolitical competition. Farrell and Newman's (2019) concept of "weaponized interdependence" captures how dominant states exploit their centrality in patents, standards and supply chains to exercise strategic influence. US restrictions on semiconductor exports to Huawei exemplify how such interdependence can be politicized. Historically, the US shaped global technological standards and IPRs regimes to reinforce its structural power (Xing et al., 2021), and China has begun to pursue similar strategies through initiatives such as Made in China 2025 and China Standards 2035, seeking influence in sectors including 5G, artificial intelligence, clean energy technologies and quantum computing (Petersen & Ueta, 2021). The shift in core economies toward nearshoring, reshoring and risk reduction reflects an attempt to reduce exposure to segments of GVCs controlled by rivals and to reconfigure strategic production networks. These adjustments directly affect LA, as some economies have become preferred destinations for export-oriented manufacturing targeting the US market (CEPAL, 2025a).

For LA countries, these shifts introduce new layers of complexity. Traditionally positioned at the periphery of GVCs, the region now confronts the possibility that China's expanding technological footprint may redistribute—but not necessarily reduce—existing dependencies. Whether this evolution represents a genuine structural transformation or merely a reconfiguration of dependency patterns remains an open empirical question. The following section reviews the literature and available evidence on China's expanding presence in LA, examining how trade, investment, and technological engagement have evolved over recent decades. This contextual foundation prepares the ground for the subsequent network analysis of transnational patent flows.

3. China's rising influence in Latin America

Over the past two decades, China has emerged as a central economic actor in LA. According to CEPAL (2025b, 2025c), the US absorbed 56 percent of regional exports and supplied 46 percent of imports in 2000; by 2024, these shares had declined to roughly 44 and 28 percent respectively, even as bilateral trade nearly tripled to US$1.07 trillion. During the same period, China shifted from marginal to structural relevance: its share in total trade with LA rose from 1.7 to approximately 17 percent, while its share in regional exports grew from 1 to nearly 14 percent, surpassing both the European Union and intraregional trade to become the region's second-largest partner.

This shift varies sharply across subregions. Mexico, Central America, and the Caribbean remain closely tied to the US: over 80 percent of Mexican exports and between 40 and 60 percent of those from several Central American and Caribbean economies still flow to US markets. By contrast, China has become the principal trading partner for Brazil, Chile, Peru, and Venezuela, and an increasingly important destination for Argentine and other South American commodity exports.

The sectoral structure of trade also reflects center–periphery logic, though with distinct profiles vis-à-vis the US and China. Trade with the US exhibits a dual pattern: imports from Mexico consist largely of medium and high-technology manufactures—roughly three quarters of US imports from Mexico in 2024—while approximately four fifths of US imports from South America and two thirds from the Caribbean comprise primary goods and resource-based manufactures. Central America and the Dominican Republic occupy an intermediate position, supplying mainly low and medium-tech manufactures.

Trade with China displays greater homogeneity across LA. The region exports primarily minerals, metals, and agricultural commodities while importing medium and high-tech manufactures. CEPAL emphasizes that medium and high-technology goods represent only a marginal share of LA's exports to China, in stark contrast to their weight in imports from China and in trade with the US. This asymmetry is most pronounced in Mexico, which accounts for approximately 85 percent of the region's high-tech manufacturing exports—nearly all destined for the US market—while South American economies exhibit persistent and substantial deficits in high-technology goods. As Li (2021) notes, this reinforces traditional patterns of trade specialization. Zhu (2022) further observes that regional trade with China is heavily centralized around Brazil, Mexico, and Chile, forming a hub-and-spoke configuration that limits knowledge spillovers and technological diffusion across the region.

Despite China's rapid rise in trade, its position in LA's investment structure remains more limited. In terms of accumulated FDI stocks, investment in LA remains overwhelmingly concentrated in advanced economies. The European Union constitutes the largest source of FDI stock at the regional level, while the US remains the single largest investor by country. By contrast, China's share of aggregate FDI stocks is still comparatively small, reflecting its more recent and sectorally concentrated entry into the region (Álvarez et al., 2025).

Turning to recent dynamics, statistics published by CEPAL (2025a) show that Western capital continues to dominate LA when measured through balance-of-payments FDI inflows. Among countries that report inflows by source, the US accounts for approximately 38% of total FDI, the EU (excluding Luxembourg and the Netherlands) for about 15%, intraregional investors for roughly 12%, and China plus Hong Kong for only about 2% in 2024. These figures capture the immediate origin of capital rather than its ultimate ownership and exclude major channels of Chinese corporate engagement, including acquisitions of foreign-owned assets, construction contracts, infrastructure concessions, and development-bank financing. As CEPAL notes, these features systematically understate China's effective investment presence in the region.

Project-level data reveal a broader picture. CEPAL (2025a) reports that Chinese firms announced approximately US$34 billion in projects between 2020 and 2024, three quarters directed toward export-oriented activities and roughly US$20 billion toward manufacturing. China accounted for 23% of announced automotive investment, 34% in electronic components, and 14% in consumer electronics—segments in which more than 80% of regional exports flow to the US market. CEPAL interprets this pattern as a response to derisking pressures and rising geopolitical tensions, with Chinese manufacturers locating production in LA to preserve access to the US market amid tightening American trade and industrial policies.

