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Technological sovereignty and smart power of the European Union in an unstable geopolitical context: the African scenario as an example of application

Abstract

The debate on the scope of the concept of technological sovereignty, and especially its implications, has gained momentum in the context of the European Union (EU) to guarantee the principle of «strategic autonomy», which has become a crucial common political piece to strengthen the bloc's position in the world. However, its political and aspirational nature, albeit abstract in its concreteness, has not been translated into defined objectives in time, space and opportunity. The article frames the discussion in the conditions of geopolitical instability that pervade international dynamics and discusses the rationality of the notion of 'smart power' as the key option for the EU in the context of implementing its strategic autonomy. On this basis, it analyses the EU and China's presence in Africa and its possible impact on the future evolution of European strategic autonomy.

Keywords

Technological Sovereignty, Smart Power, European Union, China, Africa

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Introduction

Technological sovereignty in the context of strategic autonomy

The redrawing of balances between world powers has geopolitical ramifications that spill over into economics and international affairs, unfolding in the form of military, industrial, technological and digital web competition¹. The uncertainty caused by these dynamics provides the basis for discussing theoretically and empirically a consistent analytical framework to address the prospects for the European Union (EU) in the coming decades.

Technological sovereignty, understood as having the capacity to make decisions affecting the development and use of advanced technologies without unilateral dependence on other actors, is considered a key factor in increasing the strategic autonomy of a state or federation of states. This allows it to make unconditional choices in many policy areas affected by the evolution of Artificial Intelligence and its widespread diffusion in society². From the opposite direction, without sufficient political will to obtain strategic autonomy, it does not seem possible to achieve the appropriate level of technological sovereignty. Ultimately, a strong and coherent long-term policy determination is required to forge partnerships and invest selectively in both key enabling and emerging technologies.

In practice, this dual commitment implies deciding on multiple interrelated dimensions that affect the international positioning of states, both individually and as part of a coalition. To this end, the application of a variety of policy instruments is indispensable, but in an integrated manner ensuring that they are closely linked and aligned towards concrete objectives. Success will depend on the ability to define, adapt and maintain both perspectives and versatile long-term strategies, combined with the appropriate scientific and technological capacity to attract allies to one's objectives, which may sometimes require assertive attitudes in the international arena.

The debate on the consequences of the concept of technological sovereignty, but especially its implications on public and private actors, has gained momentum in the

¹ Petricevic, O. and Teece, D.J. (2019). The structural reshaping of globalization: Implications for strategic sectors, profiting from innovation, and the multinational enterprise. *Journal of International Business Studies*; Ortega, A. (2020). La carrera entre EE. UU. y China y el futuro de las relaciones transatlánticas. *Documento de trabajo 12/2020*. Real Instituto Elcano; Mori, S. (2019). US Technological Competition with China: The Military, Industrial and Digital Network Dimensions. *Asia-Pacific Review*, 26:1, 77-120; Kaplan, R.D. (2019). A new cold war has begun. *Foreign Policy*, 7 January. Available at: <https://foreignpolicy.com/2019/01/07/a-new-cold-war-has-begun/>

² Fiott, D. (2018). Strategic autonomy: towards 'European sovereignty' in defence? *Brief issue 12*. European Union Institute for Security Studies (EUISS), November. Available at: https://www.iss.europa.eu/sites/default/files/EUISSFiles/Brief%2012__Strategic%20Autonomy.pdf

EU context framed by the principle of ‘strategic autonomy’ which became a key common policy piece to strengthen the European position in the world³. Strategic autonomy is a central concern of the bloc’s policy-makers, expanding its boundaries from defence and security to new economic and technological issues. The core of the idea of ‘autonomy’ has been described by the High Representative for Foreign and Security Policy as a process of political survival of the EU capable of acting as a ‘global actor’ and as an expression of the will of the European Commission chaired by Ursula van der Leyen to act as a Geopolitical Commission⁴.

The Community strategy aims to retain its leading role in scientific development while increasing its role in enabling and emerging technologies, while preserving the values and principles of their ethical use in society. In this sense, the concept of ‘open strategic autonomy’ expresses the synthesis between the ability to make one’s own decisions, and to shape the world around it through leadership and commitment to maintaining the highest level of international cooperation in science and technology⁵.

However, the term technological sovereignty must translate its political and aspirational nature, albeit abstract in its concreteness, into defined objectives in time, space and opportunity. Tindermans⁶ notes that European regulations rule out the creation of monopolies centred on public or controlled companies acting as ‘national champions’ as has been attempted in the past. Also, lack of resources makes self-sufficiency illusory, especially in a globalised world. In that perspective, he proposes a more pragmatic approach in which the EU should avoid using technological sovereignty as a fuzzy global notion and instead promote a precise definition that leads to specific goals. Franke and Torreblanca stress the need to weigh the «geopolitical implications and geopolitical power elements of technology» to the extent that the economic perspective has tended to ignore them⁷. Leonard and Shapiro underline as a condition for upholding multilateralism without abandoning rules or leaning towards protec-

3 Borrell, J. (2020). Why European Strategic Autonomy Matters. *A Window on the World - Blog by HR/VP*. Dec. Available at: <https://eeas.europa.eu>; Anghel, S., et al. (2020). On the path to strategic autonomy. The EU in an evolving geopolitical environment. *EPRS | European Parliamentary Research Service*. PE 652.096 – September. Available at: [https://www.europarl.europa.eu/RegData/etudes/STUD/2020/652096/EPRS_STU\(2020\)652096_EN.pdf](https://www.europarl.europa.eu/RegData/etudes/STUD/2020/652096/EPRS_STU(2020)652096_EN.pdf)

4 European Commission (2020). State of the Union 2020: Building the world we want to live in: A Union of vitality in a world of fragility (16/09/2020). Brussels, Belgium; Borrell, J. (2020). *Op. cit.*

5 European Commission (2021). Global Approach to Research and Innovation. Europe’s strategy for international cooperation in a changing world. Brussels, Belgium.

6 Tindermans, P. (2020). Technological sovereignty: from the hype to the real questions. *Science Business*, 29 Sept. Available at: <https://sciencebusiness.net/technology-strategy-board/viewpoint/technological-sovereignty-hype-real-questions>

7 Franke, U. and Torreblanca, J.I. (2021). Geo-tech politics: Why technology shapes European power. *Policy Brief*, 15 July. *European Council on Foreign Relations*. Available at: <https://ecfr.eu/publication/geo-tech-politics-why-technology-shapes-european-power/>

tionism, that Europeans «[push] for new rules that would allow them to act against countries that undermine the international system»⁸.

In this regard, it is reasonable to note that even if the right policy tools were available, but in isolation, the ability to articulate them into a coherent ‘package’, implement them and then monitor their effectiveness would not be straightforward. Thus, even if the chosen policy package could harmoniously concert several instruments to avoid undesirable side-effects within the targeted technological domain, its indirect impact is broader and could persist over time in society, as history has shown.

However, technological sovereignty cannot be seen solely as a ‘defensive term’ aimed at reducing technological dependence, as it was understood in the second half of the last century. It is now used in a broader sense, where mutual influence in other policy areas reflects the central role technology plays in modern societies as part of the concept of strategic autonomy at both national and international levels, and its influence on the structuring of technological alliances between countries (see figure 1).

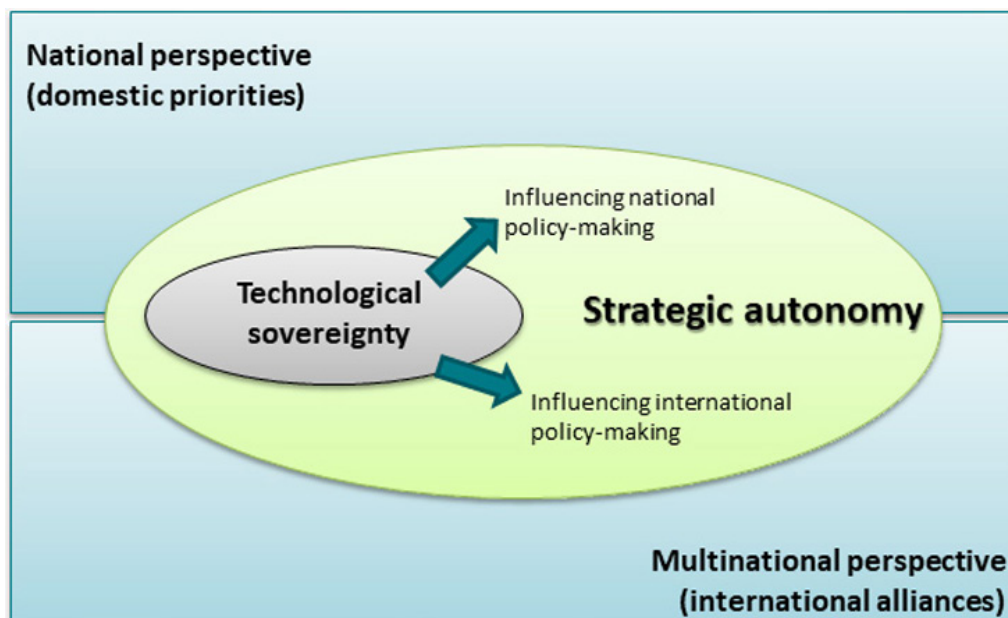


Figure 1. Relationship between strategic autonomy and technological sovereignty (Source: prepared internally)

