Third World Quarterly, vol. 43, núm. 1, 2022, pp. 94-113.

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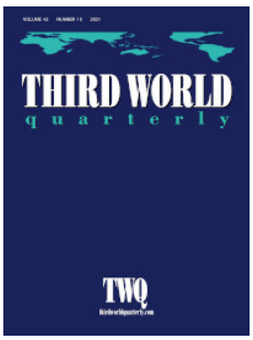
Gonzalez Levaggi, Ariel y Blinder, Daniel.



Routledge
Taylor & Francis Group

Third World Quarterly

ISSN: (Print) (Online) Journal homepage: https://www.tandfonline.com/loi/ctwq20

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To cite this article: Ariel González Levaggi & Daniel Blinder (2021): High in the sky: Turkish–Argentine South–South space cooperation, Third World Quarterly, DOI: 10.1080/01436597.2021.1993811

To link to this article: https://doi.org/10.1080/01436597.2021.1993811

Published online: 12 Nov 2021.

THIRD WORLD QUARTERLY
https://doi.org/10.1080/01436597.2021.1993811

High in the sky: Turkish–Argentine South–South space cooperation

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ABSTRACT

In September 2019, the partly state-owned Turkish Aerospace Industries (TAI) and Argentine provincial state-owned INVAP officially agreed to co-develop a geostationary satellite. Despite both being developing countries, they have extensive satellite space programmes with different stimuli. In the last two decades, Ankara has pushed for the development of a strategic industry in line with its military needs, while Argentina developed its satellite sector as part of broader initiatives to boost innovation and profits. This article examines the intersection of Argentina's and Turkey's space programmes by focussing on the goals, scope and dimensions of the geostationary joint project. The central argument is that despite their dissimilar motivations and policy paradigms, bilateral space cooperation in the Global South could be an alternative route to technological growth, bypassing the dependence on traditional geopolitical partners and technological providers.

ARTICLE HISTORY
Received 27 November 2020
Accepted 7 October 2021

KEYWORDS
Argentina
Turkey
space cooperation
South–South cooperation
geopolitics
technological autonomy

Introduction

During the Cold War, space technology was very much a great-power asset, the realm of high-tech nations with strong military industrial complexes. In recent years, a wider range of nations has joined in the technological ladder of this industry. There have been rapid changes in space technology that expand its applications, from imaging to telecommunications. Likewise, many more public and private users are joining the space market by purchasing services or acquiring technologies. This expanding space market has become an incentive for new and non-traditional space-tech providers. According to the Space Participation Metric (SPM), more than 20 countries evidence some level of space hardware or launch facilities capabilities, which can be catalogued as emerging space powers and middle power states (Harvey, Henk, and Pirard 2010; Jordaan 2003). Among them are Argentina and Turkey (Wood and Weigel 2012a). Both nations have developed strong space projects since the 1990s, although their backgrounds and ulterior aims differ. Argentina developed a military-based project during the Cold War and later moved towards a civilian, economically oriented programme, while autonomous development and pursuit of profit

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became central to space planning. On Turkey's side, even if initially the project had civilian motivations, lately it has been profit and national security oriented. As an unexpected partnership, Buenos Aires and Ankara decided to develop space cooperation by supporting the signature of an agreement between the partly state-owned Turkish Aerospace Industries (TAI) and Argentine provincial state-owned INVAP to develop together a geostationary satellite in late 2019.

Despite being space middle powers and pursuing different motivations, cooperation between Turkish and Argentinian space programmes has a common ground, which is to create autonomous and indigenous capabilities to solve national problems and to avoid reliance on foreign providers. For a long time, both countries have developed special programmes focussing on the development of low earth orbit (LEO) and geostationary (GEO) satellites. The need to reach new technological frontiers and foster marketable space products in a niche market, however, has led to a strategic crossroads. This article aims to introduce Argentina and Turkey's space development and analyse the reasons it triggered cooperation between them in order to reach their diverse goals. This work assumes that both have an emerging scientific-technological and industrial base that allows them to scale up the development of space launchers and satellites.

The literature on the space dimension of Global South cooperation is still very limited, with only a few descriptive pieces, extremely focussed on the role of China (Klinger 2018, 2020; Frenkel and Blinder 2020). This study seeks to provide a set of theoretical insights to approach space cooperation, while broadening their scope by taking as case study the cooperation between two emerging space powers with similar degrees of technological development. Framed within the South–South cooperation literature, the Wood and Weigel (2012b) space technology ladder and Latin America's approaches based on the evolutionary neo-Schumpeterian theory (Suarez and Yoguel 2020), we examine the space technology development policy of Turkey and Argentina, along with each country's motivations and limitations and the reasons that have promoted cooperation. The case study shows evidence of a complex interplay among geopolitical, technological autonomy and innovation elements during the space policy development.

By analysing the link between Argentina's and Turkey's space programmes, this article investigates how dissimilar motivations and different policy paradigms can trigger space cooperation in the Global South and provide an alternative route to technological growth, bypassing the dependence on traditional providers. The article takes a qualitative empirical-analytical approach by reviewing relevant literature, using public documents and information in the public domain, in addition to two interviews with Argentinean officials within the venture project. The interviews were conducted by email and assessed with qualitative data analysis. The interviews were conducted by email instead of in person because the interviewees were active officials and had limited time at their disposal. The authors approached Turkish counterparts for interviews also, but they declined without offering an explanation. Therefore, although documents and public information from both sides have been analysed as part of this research, the authors acknowledge that the Argentine dimension of the project is more developed due to the lack of testimonies from Turkish officials. Given that the focus is a strategic cutting-edge technology project, and that much information is protected by laws and commercial arrangements between companies, it is difficult to access open sources providing information for academic research. Most information and details remain confidential, and those who have not responded may have done so for

business reasons or to protect strategic state secrets. In any case, our methodological selection allows us to analyse the data provided by primary and secondary sources, tracing and reconstructing the trajectory of the joint venture between Turkey and Argentina.