The China–LAC Monitor compiled by Dussel Peters (2025) corroborates these trends by tracing Chinese investment transaction by transaction, independently of financial routing. Measured this way, Chinese investment in the region reached US$8.53 billion in 2024—an 11.8% decline from 2023 and well below the levels recorded in 2019 and 2022—following a peak of US$23.2 billion in 2010. Average annual flows fell from US$13.8 billion in 2015–2019 to US$11.1 billion in 2020–2024, while China's share of total FDI received by the region declined from 9.1% to 7.0% across these periods and to 4.9% in 2024, the lowest figure since 2012. Over 2000–2024, the Monitor records more than US$200 billion in cumulative Chinese investment across over 600 transactions, associated with substantial job creation and a pronounced shift toward greenfield, labor-intensive projects.

Sectorally, both sources point toward clear reorientation. Chinese investment has moved away from the resource and infrastructure-intensive pattern that dominated the 2000s toward a more diversified presence in manufacturing and domestically oriented services, with rising concentration in automotive, auto parts, and electronics closely linked to value chains serving the US. Although state-owned enterprises still account for a substantial share of the historical stock, private Chinese firms now drive the emerging configuration. This diversification has not, however, altered the broader structure of capital in the region: US and European investors remain predominant in aggregate FDI stocks, and China's overall weight—while increasingly significant in specific sectors and projects—remains comparatively limited when assessed through official BoP statistics.

These trade and investment patterns unfold across a region marked by pronounced structural heterogeneity. Classic analyses noted that technological change in LA occurs in fragmented ways, with pockets of sophistication coexisting alongside large low-productivity sectors (Pinto, 1970; Fajnzylber, 1983). Contemporary studies confirm this view: differences in productive structures, innovation capacity, and institutional quality shape how China's expanding presence is absorbed by each national economy. Brazil's industrial base, Mexico's deep integration into US-centered manufacturing networks, Chile's resource-export specialization, and the limited scientific and technological infrastructure across much of LA generate distinct forms of exposure and dependency. The spread of digital platforms further reinforces these asymmetries by centralizing data and algorithmic learning outside weaker innovation systems (Franco et al., 2024).

The developmental implications of these trends remain contested. Angulo-Bustinza et al. (2023) identify a negative correlation between trade with China and inclusive growth in LA, while Bernal-Meza et al. (2021) emphasize that apparently complementary trade relations conceal deeper neo-dependency dynamics. They argue that commodity-backed loans and vertically integrated supply chains reproduce the region's subordinate position in the global economy. López Arévalo and López Bencomo (2023) reach similar conclusions, demonstrating that even under formal trade agreements, China–LA relations remain embedded in a center–periphery structure characterized by Chinese exports of manufactures and imports of natural resources, with limited intra-industry trade or technological integration.

The technological dimension of Chinese influence has become particularly salient in recent years. Ellis (2022) and Jenkins (2021) document how firms such as Huawei and ZTE have come to dominate the deployment of 5G networks, surveillance systems, and smart-city platforms across several LA countries. Myers et al. (2024) note that Chinese investment increasingly targets emerging sectors such as digital logistics, artificial intelligence, and electric mobility, deepening long-term dependencies on Chinese standards, software, and hardware ecosystems. Wise (2020) describes this as "full-spectrum engagement," in which trade, finance, infrastructure, and digital technologies are integrated through coordinated state–firm strategies, including long-term financing, the internationalization of Chinese standards, and the deployment of turnkey technological systems.

Stallings (2020, 2024) demonstrates that China's entry reconfigures, but does not replace, the center–periphery relationship historically dominated by the US. From the postwar period through the 1990s, US hegemony rested on control over markets, financial centrality, the dominant presence of its multinational corporations, and a combined deployment of leverage and linkage. China's rise since 2000—through trade in natural resources, financing, and infrastructure—has introduced a second pole of influence, particularly over South America. Stallings emphasizes, however, that the region is transitioning toward a system of "dual and asymmetric hegemony," in which China expands opportunities while simultaneously reinforcing primary-export patterns, and the US retains structural centrality in manufacturing, investment, and institutional networks. Contemporary dependency thus operates through linkage mechanisms, with both hegemons competing to shape regional development trajectories. Pires and Nascimento (2020) examine how the US has responded by reviving geopolitical discourses—such as an updated Monroe Doctrine—especially in strategic sectors like telecommunications and energy.

Taken together, this literature suggests that China's regional influence represents a reconfiguration rather than a transformation of structural dependency. Chinese engagement diversifies partners and instruments but does not create new spaces of technological autonomy; instead, it multiplies external anchors. The region remains positioned at the periphery of global innovation networks governed by core states and their firms.

Despite these insights, a significant analytical gap persists. Most studies focus on trade, FDI, infrastructure projects, or geopolitical alignments, while relatively few examine how these interactions translate into changes in China's structural technological power. Empirical work on the networks of patents, IPRs, and technological diffusion that underpin Chinese influence in LA's innovation landscape remains limited. Recent analyses applying network methods to patent data have demonstrated that China has substantially increased its technological influence at the global level (Vázquez Rojo & Visintin, 2024; Winecoff, 2020; Yang et al., 2019) and across the African continent (Vázquez, 2024). This approach has not, however, been systematically applied to LA.