The new dimension that is gaining momentum in this century is the emergence of the relevance of the dominance of technology in international affairs as part of visions of national interests. The significance of the above consideration is not limited to the use of advanced technology when it is incorporated into products and systems deployed to fulfil their operational function (in armaments, cyber security, high value-added exports, etc., where performance is highly dependent on digital tools), but also to gain superiority, control of technological knowledge, know-how for the devel-

8 Leonard, M. and Shapiro, J. (2020). Sovereign Europe, dangerous world: Five agendas to protect Europe’s capacity to act. *Policy Brief 1. European Council on Foreign Relations*, December. Available at: <https://ecfr.eu/publication/sovereign-europe-dangerous-world-five-agendas-to-protect-europes-capacity-to-act/>

opment of advanced products, and rules to be accessible by third countries as a goal to achieve global competitiveness in the future. Mastering emerging technologies is the key to building future dominance.

This raises a number of questions: What does technological sovereignty mean and imply when used in the EU? What are the policy instruments at its disposal to implement its strategy in a global context? How can they be combined? How can it act in third countries or regions in direct competition with other major technological powers?

The article is organised as follows. It begins by framing the debate on technological sovereignty in the context of the geopolitical instability affecting the international scene. It then discusses the concept of 'smart power' as a strategic option and its articulation with three levels of technological sovereignty. It then analyses the framework of European technological sovereignty and smart power in the African context in which other major technological powers such as China interact. Finally, it presents the implications of this approach and a set of concluding remarks.

The Technology Sovereignty Framework: Lessons Learned from the COVID-19 Pandemic

Global value chains have grown so much in the last three decades because they have generally brought significant benefits. Their side-effects, dependence and interdependence, therefore seemed to be seen as an acceptable condition for their realisation. However, assuming a global scenario in which economic dynamics and trade flows are implemented according to an economic logic isolated from geopolitics and security is impossible to sustain⁹.

The concept of technological sovereignty is still under debate due to the complexity of matching it with the prevailing theoretical frameworks on innovation¹⁰. State intervention aimed solely at correcting market failures, productive outsourcing associated with boosting economic competitiveness or transitions towards sustainability presuppose multilateral behaviour and international trade based on stable and consensual rules, which is not always the case.

If one accepts as a starting point the two principles enunciated by Edler et al: *1) international fair trade increases efficiency, and 2) international cooperation in innovation allows mutual learning for the benefit of all*, the implementation of technological sover-

9 Hobbs, C. (2020). Europe's Digital sovereignty: from rulermaker to superpower in the age of US-China rivalry. *Essay Collection, ECFR/336, European Council on Foreign Relations*.

10 European Union (2021). An Open, Sustainable and Assertive Trade Policy: Open Strategic Autonomy; Schot, J. and Steinmueller, W.E. (2018). Three frames for innovation policy: R&D, systems of innovation and transformative change. *Research Policy*, 47(9), pp. 1554-1567.

eighty measures in all sectors should be economically efficient to succeed¹¹. However, economic logic is not the only logic to be taken into account when crises erupt, as the crisis resulting from the COVID-19 pandemic has shown. Indeed, strategic autonomy decisions were taken in contexts where the usual economic logic was not sufficient, but the pressure from citizens to find solutions was high.

With the COVID-19 pandemic, the problem of access to essential healthcare materials suddenly emerged in all EU countries. Many governments decided to implement a wide range of standards to secure critical supplies at additional cost and, if necessary, with large debts. The supply of masks, gloves and protective equipment (classified as 'low-tech'), or of fans and ultraviolet light purifiers ('medium-tech') was 'easily' solved in a few months by increasing local production to meet social demand, even if they were not efficient solutions sustainable in the long term. However, other high-tech products such as vaccines or specific anti-virus drugs were much more difficult to develop and deliver.

Indeed, advanced countries and large companies funded dozens of R&D projects to develop efficient vaccines and other pharmaceuticals with highly innovative approaches. As a result of this research effort, in less than a year, six vaccines were approved by health regulators and dozens more are on the way. The conventional cycle from scientific research to product was extraordinarily shortened in the face of a serious problem, as has happened on other occasions as demonstrated by the disruptive technological developments during the two world wars of the 20th century.

The geopolitical problem of health was highlighted by the 'battle of the vaccines' in which the great powers sought to secure supplies for their nationals through imports or domestic production through new or reinterpreted legislation. However, the wide access to them by less developed countries, even if they had manufacturing facilities serving large pharmaceutical companies, was not resolved.

The so-called 'vaccine diplomacy'¹² has produced winners and losers not only in terms of approved developments and their procurement capacity, but also with health effects in terms of the percentages of people immunised among countries with serious logistical problems in their distribution.

¹¹ Edler, *et al.* (2021). *Technological Sovereignty as an Emerging Frame for Innovation Policy - Defining Rationales, Means and Ends*. EU-SPRI Conference. June.

¹² Deng, C. (2020). *China Seeks to Use Access to Covid-19 Vaccines for Diplomacy*. *Wall Street Journal*, 17 August. Available at: <https://www.wsj.com/articles/china-seeks-to-use-access-to-covid-19-vaccines-for-diplomacy-11597690215>; Campbell, J. (2021). *Vaccine Diplomacy: China and SinoPharm in Africa*. *Council on Foreign Relations*. 06 January. Available at: <https://www.cfr.org/blog/vaccine-diplomacy-china-and-sinopharm-africa>; Palacián de Inza, B. (2021). *The second wave of COVID-19 in Africa: A catastrophe?* *Analysis Paper 08/2021, IEEE Bulletin 21* (January/March). Spain, Ministry of Defence. Pp. 152-161. Available at: https://publicaciones.defensa.gob.es/media/downloadable/files/links/b/o/boletin_ieee_21.pdf

Access to these critical inputs and other medical devices, as well as recent proposals to waive patents for a limited period, became issues of international policy, not just public health. In all cases, scientific and technological knowledge, as well as the availability of high-tech products to provide medical treatment to millions of people, was used as a coercive or negotiating mechanism aimed at strengthening the positions of each state at both the national and international level.

The emergence of these processes is explained by intangible (knowledge) and tangible (industrial capacities) assets, but also by countries' political priorities. The distribution of vaccines, developed mainly in the United States, the European Union, China and Russia, became part of the geopolitical strategy in third states, as demonstrated by the vaccination situation in Africa in 2021 as a result of agreements reached by many African countries with some of them.

The case of China's activity in Africa is particularly relevant. China offered COVID-19 vaccines to Nigeria and other African countries «first [and] free of charge». In December 2020, Beijing offered to build a coronavirus vaccine logistics centre in Addis Ababa, Ethiopia, while vaccine production centres are located in Egypt and Morocco. Both countries, as well as South Africa and Egypt, will soon have the infrastructure and capacity for 'fill and finish' vaccines from Pfizer and Johnson & Johnson. But gaining technological sovereignty in this field means controlling the whole process as countries like South Africa and Senegal are trying to do, and that requires more time and scientific and technological know-how.

The EU warned that it was not possible to rely on negotiations with multiple suppliers of emergency health equipment or pre-procurement of non-EU manufactured vaccines (at least in the volume needed) through many independent regional and national authorities. The need to establish a common procurement procedure and address logistical problems was clear to policy makers, despite initial failures and lack of experience in implementation¹³. Lessons were analysed and some policy and budgetary measures were taken to increase European health technology sovereignty for the future, but no immediate response was possible.

Health is just one area among many where technology plays a key role in finding solutions, and where future crises may again require planned action.

Moving towards smart EU power

In the above context, the EU has been discussing how to maximise its technological power and how it could be applied to strengthen its global position in science and technology in a globalised world while maintaining its principles and values. More

¹³ European Commission (2020). Commission Decision of 18.6.2020 approving the agreement with Member States on procuring Covid-19 vaccines on behalf of the Member States and related procedures. Brussels.

specifically, it seeks to maximise its technological sovereignty in the current situation, where its main line of external action is constrained by its relative power vis-à-vis other countries, the confluence of interests of the various EU partners in areas where they retain competences, and the need to preserve or reinforce broader commercial, knowledge and military alliances in a context where unanimity among 27 member states is difficult to use with the risk of missed opportunities and delayed adoption of key decisions.