This article addresses that gap by applying SNA to examine LA's regional patent network. This approach enables assessment not only of which countries lead in technological presence, but also of how that presence is distributed, embedded, and consolidated across the region, thereby revealing the emerging structure of technological dependency. In doing so, it provides a structural perspective on China's technological influence that complements existing research on trade, investment, and geopolitical rivalry, while empirically examining whether the regional patent network retains its traditional center–periphery configuration or is undergoing fundamental reconfiguration.

4. Methodology

This study applies SNA to examine the structural dynamics of technological diffusion into LA through foreign patent activity. SNA provides a powerful framework to map directional relationships over time, assess the centrality of global actors, and evaluate the degree of concentration and diversification in cross-border knowledge flows. By conceptualizing patent exchanges as proxies for technological influence, this approach operationalizes the key theoretical constructs of asymmetry, dependency, and structural power discussed in Section 2.

The empirical analysis focuses on 13 LA countries selected based on data availability and continuity between 2013 and 2023: Argentina, Brazil, Chile, Colombia, Costa Rica, Cuba, the Dominican Republic, El Salvador, Guatemala, Honduras, Mexico, Peru, and Uruguay. Together, these countries account for over 80% of the region's GDP and population, ensuring that the network captures the core technological dynamics within LA.

Patent data were obtained from the World Intellectual Property Organization's Intellectual Property Statistics Data Center (WIPO, 2025), which annually collects information on transnational patent registrations. A transnational patent is defined as a patent initially filed in country i and subsequently recognized in country j. The dataset records three key pieces of information: (i) the origin country where the patent was first registered; (ii) the destination country where the patent was later recognized; and (iii) the year of recognition.

Following established methodological approach (Vázquez, 2024; Vázquez & Visintin, 2024; Winecoff, 2020; Yang et al., 2019), the analysis focuses exclusively on national-level filings, excluding regional offices such as the European Patent Office to avoid duplication. Only transnational patents are considered, filtering out domestic patents to ensure that the network reflects genuine cross-border technological diffusion. This choice mitigates biases associated with national patenting strategies and prioritizes high-quality, internationally relevant innovations. Moreover, the network is intentionally restricted to inbound flows toward LA countries to isolate external technological influence.

The resulting structure is modeled as a weighted directed network, $G = (V, E, W)$, where V represents the set of nodes (countries), E the set of directed edges (patent recognitions), and W a matrix of edge weights corresponding to the number of patent applications from origin i to destination j. Nodes are connected if at least one patent is recognized between them during the period.

Several network metrics were computed to characterize the structure and evolution of technological diffusion into LA. First, the complementary cumulative distribution function (CCDF) of edge weights was calculated by aggregating patent filings between 2013 and 2023 for each origin–destination pair. CCDF plots the probability that a link has a weight greater than or equal to a given value. When represented on a log-log scale, it allows detection of heavy-tailed distributions, in which a small number of links concentrate the majority of flows, revealing hierarchical network structures and preferential attachment dynamics typical of power-law networks (Clauset et al., 2009).

Second, in-strength centrality was computed for each LA country as a measure of technological absorption. This weighted centrality indicator captures the total volume of international patent recognition received annually from all origin countries. Values were normalized using a $\log_{10}(x + 1)$ transformation to correct for distributional skewness and enhance comparability (Winecoff, 2020).

Third, out-strength centrality was calculated for all emitter countries as a measure of their technological diffusion power toward the region. This metric quantifies the annual number of patents each emitter registered in LA countries, reflecting its influence in cross-border knowledge flows. Special attention was paid to the US, China, and other leading global actors. Log-transformation was again applied to reduce the impact of skewed distributions (Winecoff, 2020).

Finally, the Herfindahl–Hirschman Index (HHI) was computed annually for each LA country to assess the concentration of technological dependence. The HHI is calculated by summing the squared shares of patents received from each emitter relative to the total inflow. Values approaching 1 indicate high concentration (i.e., reliance on a few sources), while values closer to 0 reflect diversification. This index, adapted from Motta-Santos et al. (2025), offers a robust measure of exposure to technological dominance.

Each of these metrics operationalizes a specific theoretical dimension discussed in Section 2. The CCDF of edge weights captures the hierarchical architecture of the network, identifying whether a small number of countries dominate technological diffusion into LA—consistent with center–periphery structures and preferential attachment dynamics. In-strength centrality measures the degree of technological dependence of LA countries by quantifying the intensity of external patent flows they absorb. Out-strength centrality reflects the technological power projection of emitter countries—particularly the US and China—through their capacity to insert patents into the region and occupy central positions within the network. The HHI quantifies the concentration of technological influence within each LA country, revealing whether external dependency is distributed or heavily reliant on a few dominant actors.

Together, these indicators provide a comprehensive empirical basis for analyzing structural asymmetries, technological dependency, and the evolving dynamics of technological power in LA. By combining weighted centrality and concentration measures, the methodology enables empirical assessment of the relative influence of global actors—particularly the US and China—within the regional patent network. This framework directly supports the study's central objective: to evaluate whether China's rising technological presence is reshaping, reinforcing, or diversifying existing patterns of dependency traditionally dominated by the US.