Hard power and soft power are terms commonly used to reflect the way in which a country can impose its views on other countries using a broad set of political tools (assertive or otherwise). Hard power and soft power are not entirely independent terms and have coexisted over the years in strategic policymaking, depending on context, capabilities and the relative national situation vis-à-vis other countries. These concepts also apply to large multinational corporations that make decisions (many of them backed by the governments of the host countries) that affect (positively or negatively) millions of citizens in the many countries where they operate.

The shortcomings of the two approaches (hard and soft power) led to the emergence of the concept of «smart power» as a more effective and plausible option for dealing with conflicts where countries are closely interlinked simultaneously in several domains¹⁴. Within the EU, the relevance of implementing smart power strategies in the components of the science and technology system has increased dramatically in 2020-2021 to cope with the disruption of global chains due to geopolitical tension, natural disasters and the COVID-19 pandemic. Countries were aware of the subtle interplay of policy areas and the need to employ holistic policies as defined in the European green pact¹⁵. In this perspective, how could the EU employ instruments of smart power to enhance its technological sovereignty? The following section addresses this issue.

Implementation of the smart power concept in the EU

The EU has been considered a major global economic power with a well-developed internal market of over 400 million citizens with relatively high purchasing power. It is also a region of the world where the most advanced technologies were deeply adopted by society, nurtured by both domestic and foreign manufacturers with high rates of imports and exports, taking advantage of a well-educated population to accelerate innovation processes.

¹⁴ Nye, J. (2009). Get Smart: Combining Hard and Soft Power. *Foreign Affairs*, Vol. 88, No. 4, July/August.

¹⁵ European Commission (n.d.). Research and Innovation for the European Green Pact', Strategy 2020-2024. Available at: https://ec.europa.eu/info/research-and-innovation/strategy/strategy-2020-2024/environment-and-climate/european-green-deal_es

However, the lack of a single foreign policy or common defence capability, despite efforts since 2015 to do so, makes it difficult to act with one voice in global conflicts. The EU was built on the basis that a large part of its common defence and related policies (clearly on the hard power side) is subordinate to NATO, even if there is no full membership correspondence with the 27 EU members¹⁶. In any case, the EU assumed that a common defence was not necessary to sustain the development of emerging technologies or to secure supplies in the global value chains on which its growth model was based.

Moreover, individual member states retain responsibility for foreign affairs in line with their own individual interests because the effectiveness of the EU's intergovernmental pillar is, in practice, conditioned by the lack of mandatory unanimity of the 27 member states' position, which is a precondition for action. Many EU Council resolutions, after intense negotiations to reconcile divergent positions, resulted in generic statements on the main issues without profound practical consequences, or simply collapsed for lack of agreement. The debate on the advantages or disadvantages of maintaining unanimity in foreign policy has been going on for years in the EU Council, and it does not seem possible to initiate a reform of the EU treaties in the short term that would change this situation. In this sense, the EU's problems in adopting strong and consensual positions are similar to those found in the UN Security Council in adopting a clear resolution in many global conflicts, which undermines its ability to address urgent conflicts.

Despite this context, Europe became a strong regulator with a lasting influence on international markets¹⁷. Historically, EU regulations designed to operate in the European market or to export/import goods to/from the EU to protect European citizens have conditioned the behaviours of third countries and companies.

Well-known examples of this effect are the REACH regulation¹⁸ in the chemical sector or, more recently, the GDPR (General Data Protection Regulation). These initiatives have inspired similar regulatory processes in other countries beyond the need for access to the European market, as they are considered appropriate, balanced and adjustable. Moreover, many large companies and exporting countries around the world have preferred to use European legislation, even if it is more restrictive than the national equivalent, rather than manage several for different markets; simply forget-

16 Laborie Iglesias, M. (2017). The time for European Defence. *Opinion Paper 92/2017*. Spanish Institute for Strategic Studies, 6/09/2017. Available at: https://www.ieee.es/Galerias/fichero/docs_opinion/2017/DIEEO92-2017_Defensa_UE_MLI.pdf; 47; Csernaton, R. (2020). EU Security and Defense Challenges: Toward a European Defense Winter? *Carnegie Europe*, 11/06/2020. Available at: <https://carnegieeurope.eu/2020/06/11/eu-security-and-defense-challenges-toward-european-defense-winter-pub-82032>

17 Bradford, A. (2020). *The Brussels effect. How the European Union rules the world*. Oxford University Press. ISBN 978 0190088583.

18 REACH: Regulation on Registration, Evaluation, Authorisation and Restriction of Chemical Substances. Available at <https://osha.europa.eu/es/themes/dangerous-substances/reach>

ting access to the European market in order to focus on less regulated markets was not an option for most of them.

This regulatory capacity is part of the impact of the EU's 'soft power' in the world, but it is not the only one. The effort in development policy cooperation, where the EU is one of the most important donors (the economic resources allocated to this policy, when the Community budget is added to the contributions of the Member States, are much higher than the amounts contributed by other powers for the same objective)¹⁹; also, the opening up of European higher education institutions (for example, by extending the ERASMUS+ mobility programme to other countries outside the EU) should be framed within this concept. It also adds to the cultural dimension, where European humanities, such as literature and art, are cornerstones of the EU's visibility in the world (even if measured in terms of non-European tourists each year and the difficulty of managing a single language with a multiplicity of activities promoted by different EU Member States).

In this context, European policy makers have progressively assumed that long-term prosperity is clearly conditioned by their ability to exercise a leading position in the 'global technology battle'. This means managing the influence of technological powers that condition the introduction of their own products on the European market. In some key advanced technologies, such as mobile telephony, artificial intelligence, microelectronics, satellite constellations, robotics, or biotechnology, where both industrial competitiveness and high quality public services depend to a large extent on other countries having taken the lead in the last decade or being close to it.

In such cases, the EU should compete with other countries to share leadership within the framework of large industrial partnerships. Even in the areas mentioned above, such as development cooperation or higher education, technological leadership is essential to deploy European technology solutions in third countries. However, the lack of a single 'European technological voice' resulting from the weaknesses mentioned above could jeopardise the individual efforts of Member States and European companies.

The open question that has been raised at the highest decision-making level in the EU over the past three years is to what extent policy instruments –hard and soft power– can be combined in practice as necessary ingredients to improve Europe's positioning in global scenarios dominated by scientific and technological advances.

The common use of terminology borrowed from the military (i.e. battle, domination, winners and losers, technological weapons, conquered markets, defensive measures) to describe a commercial and mercantile competition to access and dominate high-tech markets might seem excessive, but it reflects a common underlying sentiment: the objective pursued is not just to sell or buy products and services in search of

¹⁹ For details see *International Partnerships*. European Commission. Available at: https://ec.europa.eu/international-partnerships/home_en

market shares; it goes beyond that to reaffirm the role technology plays in a globalised world to ensure the long-term prosperity of the EU and its society. The bloc has responded to this challenge by taking almost simultaneous decisions in several areas: a redefinition of the global research cooperation schemes²⁰ and the eligibility conditions for Horizon Europe 2021-2027²¹ based on the motto «as open as possible, as closed as necessary», the introduction of strategic autonomy concerns in the new industrial and digital policies linked to the recovery and resilience funds of the «Next generation» programme, and the reinforcement of science diplomacy in member states when dealing with other countries in cooperation with the European Commission to suggest some of them²².

In this context, technology is not only seen as relevant for driving innovation, but also because it plays a wider role in international affairs. As an example of this view, the European Parliament declared in June 2021, as part of the EuroHPC Joint Undertaking regulation, that high-performance computing (HPC), in which the EU competes strongly with other countries, is a «*strategic asset to safeguard the Union's innovation capacity and strategic autonomy and to foster economic growth*». Note that here, both innovation and economic growth are linked to strategic autonomy in a «deep-tech» area where several technologies must be tightly integrated.

Even as high-level policy debates and positions progressively focus on emerging technologies to ensure long-term competitiveness, ways to impose national views are not based on hard power measures, as the combination with other types of more effective tools to win technology battles is available. The use of a 'hard' policy instrument such as 'sanctions' adopted by countries or international organisations has evolved to deny control, trade or access to key technologies when applied to some countries, and is not only based on economic decisions (e.g. tariffs), movement of people (e.g. labour visa policies) or criminal decisions by appealing to the International Criminal Court.

Moreover, an additional element has gained prominence: the main driver for the development of emerging technologies comes from civilian rather than defence efforts (except in some niche areas, the volume of investments and the size of the markets make civilian use the most relevant driver in the development of emerging technologies). Defence policy definition is generally addressed separately from science and technology policies, although the development of dual-use technologies is a mainstream for advanced military systems as the only way to achieve superiority, and government

20 European Commission (2021). Global Approach to Research and Innovation. Europe's strategy for international cooperation in a changing world. Brussels, Belgium.

21 International Service Facility (2021). International Cooperation in Horizon Europe: Participation and Novelty. April 2021. Available at: https://horizon-ncp.eu/sites/default/files/2021-05/ISF_2%C2%B0webinar_HE_International%20Cooperation%20strategy%20and%20novelties_o.pdf

22 SFIC (2021). Survey Analysis on Science Diplomacy. Strategies, Activities and Actors of EU Member States and Associated Countries. *SFIC Task Force Science Diplomacy. Strategic Forum of International Cooperation*. May.

defence agencies seek their applicability with dedicated funding. Closer approaches are being explored, such as the approval of the European Defence Fund²³ in the context of the EU's strategic autonomy to complement civilian Horizon Europe funds.

Levels of technological sovereignty

Simple awareness of the relevance of technological sovereignty is not sufficient for action; a pragmatic and measurable action plan needs to be defined and implemented in the areas where policy actions can intervene. A country's weaknesses can come from many different directions, and strategies to improve technological sovereignty must be tailored to its constraints.

From the research carried out by the authors of this article, it is clear that there are multiple possible «areas of intervention» in which a state's specific situation could range in a given technology from self-sufficiency to no self-sufficiency at all. Figure 2 sets out the identified areas of intervention grouped into three levels of strategic autonomy.

- Level 1: strategic autonomy to access raw and processed materials and associated logistics. It reflects the autonomy to access the necessary materials when and where they are needed.
- Level 2: strategic autonomy to develop technological components and systems. It reflects self-sufficiency in the development of advanced and competitive high-tech products and services for the global market.
- Level 3: strategic autonomy to ensure a level playing field. It reflects the self-reliance to push (together with other allies) for a set of fully agreed principles and values to establish the rules of a global market subject to shared rules based on broadly agreed international agreements.

These are not independent levels and success in increasing the desired strategic autonomy will depend on wise interaction at all levels with policy measures tailored to each priority technology area. Note that the main elements in figure 2 are subdivided into several «intervention areas», as the associated policy measures can be very different.

Furthermore, the above-mentioned levels influence each other depending on the chosen technological area. It is not possible to act proactively in shaping the market structure (e.g. by pushing for a new industry standard or long-term technology alliances) if the industrial fabric is very weak, which could reflect inherent difficulties in

²³ European Commission (2021). EU defence gets a boost as the European Defence Fund becomes a reality. 29 April. Brussels. Available at: https://ec.europa.eu/commission/presscorner/detail/en/IP_21_2007

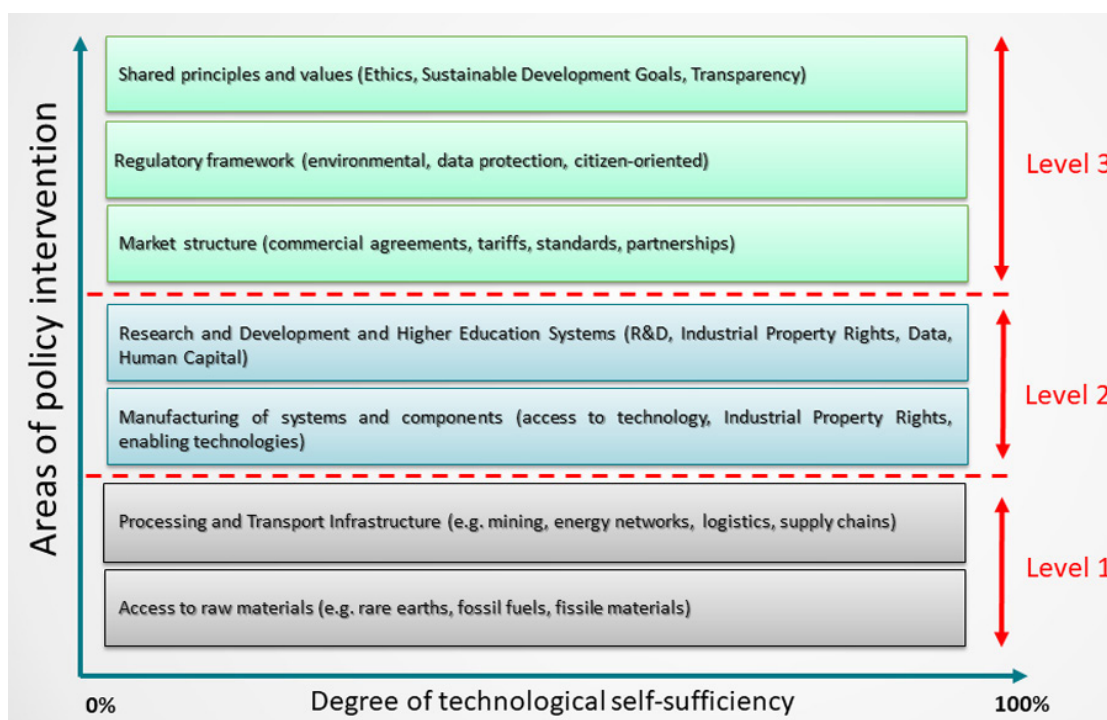


Figure 2. Areas of intervention vs. level of technological sovereignty. Source: prepared internally

accessing the science and technology base. The same is true for efforts to push forward standard-setting processes whose free adoption by third countries should be based on non-binding shared values and principles.

The EU case is clearly an example of the successful impact of data regulation in other countries, even if the objective in other countries was not just to enter the EU market. The EU can offer examples of unsuccessful impacts of its regulation of artificial intelligence, simply because the industrial effort and market position were not the same. Each of these is briefly described below.

Level I. Autonomy to obtain and dispose of the materials and components needed to develop technological products when and where needed.

The strategic autonomy objective of this level is to ensure access to natural resources (in many cases, they do not exist locally, and their availability depends on agreements with third countries) in the required quality and volume, the capacity to process them for industrial use, and to transport them to/from the place of origin to their destination when and where they are needed by industry and society. International conflicts exacerbated by long and dangerous trade routes for consumer goods led to countless inter-state clashes. This situation is repeated with international flows of raw materials, live stocks and technological components.

The major powers have attempted to increase their self-sufficiency at this level through a myriad of economic and political measures supported by trade agreements signed with many countries and organisations around the world. Today, the problem is not only accessing raw materials, but also obtaining the processed elements (e.g. at the chemical level of purity) needed for advanced manufacturing of components un-

der stable conditions, which must protect natural resources through a combination of appropriate regulations and technologies.

A relevant sub-level of strategic autonomy is the logistics required to transport them to their destination, which implies not only the use of sophisticated technologies (e.g. robotic cranes in ports to reduce time, underwater pipelines, liquid or gas container ships, GPS tracking, offshore logistics and also to guarantee data traffic through space infrastructures, or high-capacity land and submarine cables), but also to guarantee security to international routes where in some geographical areas it could imply a coordinated military intervention. In this context, economic and technological support for the construction of (or specific facilities in) advanced ports, airports or rail infrastructure is now used as a battleground between major powers willing to invest substantial amounts, even beyond their borders, to ensure the resilience of their supply chains.

One prominent area where both access to natural resources and logistics are closely linked is sustainable fisheries. The use of sophisticated technologies to sustainably harvest living natural resources such as fisheries, even when they are located in disputed territorial waters, has been a source of international conflict for decades.

The evolution of the major powers in the protection of their fisheries became a geopolitical issue in some geographical areas where the predatory behaviour of certain countries has led not only to a problem of depletion, but also of international enforcement²⁴. Fishing technology has evolved into large vessels with on-board manufacturing capacity which expands the problems. It is not only about the regulatory «maximum tonnage» approach, but also about the development and acceptance of sophisticated technologies that allow the processing of catches, eventually affecting marine biodiversity, and securing the biosphere's diversity in the long term.