While transnational patents serve as robust proxies for international technological diffusion, this approach has inherent limitations that merit acknowledgment. Patents vary in their technological significance, commercial relevance, and strategic intent: some represent frontier innovations that shape industry standards, while others constitute defensive filings with limited economic impact (Tong & Frame, 1994; Frame, 1991; Yang et al., 2019). Following established practice in network-based patent research (Vázquez, 2024; Vázquez & Visintin, 2024; Winecoff, 2020; Yang et al., 2019), our analysis treats patents as structural indicators of cross-border technological linkages rather than as homogeneous units of innovative value. The focus therefore lies on relational patterns within the global patent network rather than on the intrinsic quality of individual patents. Additionally, cross-national differences in intellectual property regimes, innovation systems, and patenting practices influence the propensity to file abroad, independently of underlying technological capabilities.

The network approach also abstracts from the pronounced structural heterogeneity of LA economies—including disparities in industrial development, research capacity, and institutional quality—which, while central to understanding technological trajectories, lies beyond the scope of a SNA. These limitations do not diminish the analytical value of the approach but rather delimit its scope: the findings capture the structural configuration of transnational patent flows as one specific and empirically tractable channel of technological influence, complementing rather than substituting for analyses of other dimensions of technological power.

5. Results

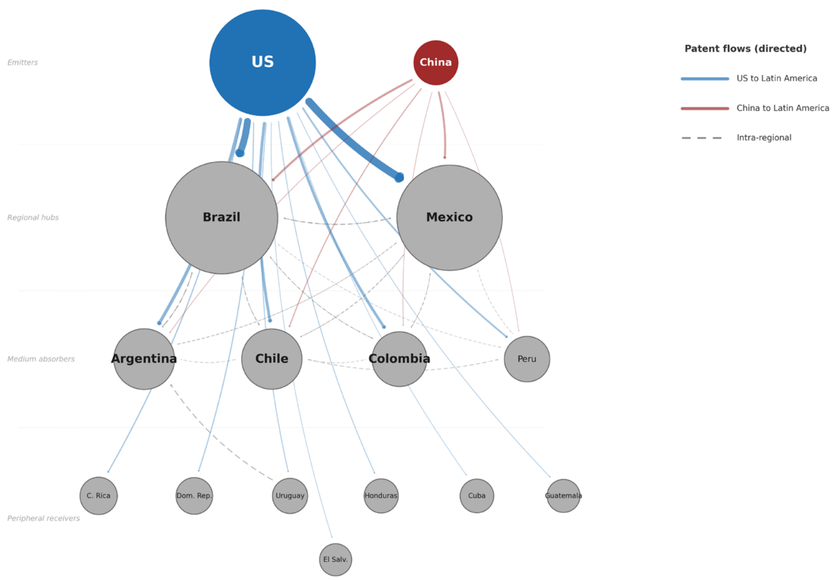
This section presents the empirical findings following the structure outlined in the methodology. The analysis begins with the overall architecture of the LA patent network, proceeds through weighted centrality metrics for emitters and recipients, and concludes with an examination of concentration patterns using the HHI.

The evolution of the regional patent network between 2013 and 2023 (Figure 1) reveals a marked increase in the number of connections, while overall network density remains relatively stable. This indicates uneven expansion, where new ties concentrate around a few structurally central nodes rather than distributing uniformly.

The persistence of low reciprocity throughout the period confirms LA countries primarily act as recipients rather than originators of technological flows, displaying stable directional asymmetry with inflows far exceeding outflows for most countries.

Visual inspection of the network shows that by 2013, a core–periphery structure was already clearly present, with a handful of origin countries dominating patent flows into the region. Over the following decade, this pattern not only persisted but intensified. By 2023, the network had grown yet retained its hierarchical shape, with core countries—most notably the US—occupying central positions from which technological influence radiates. In contrast, LA countries remained largely peripheral, underscoring the reproduction of structural technological dependency. Notably, Brazil, Mexico, and Chile began to act as regional gateways, receiving and partially intermediating external technological flows.

FIGURE 1: LA REGIONAL PATENT NETWORK (2013-2023)

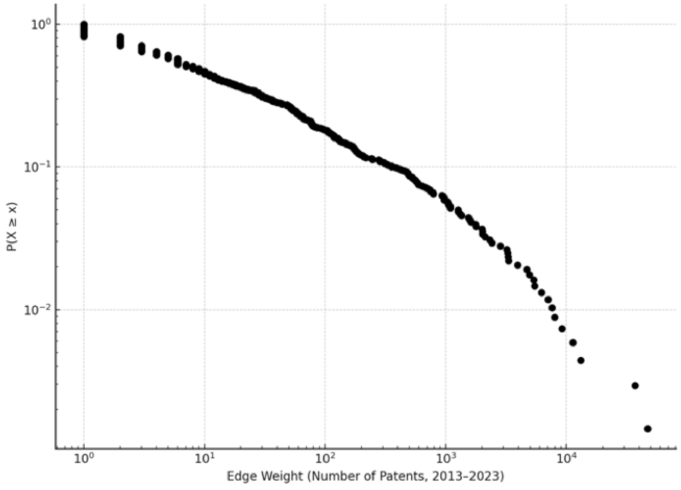


Source: WIPO and own elaboration.

To further assess the structural configuration of the network, the complementary cumulative distribution function (CCDF) of edge weights was plotted on a log-log scale (Figure 2). The distribution displays a clear heavy-tailed pattern, in which a small number of origin–destination links account for disproportionately high volumes of patent activity, while most connections remain marginal. This configuration reflects power-law behavior and supports the presence of preferential attachment dynamics, whereby already central actors attract a growing share of flows over time.