Level 1 Technological sovereignty issues	Sub-level 1 Raw materials	Sub-level 2 Logistics	Geopolitical implications	Key emerging technologies examples
Protection of natural resources	Wood, fish, Agro-food. Maximum surface areas for crops in protected areas	Transportation from the source to the trade routes	Biomass preservation Compliance with climate change agreements	Fishing for endangered species. Gas/oil extraction Protected areas of the Amazon
Access to raw materials	Mining or rare earths	Hazardous materials transport conditions	Commodities are found in areas with weak governance	Lithium for electric batteries Uranium mining
International law	Environmental legislation Paris Agreement	Hazardous materials transport conditions Fissile material	Mutual enforcement of rules Regulation of space	Ban on the use of chemical fertilisers in the agri-food sector for EU markets
Trade route protection	Drug trafficking routes	Free movement in international waters	Fighting piracy	Agreements on the Panama or Suez Canal. Atalanta Mission
Generation and off-shore logistics	Energy harvesting	International power grids	Offshore wind energy fields	International waters storage
Digital links	Not Applicable	Submarine cables	Protection of key submarine links	Bella Programme
Trade agreements	Certification to market products based on extraction techniques	Import/export tariffs	Effective implementation of agreements	Restrictions on dual-use items
Key emerging technologies affected at level 1	Mineral or living resource identification (e.g. satellite imagery)	Tracking of cargo shipping Robotics for container handling	Multiple sourcing from state-owned enterprises Competing technologies	GPS/Galileo Unmanned ports. Starlink or One Web

Table 1. Natural Resources and Processing Infrastructure Issues (level 1). Source: prepared internally

24 Grare, F. (2021). Fish and Ships: Chinese Fishing and Europe's Indo-Pacific Strategy. *European Council on Foreign Relations*. Policy Brief. August. Available at: <https://ecfr.eu/wp-content/uploads/Fish-and-ships-Chinese-fishing-and-Europes-Indo-Pacific-strategy.pdf>

Table 1 reflects the main issues of layer 1 and its sub-layers from a technological sovereignty perspective.

Level 2. Autonomy to develop advanced technology products.

Even when Level 1 is fully guaranteed, countries need to be able to generate technology components and systems with the highest level of strategic autonomy, working together with partners, if necessary, to complement their capabilities. To achieve this, they need to secure access to the technological foundations of the key technologies required (e.g. intellectual property rights, know-how, skilled labour and sophisticated machinery) and to the relevant data (e.g. large volumes of user information, and the deployment of high-capacity digital links) needed to increase self-sufficiency in the process of manufacturing advanced systems.

It includes, in order to be competitive in international markets, the mastery and deployment of a set of enabling technologies (e.g. mobile communication networks and internet services) together with having the right digital skills in the workforce and the population at large.

This level can be broken down into two main sub-levels: the component and system manufacturing sub-level and the system research and development sub-level. These sub-layers have very different implications for achieving a given level of technological sovereignty. The former provides the means to manufacture individual components and systems, but not to design them, which is linked to R&D activities and requires greater skills and access to the technology base.

The approach of separating design from manufacturing processes is used by many companies to outsource manufacturing capabilities to other countries in search of cheaper prices or less stringent regulations, while keeping design capabilities in-house. Indeed, one of the sources of the current problems of the technologically advanced countries lies in weaknesses at the manufacturing level (even if they have managed to maintain their R&D capacity) based on voluntary decisions by the private sector to outsource these capabilities to other countries in search of greater efficiency and lower manufacturing costs. In the event of a crisis, this decoupling has shifted the problem to the supply chain.

The second sub-level provides the capability to design and develop advanced products and services with strong links to universities and research centres, as well as sophisticated equipment for rapid prototyping. In the last two decades, large companies have decoupled this sub-layer from the previous one, including geographically, creating more dependencies on supplies from third countries.

Today, a large set of the living 'technology wars' between technological powers are related to the control and dominance of emerging technologies (e.g. advanced semiconductors, 5G, artificial intelligence, robotics, autonomous vehicles) in search of better positions in the global market, even if other layers should also be controlled. This domain is not only a Level 1 problem, but also a way to increase resilience at Level

2 when supported by public-private industrial partnerships strongly driven by public administrations.

Table 2 reflects the main issues of level 2 and its sub-levels from a technological sovereignty perspective.

Level 2 Technological sovereignty issues	Sub-level 1 Manufacture of components and systems	Sub-level 2 Research and development of systems	Geopolitical implications	Key emerging technologies examples
Large-scale research facilities	Research into new materials and devices as a basis for new components	Research on new basic principles and state-of-the-art developments	Multilateral agreements for construction and operation. Concentration of facilities in advanced countries ITER (nuclear fission)	ISS (International Space Station) EBRAINS (brain) Participation in the ESFRI roadmap
Prototyping facilities	3D printing of components. In-situ maintenance of small components. High performance computing	3D printing of large systems (e.g. houses, vehicles). High performance computing	Innovation ecosystem development. Acceleration of production	New market entry
Data Management	Digital links. Large servers	Digital links Cloud systems Knowledge graphs	Data hosting security	European cloud
Technology demonstrators	Nano-manufacturing facilities	Facilities to accelerate the adoption of emerging systems	Faster deployment of advanced technologies	Copernicus. Desalination plants. Digital innovation centres
Manufacture facilities	Move towards fully automated production	Battery or semiconductor gigafactory	Outsourcing Working conditions Problems of technology transfer	Tesla in Berlin. Semiconductor foundries
Assembly plants	Solar cells. Semiconductors. Vaccine production	Electric vehicles. Solar panels	Less sophisticated model for third countries	Conventional vehicle plants. OEMs. "Fill and finish" vaccines COVID-19
Qualified researchers and technologists	Skilled people in production sites (mainly engineers and data scientists). Digital skills	Qualified researchers linked to industry. Digital skills	Brain drain Brain circulation Code of conduct for recruitment Digital gap	EU Charter for recruitment. Industrial doctorates
High-tech start-ups and venture capital	Specialised venture capital firms	Corporate risk investments	Business incubators. Public-private co-financing schemes. International expansion	NeuroLink Hyperlink Moderna Google Ventures
Key emerging technologies affected at level 2	Nanotechnology. 4D printing. Quantum bits. Graphene. RNA vaccines	Internet of things. Robotics. Artificial intelligence. Autonomous vehicles	Intellectual Property Rights suspensions	Quantum computing

Table 2. Issues related to R&D Systems and System/Component Manufacturing (Level 2). Source: prepared internally

Level 3. Autonomy to impose or create a level playing field for technology product markets.

Level 3 refers to the ability to create or access international markets for the advanced technology products and services mentioned in Level 2 to reach end-users on fair terms worldwide, facilitating global growth. In many cases, it involves the creation and adoption of international standards and regulations supported by international bodies, as well as the political will to both implement and enforce them.

The expansion of globalisation in the last decade has highlighted the growing relevance of Level 3 issues. Both world powers and smaller countries compete (sometimes cooperate) in international bodies and third countries to impose their views and interests with broader perspectives than a single industry could afford. Many long-term geopolitical strategies put in place by major powers (e.g. elements of China's Belt and Road initiative, industrial standards on emerging technologies, tariffs on critical components, or even ethical guidelines such as on the use of AI) are examples of policy measures framed by Level 3 concerns.

In particular, this level relates to the rules needed to define a sustainable market structure (e.g. through competition rules to prevent market abuse), the definition of industry standards to facilitate the development of high-tech products with international allies to enter other markets, and the definition and implementation of import/export regulatory frameworks applying the precautionary principle. The rules are gen-

erally related to sanctions regimes whose application at the international level is also a source of governmental conflict.

Finally, the need to share a set of common principles and values with other stakeholders around the world to frame technological self-reliance is included as a distinctive level. This level promotes the definition of specific policy measures to ban technological products from places/countries that do not comply with environmental or human rights conditions in manufacturing processes (e.g. high levels of pollution, use of children in manufacturing plants, freedom of research). From the EU's point of view, these aspects are more relevant as prerequisites for participation in Community or Member State international research and innovation programmes.

Table 3 reflects the main issues of Level 3 and its sub-levels from a technological sovereignty perspective.

Figure 2 could be applicable to specific countries at a specific time in history for specific technologies. The position of any country is very dynamic and evolves very rapidly in the case of emerging technologies, forcing competing states to regularly review their options and use new policy instruments to meet their technology sovereignty objectives.

Level 3 Technological sovereignty issues	Sub-level 1 Shared principles and values	Sub-level 2 Regulatory framework	Sub-level 3 Market structure	Geopolitical implications	Key emerging technologies examples
Research freedom	Bonn Declaration	Conditions for R&D programmes	Working conditions	Researchers' protection policies	Visa Afghanistan request investigators'
Reciprocity	Mutual opening of R&D programmes	Calls for public programmes	Opening of international contests	Asymmetric negotiations	Horizon Europe Partnership
Standards and Regulations	Support to official standardisation bodies	De jure and de facto technical standards	Single market regulation	Big business imposes industry standards	5G Standards AI Guidelines
Open Science	Open access to public research results	Open licences	Impact on the publishing sector	Power concentration in large companies	Access to clinical trials of COVID-19 vaccines
Data privacy	Protection of users' personal data	Use of personal data in digital services	Open digital platforms	Citizens' vigilance Cybersecurity	GDPR (General Data Protection Regulation) Control of AI algorithms
Market competition rules	Level playing field	Transition from national to supranational regulations	Mergers and acquisitions Oligopolies	Tariffs Precautionary Principle	EU competition rules towards a single market
Patents	Public access to proprietary information	Protection of property	Patent trolls	Triadic patents	European patents
Protecting diversity	Non-discrimination principle	Mobility programmes	Minority presence in decision-making bodies	Protection of women and children	Women in Science
Science diplomacy	Alignment with the objectives of international relations	Signature of international science and technology agreements	Participation in international organisations	Science and Technology Counsellors in Embassies Principles for international agreements	SESAME (synchrotron in Jordan)

Table 3. Issues related to principles/values, regulatory framework and market structure (level 3). Source: prepared internally

Figure 3 shows a snapshot in which two fictitious countries (A and B) have different levels of autonomy for a given technology. Country A has a weaker position in Stratum 1, but the situation is reversed in stratum 3. The analysis of this model suggests that, in order to modify the current weaknesses in some time interval, each of these countries will have to proceed with the implementation of priority actions (highlighted with blue arrows). It will do so by employing a set of policy instruments that act on the necessary layers depicted in figure 2 (see p. 12).