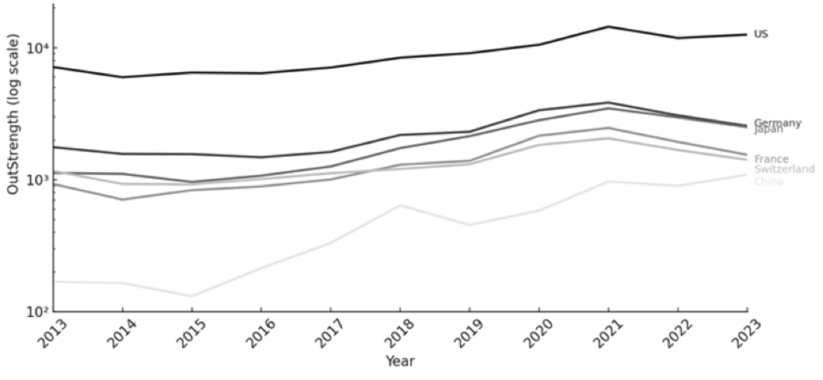
Turning to out-strength centrality, Figure 3 shows the evolution of the main global emitters of patents toward LA. The US consistently maintained a dominant position, with emission volumes at least one order of magnitude higher than any other country. Germany, Japan, France, and Switzerland followed at significant distances, displaying relatively stable trajectories. China, although starting from a very low base, exhibits sustained and accelerating growth after 2015. Between 2013 and 2023, China's out-strength toward LA rose almost sevenfold, from 171 to 1,153 patents, whereas US emissions grew by less than a factor of two, from 7,382 to 13,169. Although this represents the fastest relative growth among major emitters, the absolute difference with the US remained substantial throughout the period.

FIGURE 2: CCDF OF EDGE WEIGHTS (2013-2023)



Source: WIPO and own elaboration.

FIGURE 3: TOP 5 + CHINA OUT-STRENGTH CENTRALITY

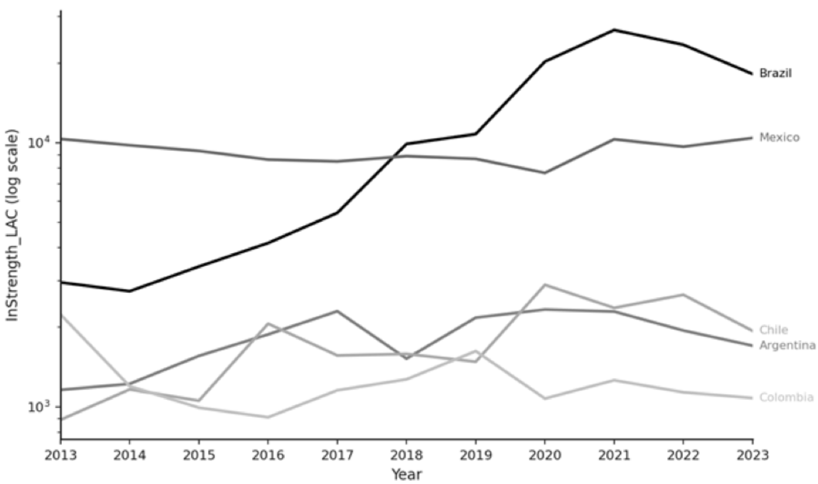


Source: WIPO and own elaboration.

Regarding in-strength centrality, Figure 4 shows the evolution of technological absorption among LA countries. Mexico and Brazil emerged as the primary destinations of foreign patent activity: Mexico maintained stable and consistently high inflows, while Brazil displayed marked acceleration from 2017 onward. From 2018 onwards, Brazil not only accelerated but consistently overtook Mexico in total patent inflows, consolidating its position as the region's main absorption hub. Other countries such as Argentina, Colombia, and Peru remained in relatively marginal positions, with lower and more volatile absorption rates. These disparities reflect the internal stratification of technological dependence within LA: a dual core composed of Brazil and Mexico, surrounded by a wide periphery of economies with much thinner and more unstable technological linkages.

A complementary analysis of intra-regional flows reveals that endogenous technological exchange within LA remained minimal. Throughout the period, patents originating from LA countries accounted for only 0.8% to 1.5% of total filings in the region, with a single peak of 5.15% in 2014. By 2023, this share had fallen below 1%, reinforcing the notion that the region functions primarily as a recipient of external technologies rather than as an autonomous source.

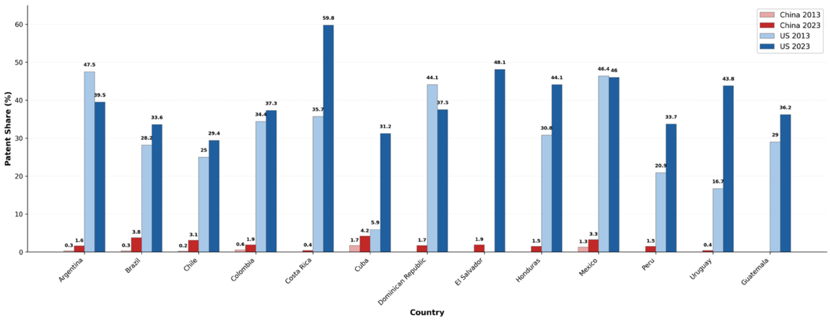
Figure 4: Top 5 in-strength centrality



Source: WIPO and own elaboration.

Figure 5 compares the relative shares of US and Chinese patents received by major LA economies in 2013 and 2023. While the US continues to dominate across all countries, China's presence expanded significantly over the decade, particularly in Brazil, Chile, and Mexico, where its share surpassed 3% by 2023. The temporal comparison also shows that US shares remained high and, in several cases, even increased—for example, from 28.2% to 33.6% in Brazil, from 25.0% to 29.4% in Chile, and from 28.9% to 33.7% in Peru. China's participation rose from below 1% to between roughly 1.5% and 3.8%, adding new technological linkages without eroding the historically consolidated weight of the US. China's penetration thus advanced rapidly in relative terms but did so alongside—rather than in place of—long-standing US technological dominance.

Figure 5: Evolution of China and US patent share in LA (2013 vs 2023)

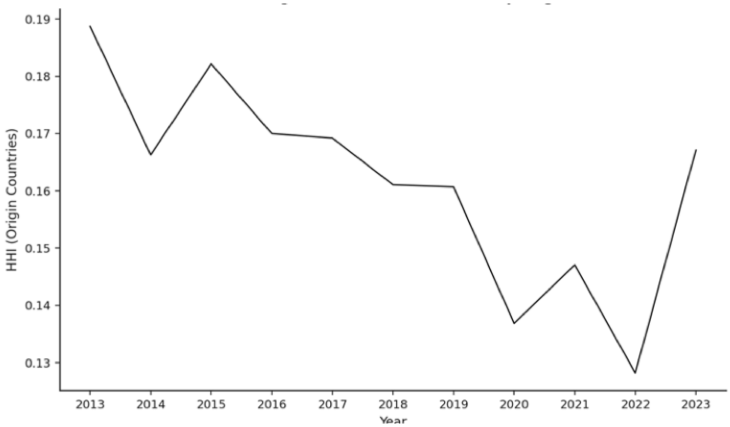


Source: WIPO and own elaboration.

Finally, Figure 6 presents the HHI for patent origin concentration across the region. At the aggregate level, HHI values oscillated between 0.16 and 0.19 over the period, indicating moderate but persistent concentration of technological inflows. The US share declined slightly—from 40.2% to 37.8%—while China increased its share from 0.44% to 2.75%. These trends point to incipient diversification, though the overall structure remained shaped by a limited number of dominant emitters.

Country-level variation reveals important differences in dependency intensity. Brazil, Chile, and Peru exhibited relatively low HHI values, suggesting more diversified portfolios of technology sources. In contrast, Mexico and several smaller Central American economies—including Costa Rica, El Salvador, and Honduras—displayed high HHI scores, indicating heavy reliance on one or two emitters, primarily the US. These differences underscore how structural dependency is unevenly distributed across the region.

Figure 6: HHI index in Latin America



Source: WIPO and own elaboration.

6. Discussion

The empirical findings reveal that LA's patent network remains characterized by enduring structural asymmetries. While China's growing presence introduces a new axis of influence, the overall architecture remains hierarchical and centered on pre-existing power poles. Rather than replacing US technological dominance, China's role appears to complement and redistribute it, reinforcing the persistence of a core–periphery configuration. This section interprets these patterns in light of the theoretical framework outlined in Section 2, examines their convergence with broader trade and investment dynamics, and discusses their implications for understanding contemporary technological dependency in the region.

The technological structure revealed through patent networks aligns closely with the commercial and investment patterns documented by CEPAL (2025a, 2025b, 2025c) and Dussel Peters (2025). In aggregate terms, US centrality as the principal emitter of technology toward LA reproduces with remarkable consistency its positions in FDI and trade. US out-strength maintained an order of magnitude above any other country throughout the 2013–2023 period, reflecting the same hierarchy documented in FDI flows—where the US accounted for approximately 38% of total inflows in 2024, far exceeding China and Hong Kong's 2% share in balance-of-payments statistics—and in the trade orientation of Mexico, Central America, and the Caribbean. The persistence of the US as the dominant technological core thus proves fully coherent with its condition as structural trade partner and principal aggregate investor in the region.

The Chinese expansion identified in our technological metrics also aligns with observed trends in trade and investment. Between 2013 and 2023, China multiplied its out-strength toward the region sevenfold and increased its participation in major LA recipients—Brazil, Chile, and Mexico—to levels exceeding 3%, paralleling the growth CEPAL highlights in bilateral trade, whose weight rose from 1.7% in 2000 to 17% in 2023. Similarly, the greater presence of Chinese patents in South American countries coincides with China's consolidation as a dominant trading partner in primary commodities and with the recent diversification of Chinese outward FDI toward manufacturing, services, and knowledge-intensive sectors. The China–LAC Monitor shows that despite the decline in official FDI captured through balance-of-payments data in 2020–2024, Chinese corporate activity has expanded through greenfield investments, manufacturing projects, and digital activities, reinforcing the reading of growing technological integration albeit from reduced levels compared to the US.