It is pertinent to note that while in this example the countries will operate in different layers (1 and 3 respectively), in other cases competition at the same level is not

only possible, but in fact occurs with many emerging technologies of broad impact (5G networks). On the other hand, when considering another technology, the relative capabilities between A and B could change dramatically, requiring different policy measures. This approach is also relevant when a major technological power develops its strategy of cooperation with another country (or group of countries) to open markets for its technologies.

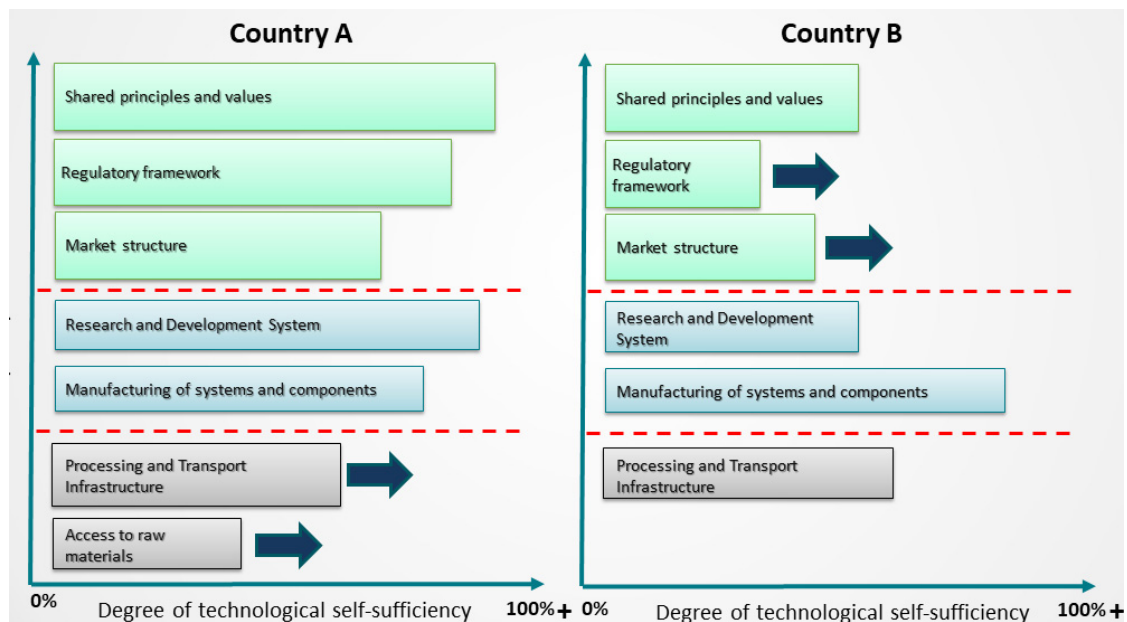


Figure 3. Comparison between countries A and B in relation to one technology. Source: Prepared internally

EU technological sovereignty and smart power in the African context

This section applies the conceptual approach developed in the previous sections to the African scenario. Figure 4 shows a subjective view of how the EU cooperates with continental countries at the levels represented in the figures above to improve their relative position. It is important to note certain issues that were considered in the development of the map. Firstly, only a few interactions are incorporated for the purpose of exemplifying their diversity. Secondly, interventions have different weights for the EU (in the graph exposed by the thickness of the lines) when large geographical areas are used (see black circles). Thirdly, each area of the continent that has been differentiated needs to be studied in greater detail, taking into account the peculiarities of each country and its economic situation.

In some cases, the EU's rationale is strongly conditioned by access to natural resources, while in other cases the motivations reflect historical and economic ties of member states. Other reasons for intervention, such as security (e.g. in the Sahel zone), are not stated because they are not directly related to technological sovereignty, although they may condition the implementation of actions at other levels such as those mentioned above. For example, the Maghreb area is very relevant for the EU in the framework of its European Neighbourhood Policy (ENP), where specific funds

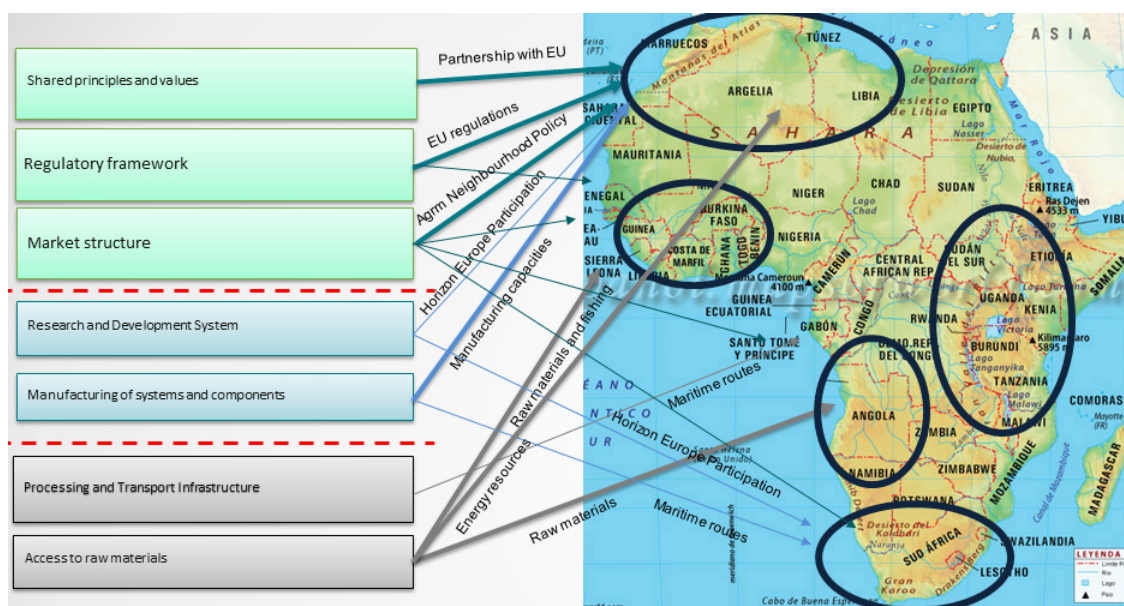


Figure 4. Priorities for EU technological sovereignty in the African context. Source: Prepared internally

have been allocated to the region to promote its stability and socio-economic growth. In addition, the European Commission launched a set of initiatives around the Research and Innovation Framework Programmes in cooperation with Member States to strengthen their national innovation systems.

However, the EU is not the only technological power with the capacity to influence the continent. Both China and the United States, and to some extent Russia as well, use Africa as a position of strength to advance their own interests using technology as leverage. All these technological powers use a wide range of instruments, adapted to specific technologies and local conditions. Indeed, the specificities of China's strategy need to be explored in greater depth because it is more complex than a superficial approach would suggest. On this basis, it is necessary to align the objectives of EU-related actors in order to avoid gaps that turn into disadvantages.

The public-private conflict of interest can be illustrated by statements made to Reuters by Orange's CEO in June 2021: «*France will avoid using equipment from Chinese suppliers when developing Europe's 5G networks, but the company sees no problem working with Huawei in Africa [...] [They] have invested in Africa while European suppliers have hesitated*»²⁵. The aim is to implement a dual security strategy with different effects in the EU and in third countries. Economic logic and geopolitics do not always go hand in hand.

Another area in which the EU wishes to strengthen its position in Africa is space, where it intends not only to stimulate the use of its Galileo navigation system, but also to take advantage of the Copernicus system to obtain observation data that it can make available to African countries (its use for detecting forest fires or discovering

25 Reuters (2021). Orange sees role for Huawei in 5G Africa rollout. 29 June. Available at: <https://www.reuters.com/business/media-telecom/orange-sees-role-huawei-5g-africa-rollout-2021-06-29/>

aquifers is very relevant and constitutes a key tool for development cooperation and climate change monitoring). Africa has also collaborated with the European Union through the Joint Africa Programme Office (JPO) for an EU-Africa partnership to introduce GNSS/EGNOS services in Africa for all types of applications, with a focus on the aviation sector as a driver.