The regional heterogeneity emerging from our in-strength metrics also reproduces patterns described in trade and FDI studies. The "dual core" formed by Brazil and Mexico—clearly visible in patent absorption—coincides with their role as principal FDI recipients and regional productive centers. Mexico maintains high stability in receiving external technology, consistent with its deep integration into North American value chains, while Brazil shows marked acceleration after 2017, reflecting both its role as a destination for Chinese FDI and its growing weight in sectors intensive in natural resources, energy, and manufactures. By contrast, countries such as Argentina, Colombia, and Peru exhibit more fragile and volatile technological positions, consistent with their primary-export profiles and the lower density of high-technology FDI linkages identified by CEPAL and the Monitor.

The sectoral shift documented in Chinese FDI—from primary commodities toward manufacturing (24.3% of total in 2020–2024) and domestically oriented services (27.7%)—finds partial echo in our data. The increase in Chinese patents in Brazil and Mexico may be associated with sectors linked to transport, electronics, and machinery, the same areas in which CEPAL identifies a surge in Chinese investment announcements during 2020–2024. The export orientation of these projects toward the US, resulting from derisking and geopolitical reorganization of value chains, suggests that Chinese technological penetration in LA use the region as a productive platform to maintain access to the US market.

Two important nuances nevertheless emerge. First, the growth rate of Chinese technological presence exceeds that observed in official FDI, whose share has declined over the past decade. This mismatch indicates that Chinese technological projection also operates through channels not fully captured by balance-of-payments statistics—triangulated investments, acquisitions of assets not recorded as FDI, technology transfer, and corporate cooperation—a phenomenon Dussel Peters explicitly emphasizes. Second, although China has already become a structural trading partner for much of South America, its technological participation remains modest in comparative terms, suggesting a lag between achieved commercial depth and the consolidation of more complex technological capabilities.

Taken together, the available evidence depicts a scenario of dual dependency: the US maintains technological hegemony and investment primacy, while China consolidates a growing commercial presence alongside a dynamic but still less central technological role. Our results show that the ongoing reconfiguration does not consist of replacing the traditional center but rather of overlapping linkages: China gains ground in trade, sectoral FDI, and patents, but does so within a structural architecture historically shaped by the US, whose centrality remains the region's dominant reference.

These findings align with theoretical expectations formulated by Rikap and Lundvall (2021) and Schwartz (2019), who emphasize that control over intangible assets such as patents plays a key role in perpetuating hierarchical power structures within GVCs. The persistence of a center–periphery configuration in LA's technological network mirrors Winecoff's (2020) argument about the resilience of structural power within complex global systems, even amidst shifting geopolitical conditions. The CCDF analysis confirms the existence of heavy-tailed distributions in patent flows, indicating that technological influence remains highly concentrated among a few dominant emitters. Weighted centrality metrics highlight the central roles of the US and, to a growing but still secondary extent, China, in structuring technological flows into the region. The HHI results reveal moderate but persistent levels of concentration, suggesting that diversification of technological sources is occurring slowly and unevenly across LA.

Our results also resonate with Stallings's (2020, 2024) argument that competition between the US and China does not imply hegemonic substitution but rather partial reconfiguration of dependency at the periphery, where China expands commercial and financial presence without displacing US technological centrality. Although China rapidly increases its technological projection in LA, it does so from very low levels, while US out-strength and participation in the region's major economies remain at substantially higher magnitudes. The persistent asymmetry in knowledge flows and technological positions confirms Stallings's thesis of emerging "dual dependency": China creates new economic and productive linkages, but the regional technological structure remains anchored in the US, which retains control over the most complex and strategic knowledge nodes.

When contrasted with the broader literature on China's growing role in LA (Ellis, 2022; Jenkins, 2021; Myers et al., 2024), our findings suggest a more nuanced scenario. While these studies document China's expanding influence in sectors such as trade, infrastructure, and digital technology—particularly through firms such as Huawei and ZTE dominating 5G networks, surveillance systems, and smart-city platforms—our analysis indicates that in the specific domain of IPRs, particularly patent registrations, China's structural presence remains comparatively limited. This divergence points to sectoral asymmetries in China's engagement with the region: while economically significant in infrastructure and digital deployment, its technological influence through formal innovation assets has yet to reach transformative scale.

This sectoral asymmetry is reinforced by regional variation in China's structural positioning. A comparative reading of our findings reveals that China's position in LA's patent network diverges significantly from patterns observed in other peripheral regions. In Africa, Vázquez (2024) demonstrates that Chinese firms have achieved a structurally central position, reshaping the continental patent network and displacing European actors that historically dominated technological flows. At the global level, Vázquez Rojo and Visintin (2024) show that, although China has not surpassed the US, it has consolidated itself as the second structural node of the world patent network, benefiting from cumulative growth mechanisms that reinforce already central actors. In contrast, our results for LA suggest that China's influence remains relatively limited and does not appear to generate strong regional lock-in effects or a clear hierarchical reordering of technological flows. This divergence indicates that the mechanisms through which China expands its technological footprint—visible in Africa and at the global scale—may operate more unevenly in LA, where long-standing US embeddedness, dense legacy networks, and the absorptive weight of Mexico and Brazil continue to shape the region's technological dependency.

A complementary structural factor helping explain the persistent predominance of the US in the regional patent network is the long-standing presence of US multinational corporations in LA. As documented in the literature on dependency and global production networks, US subsidiaries have been deeply embedded in the productive structures of many LA economies for decades, especially in Mexico, Central America, and several smaller South American countries. This historical density translates into a significant and persistent technological imprint: large US firms continue to dominate high-value segments in manufacturing, pharmaceuticals, information and communication technologies, and business services, reinforcing their centrality as the main external source of technological knowledge for the region. The structural weight of these corporate networks—which predates China's expansion by several decades—helps contextualize why, despite China's rapid growth in relative terms, US patent emissions remain an order of magnitude higher and its technological influence structurally entrenched.

In addressing the research question posed in the introduction, the evidence points to a redistribution of technological influence rather than a fundamental transformation of dependency patterns. China's growing footprint introduces a degree of diversification, most notably in countries such as Brazil and Chile, yet the underlying hierarchical architecture of technological dependency remains firmly centered on the US. The findings thus support a view of incipient diversification in technological flows—with China emerging as a secondary pole of influence—without dismantling the structural core–periphery dynamics embedded within LA's integration into the global knowledge economy. The regional technological network exhibits what might be termed "asymmetric dualization": the addition of a new external anchor that expands options but does not fundamentally alter the hierarchical structure or reduce overall external dependency.

These insights contribute to understanding how technological power is reproduced, rather than disrupted, across peripheral regions. They suggest that structural asymmetries persist even as new actors gain presence, reinforcing the importance of examining technological dependency through network-based and relational frameworks rather than purely through economic volume or sectoral expansion.

The following section concludes by synthesizing these findings, reflecting on their implications for the study of technological dependency and global power dynamics, and suggesting avenues for future research on the evolving role of China and other emerging actors in shaping regional technological landscapes.

7. Conclusions

This article examined the extent to which China's rising technological influence in LA is reshaping the region's historical patterns of external technological dependence, traditionally dominated by the US. By applying SNA to transnational patent flows between 2013 and 2023, and focusing on weighted centrality and concentration metrics, the study mapped the evolving structure of technological power in the region.

The findings suggest that although China's footprint in the LA patent network has expanded significantly—particularly in countries such as Brazil and Chile—it has not yet fundamentally altered the core–periphery configuration of technological relations. The US continues to occupy a structurally dominant position, especially in terms of patent-based technological diffusion. China's growing engagement appears to represent a process of diversification rather than disruption of existing asymmetries. The results thus point to "asymmetric dualization": a redistribution of influence that adds a secondary external anchor without transforming underlying dependency structures.

This study makes three principal contributions to literature on global technological power and structural dependency. First, it applies network-based analysis of transnational patent flows to LA for the first time, demonstrating that this methodological approach offers a precise empirical lens for mapping structural asymmetries in cross-border knowledge diffusion that complement existing evidence from trade and investment data. Second, it provides systematic evidence that the patterns of dual dependency documented in commercial and financial relations are reproduced—and in some respects intensified—in the domain of formal intellectual property rights: while China's technological projection in LA grows rapidly in relative terms, it operates within pre-existing hierarchical structures in which the US retains an order-of-magnitude advantage in patent-based influence. Third, the study reveals that technological dependency in the region exhibits "asymmetric dualization": a configuration in which diversification of external sources proceeds without reducing overall external dependence or altering the core–periphery architecture of the regional innovation network.

These findings carry broader theoretical implications. They suggest that the contemporary reorganization of GVCs and the intensification of US–China rivalry do not necessarily dismantle center–periphery relations but may instead reconfigure them by multiplying external anchors. For peripheral regions such as LA, this reconfiguration introduces new options and partners without generating autonomous technological capabilities or reducing structural exposure to decisions made in core economies. The persistence of hierarchical network structures—evidenced through heavy-tailed distributions, concentrated centrality, and moderate HHI values—underscores the resilience of intellectual monopoly capitalism even as new actors gain ground.

Several limitations merit acknowledgment. While international patents serve as robust indicators of cross-border technological influence, they capture only one dimension of technological power. The analysis abstracts from other important channels of technological engagement—including foreign direct investment in R&D, trade in high-tech goods, technology licensing agreements, and the deployment of digital platforms—which may reveal additional facets of China's and the US's regional influence.

Future research could build on this framework in several directions. First, comparative analysis of other forms of IPRs—particularly trademarks, which signal brand power and consumer market penetration—would enrich understanding of how technological and commercial influence are exercised across sectors and institutions. Second, given that similar network-based approaches have been applied to Africa, extending systematic comparative analysis across peripheral regions such as Southeast Asia would clarify whether the patterns observed in LA reflect region-specific dynamics or broader structural features of technological dependency in the global South. Third, integrating patent network analysis with qualitative case studies of specific sectors—such as electric vehicles, renewable energy, or digital infrastructure—would provide deeper insight into the mechanisms through which technological influence translates into strategic dependence. Finally, further work is needed to explore the role of regional actors, including local firms, state institutions, and South–South cooperation initiatives, in mediating or contesting external technological dependence.

In sum, this article contributes to the growing literature on global technological power by offering a relational, network-based perspective on the dynamics of dependency and diversification in LA. The evidence presented suggests that while China's technological rise is notable, the structural imprint of US dominance remains deeply embedded in the region's integration into the global IPRs regime. The regional technological network exhibits incipient diversification but not structural transformation: new linkages emerge, yet hierarchical asymmetries persist. Understanding how these asymmetries evolve—and under what conditions they may be transformed—remains a central challenge for scholarship on technological dependency, global power dynamics, and the political economy of innovation in an era of intensifying geopolitical competition.

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