Similarly, communications satellites provided by the European Space Agency and various EU member states can offer rural internet access connectivity that is also much needed in many African countries, although the costs are high²⁶, pending services offered by low orbit satellite constellations where the EU is lagging behind and other initiatives (such as Starlink in the US)²⁷ can take advantage of easier regulatory guidelines and targeted financial support²⁸.

Regarding China's role on this continent, it is necessary to analyse the background with data (with greater or lesser reliability), the objectives and needs of both parties (understanding that Africa is complex and diverse), but also to note the multidimensionality and temporality of the former's strategy²⁹. For reasons of space and the focus of this article, only a few points will be addressed, although it is pertinent to mention that the general projection of business, politics and 'soft power' is intertwined with its defence and security focus.

Since the beginning of the 21st century, China's rate of Foreign Direct Investment (FDI) in Africa has increased at a rate of 25% per year. FDI reached \$2.96 billion in 2020, with an estimated cumulative stock of \$47.35 billion. Private Chinese companies account for 90% of all firms investing in the mainland, and 70% of the value of Foreign Direct Investment (FDI), but state-owned enterprises dominate in the energy, transport and resources sectors, and in relative terms make the largest investors by value³⁰.

The model is mainly greenfield investment³¹. In fact, few projects are carried out in the form of joint ventures or through mergers and acquisitions. Most companies

26 The European Space Agency will contribute its telecommunications satellites to the Sway4edu project, designed to improve life in rural Africa. This initiative will seek to develop a technology platform to support farmers, teachers and voters in various regions of the continent. Available at: <https://blogthinkbig.com/satelites-africa>

27 Company offering high speed internet and low latency broadband. See <https://www.starlink.com/>

28 Starlink, the satellite internet constellation being developed by SpaceX, is targeting coverage of Africa in late 2021 and 2022. Only Nigeria can expect launch by the end of 2021, while other African countries such as South Africa should have access to the Starlink satellite internet service by 2022. Available at: <https://africanews.space/starlink-satellite-internet-target-africa-coverage-late-2021-2022>

29 China-Africa Business Council (2021). Market Power and Role of the Private Sector, Chinese Investment in Africa. Beijing. P. 15. Available at: <http://www.focac.org/eng/zgqytzfbg/t1904028.htm>

30 Yu, S. (2021). Why substantial Chinese FDI is flowing into Africa. *LSE Blog*. Available at <https://blogs.lse.ac.uk/africaatlse/2021/04/02/why-substantial-chinese-fdi-is-flowing-into-africa-foreign-direct-investment>

31 *Greenfield* investment dominates the scene in the case of Africa. This increases the benefit to the host state, among other reasons, by generating employment.

choose to set up subsidiaries with independent legal personality instead of agencies, representative offices and branches. In the territory, the generation of employment and modern infrastructures implies a win-win link between both parties. In 2015, they agreed to cooperate on railways, roads, regional aviation networks and projects for the industrialisation of the continent. Likewise, the launch of the *Digital Silk Road* in the same year gave ICTs great centrality, including some African countries within the priorities of this initiative.

Multidimensionality refers to disaggregating the various spheres that constitute the link that goes far beyond the commercial level. An example to illustrate the point. In 2018, 16% of foreign students in China came from Africa. This placed the Asian country in second place as a recipient after France. It also pledged to offer 50,000 scholarships by 2021. According to the Forum on China-Africa Cooperation (FOCAC), Huawei's collaboration with African universities has enabled thousands of university students to obtain ICT certification from the company. The company has signed cooperation agreements with more than 250 universities in 14 sub-Saharan countries to establish academies to grant the certifications.

Temporality means detecting continuities and changes in the Sino-African relationship, especially in the last two decades. In addition, analyse short-term actions with a rationale that is differentiated from medium-term actions. This involves characterising each of them and then identifying where the economic and geopolitical dimensions converge.

The *China-Africa Business Council's Report on Chinese Investment in Africa* notes that Chinese private companies are moving into a third stage characterised by 'putting down roots in Africa' with its attendant derivations (in the past the strategy was 'going to Africa' and then moved to 'setting up in Africa'). Clearly, US and European companies will experience a decline in both relative market share and absolute unit sales. However, the fulfilment of the new phase objective can have much more far-reaching consequences.

China's Belt and Road Initiative (BRI), which 46 African countries have joined, has heavily increased foreign trade investments, FDI, loans and aid, but has recently added a national security and defence dimension³². Although trade and investment precede BRI, its geopolitical role is undeniable. South Africa, Nigeria, Angola, Egypt and the Democratic Republic of Congo (DRC) are the five main trading partners. In terms of products, the volume of trade in mineral products, machinery and equipment, and base metals (iron and steel, copper, aluminium, etc.) and base metal products occupy the top three positions.

This is not to assert that there are no cases of turnkey contracts or to ignore China's interest in the continent's natural resources. In any case, it is necessary to delve into the

32 Nantulya, P. (2021). Reshaping African Agency in China-Africa Relations. *African Center for Strategic Studies*, 2/02/2021.

details, as it is through these that the most significant dangers to Europe's interests can be detected. In this respect, a strategy can be observed whose most obvious content is mainly economic and in which the continent constitutes a platform that guarantees level 1 technological sovereignty while at the same time a region of growing relevance at Level 2 (complementary to both Asia and Latin America). However, based on the available information, Tugendhat and Voo's study warns of the possible articulation between the Digital Silk Road (DSR) and future internet governance through the push for standards and regulations, both of which are relevant to China's global technological ambitions. Indeed, digital technologies occupy a 'critical role' for the RSD³³.

Access to critical raw materials and food, as well as their processing (in many cases) and movement to ports (road and rail construction contribute to displacement) is translated into localised initiatives both in those countries identified as resource-rich which are described as «*Enablers in economic diversification*» (Nigeria, Angola, the Republic of Congo, Zambia, Ghana, Algeria and the Democratic Republic of Congo), and in those resource-poor countries where infrastructure is developed, and which are described as «*Enablers of industrialisation and modernisation*» (Ethiopia, Kenya, Rwanda and Tanzania)³⁴.

The objectives do not seem to be exhausted there, as factories are being set up to compensate for the increase in China's labour force, in particular labour-intensive processing companies that outsource production to Asia and increasingly to Africa because of low labour costs. Likewise, the promotion of the Information and Communications Technology industry, vis-à-vis the control of cyberspace and access to the internet, are central aspirations for the Chinese government, which find in some authoritarian governments on the African continent a support base to promote related regulatory frameworks³⁵.

The analytical framework proposed in previous sections allows for the disaggregation of China's actions to identify the interlinkages that exist between many of the activities. This does not imply asserting a degree of seamless coordination on the part of all actors (large companies, SMEs, credit institutions and banks, diplomatic personnel and political authorities), but neither does it imply a perspective that reflects on the issue as if it were a set of isolated projects. This is key to assessing the current and potential impact on European technological sovereignty.

33 Tugendhat, H. and Voo, J. (2021). China's Digital Silk Road in Africa and the Future of Internet Governance. *Working Paper No. 2021/50. China Africa Research Initiative*. Washington DC, School of Advanced International Studies, Johns Hopkins University. Available at: <http://www.sais-cari.org/publications>

34 The ranking is from the *China Investment in Africa Report*. See Footnote 26.

35 Ministry of Foreign Affairs of the People's Republic of China (2015). Remarks by H.E. Xi Jinping President of the People's Republic of China at the Opening Ceremony of the Second World Internet Conference. Wuzhen, China, 16 December. Available at: https://www.fmprc.gov.cn/mfa_eng/wjdt_665385/zyjh_665391/t1327570.shtml

Figure 5 presents the countries in which the largest volume of Chinese investment in Africa is concentrated. The classification into three groups of countries is that given in the above-mentioned report of the Business Council.

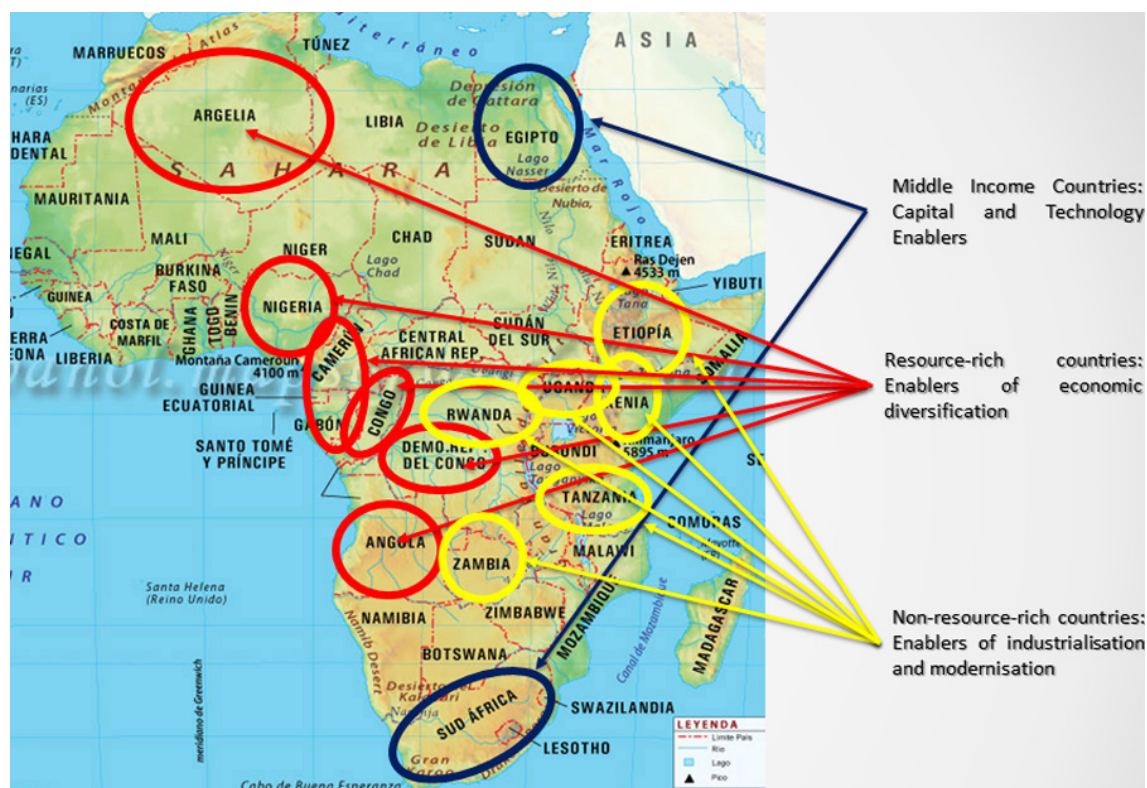


Figure 5. China's presence/investments in Africa. Source: prepared internally based on the classification used in the Sino-African Business Council 2021 report

Although there are many important initiatives that could be included, a selection of projects of various characteristics classified according to levels of technological sovereignty is sufficient to reveal how Sino-African relations should be analysed from a comprehensive perspective.

In relation to level 1 of technological sovereignty, investments are identified that objectively guarantee access to resources, but also to their processing for industrial use, as well as the development of infrastructures (ports, roads, railways) that facilitate their transfer. The following selection of projects illustrates this point:

- Ningxia Tianyuan Manganese Industry Group: Mineral processing and resource cooperation in the Democratic Republic of Congo and Ghana.
- Hengtong and Huawei Marine: Deployment of 12,000 km of submarine cable to connect China, Pakistan, Djibouti, Kenya and along the coast of East Africa to South Africa.
- China Harbour Engineering Company (CHEC): investment to develop a deepwater port in Lekki (Nigeria) under the BOOT model, which means build, own, operate and transfer (BOOT) with a 45-year franchise.

Level 2 identifies investments that indirectly contribute to Chinese autonomy in advanced technologies, but which in turn generate employment and consumption in African countries, acting as an enabler for other ventures.

- a) BAIC Group and Hisense Group: installation of an automotive manufacturing line in Port Elizabeth and construction of a white goods industrial park in Cape Town, South Africa.
- b) China-Egypt Economic and Trade Cooperation Zone TEDA Suez and Photon Engine: New construction materials, petroleum equipment, high and low voltage equipment and machinery manufacturing; production of pure electric buses in Egypt and providing manufacturing technologies and related new energies.
- c) China Road and Bridge Corporation: The Nairobi-Mombasa section (470km) is the first phase to link the port city of Mombasa with the western border town of Malaba. A map shows the proximity to the Democratic Republic of Congo.

At level 3, related to the market structure and regulatory framework, the strong presence in the telecommunications infrastructure of Huawei (it built around 50% of Africa's 3G networks and 70% of its 4G networks and is present in 20 African countries) and ZTE, allows them to influence the companies themselves, but also other players in the Chinese innovation ecosystem. Such is the case of the proposal for a new internet protocol under consideration by the International Telecommunications Union, which, according to critics, would lead to a more centralised and top-down control of the internet, which could even reach users, with implications for security and human rights. The initiative is driven by a range of actors³⁶ and was endorsed by 11 countries on the continent. The evidence so far reveals minority public and formal support, but the voting system of the technical standards and norms bodies –one country, one vote– could be a Chinese asset in the global leadership contest if it can persuade at least the Digital Silk Road constituency.

A comparison of Figures 4 and 5 shows an overlap between the priority regions for the EU and the countries where the presence of the Asian country is most important on the African continent. Not all EU-China relations in Africa can and should be confrontational, but there is room for cooperation in science and technology. There must be a focus on global challenges such as climate change or the protection of biodiversity, and also on ensuring that the exploitation of natural resources does not lead to negative environmental consequences. In these contexts, awareness-raising in African countries is essential, beyond long-term benefits. From 2007, when the EU began to

³⁶ Huawei Technologies, China Unicom, China Telecom, China Mobile, Tsinghua University, Beijing University of Posts and Telecommunications, the Ministry of Industry and Information Technology (MIIT). Received public endorsement from Côte d'Ivoire, Guinea, Mali, Niger, Nigeria, Senegal, South Sudan, Tanzania, Zambia and Zimbabwe.

consider a cooperation strategy with China in Africa, to the present day, the context has changed significantly. As early as 2009, a trilateral dialogue was postulated, but it has proved to be very slow³⁷. Interest does not seem to be joint, and except in very specific areas (e.g. support for African universities) it does not seem easy to find areas of trilateral cooperation. It is therefore relevant to continuously assess the evolution of this presence both to promote areas of collaboration and to anticipate potential conflicts.

Conclusions

While the concept of strategic autonomy has connotations more or less confined to security and defence issues, the notion of technological sovereignty is an essential pillar for analysing the EU's global positioning in the coming decades. Moreover, it has become a key element in a much broader perspective for the assessment of strategic autonomy. Excessive technological dependence on external assets and resources could imply difficulties, or at least constraints outside the EU framework, in defining national strategies for key enabling and emerging technologies.

Multiple possible 'areas of intervention' have been identified in relation to the specific situation of a state in relation to a given technology. In view of the heterogeneous problems inherent to the issue, the authors of this article have proposed a three-level classification. Level 1 linked to access to raw and processed materials and associated logistics; Level 2 related to the capacity to develop technological components and systems; and Level 3 linked to ensuring a level playing field in the international market for goods and services.

However, only a small number of geopolitically relevant countries are likely to be able to secure level 3, while having weaknesses in level 1 because they lack direct access to natural resources. Indeed, a significant number of states are not even able to reach Level 1 because they lack the resources or because they choose to preserve their natural environment, avoiding manufacturing processes with harmful environmental consequences on their own territory and opting instead to purchase them from abroad. Indeed, at a given time and for a given technology, not all countries can have an influence at all levels. The proposed approach therefore provides a framework for an actor to make an assessment of their situation. On this basis, it can define the actions it deems appropriate to sustain or improve its position.

The implementation of the elements of technological sovereignty set out in the article applies not only to the territory of a country or group of countries such as the EU, but also to its interaction with third countries. The example of Africa has been

37 Alden, C. and Sidiropoulos, E. (2009). *Africa-China-EU Cooperation in Africa. Prospects and Pitfalls. Policy Notes 2009/11. SPECIAL ISSUE on the EU Africa Partnership Strategy*. The Nordic Africa Institute. ISSN 1654-6695 ISBN 978-91-7106-660-2.

chosen to show this impact. China's presence in Africa offers a relevant environment for analysis because it affects and conditions European technological sovereignty at the three levels described in this paper, albeit at different scales. It also implies an objective decrease in the margins of strategic autonomy in the medium term. The case also allows us to theoretically refine the scope of the concept of technological sovereignty and to disaggregate it. In addition, it argues for the need to explore its articulation with the notion of smart power.

In the next decade, Africa's prosperity and development is a major objective for asserting Europe's technological sovereignty in its confrontation with other powers at all three levels; it is not just a question of access to raw materials, there is much more at stake. Therefore, studying China's actions in Africa is a fundamental exercise in rethinking a comprehensive EU policy package towards the continent that goes beyond development cooperation and designs initiatives in innovation and education, such as the extension of ERASMUS+, association with the Horizon Europe programme, and increasing the number of student scholarships.

In short, the definition of policy packages framed within the concept of smart power to ensure the appropriate level of technological sovereignty, and thus to strengthen strategic autonomy, is a top-level objective for the EU. Its implementation at the global level will require a specific analysis of each technological system, seeking to strengthen alliances that ensure open strategic autonomy.

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