In the first section, we introduce some conceptual ideas to frame the bilateral cooperation within the South–South cooperation agenda. In space technology terms, beyond the two countries' individual motivations, climbing the space technology ladder seems to be a common goal. The second and third sections introduce the Argentine and Turkish space programmes, respectively. A fourth section explores the main elements of the joint project by focussing on its goals, scope and dimensions, and, finally, we present some concluding remarks and lessons learnt from the joint space project.

South–South cooperation in space: developing joint GEO satellites

Access to space is highly contested because of its geopolitical nature. The military and diplomats clash over strategic needs and opportunities for economic and technological development (Doboš 2019). A key indicator of the competition for space access is the development of satellite technology. The cause for conflict is satellites' dual use for military or civilian purposes. On the one hand, satellites and other telecommunications networks have redefined the world, altering patterns and even many of modern society's goals. Satellites globalised and interconnected our world, closing distances among nations with worldwide access to rapid telecommunications networks (Pelton 2004). On the other hand, states – especially developed ones – implement strict export controls over space systems through licensing authorisations.

Licences are granted depending on the nature of the space item and according to the technical sensitivity, international oversight, the end user and the technological end use. Nowadays, the paradigm of space technology control is nation-centric since 'states seek to maximize their legal discretion in exercising space technology trade and proliferation controls in the interests of "national security"' (Mineiro 2012, xiv–xv). Despite their state-centric nature, there is room for bilateral and multilateral cooperation on projects such as the International Space Station; committees such as the United Nations Committee on the Peaceful Uses of Outer Space (Froehlich, Seffinga, and Qiu 2020); treaties such as the Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies (1967), the Agreement Governing the Activities of States on the Moon and Other Celestial Bodies (1979); or United Nations resolutions such as the Prevention of an Arms Race in Outer Space (Moltz 2014). Due to the high-tech nature of space activity, the principal players are great powers, while technology transfer cooperation hardly ever goes in the North–South direction for developing countries (Harding 2013; Serna 2018).

There are different approaches to space policy in developing countries. While the developed nations' space programmes are focussed on their military or economic clout, in which players have larger degrees of agency, the approaches of middle powers are generally centred on cooperation and technological development, being largely constrained both by technological capabilities and scarce human and economic resources. When the developer is perceived as defiant of the international technological order, the country is considered a challenger or even a security threat (Sheldon 2006; Hertzfeld and Li 2013).

The literature on space programmes portrays how a state develops capabilities in order to accomplish goals of power and technological improvement. Dolman centres his analysis on the *astropolitik* (2002), a realist formulation for space-based geopolitics in which great powers can achieve the domain of the final frontier, and it is likely to have the United States as the most important player. The United States' space policy is generally portrayed as the result of the Space Race against the Soviet Union (Bulkeley 1991; Mowthorpe 2002; Chertok 2009), while the literature focuses on foreign partnership (Newton and Griffin 2011), or policymaking about technical decisions (Sadeh 2009; Logsdon 1986; Logsdon 2015). The literature on Russia, a major space player, usually deals with current space projects, industry and the interplay of space and national identity (Makarov and Payson 2009; Eriksson and Privalov 2021). On the EU, the literature deals with technological autonomy for civilian and military purposes, the industrial and institutional framework on space, the EU foreign policy with third parties, or the provision of public goods such as environmental or human security (Al-Ekabi and Mastorakis 2015; Hörber and Stephenson 2016). Finally, the arrival of China – a recent full-fledged space player – has been perceived as a new route to achieve their national goals and ambitions (Aliberti 2015), or as a threat to international security (Johnson-Freese and Erickson 2006; Wu 2015; Zhang 2011).

Finally, neo-Schumpeterian analysis focuses on climbing the technology ladder through innovation, catching up with industrialised states (Lee and Lim 2001; Mu and Lee 2005; López, Pascuini, and Ramos 2018). Barriers are not just economic in nature (Lee 2005); they are political too. Such analysis disregards geopolitical variables such as the involvement of the state in the development of strategic industries and global competition in market niches for economic advantages, and the search for autonomy of developing countries (Almeida 2019; Blinder 2017a, 2017b). Recent literature suggests that the systemic constraints over some emerging space powers are pushing the need to develop autonomous programmes. These new space players encounter economic limitations and international pressures from developed nations and private companies (Blinder 2015a, 2015b). However, as Wood and Weigel point out, governments take decisions subject to 'many non-technical factors when they consider space policy decisions, including factors such as geopolitical relationships, regional status, military postures and national pride' (Wood and Weigel 2011).

Technological development also matters. Developing space players are rule takers, rather than rule makers, while they are often compelled to adapt their technology policies to the international norms and rules, in line with major powers' normative regulatory regimes such as the US-led International Traffic in Arms Regulations (ITAR). In this case, the treaty aims to restrict and control the export of defence- and military-related technologies to safeguard national security. However, developing nations can opt to circumvent global and national obstacles by developing bilateral and multilateral cooperation to achieve their space policy goals. International cooperation could be an alternative route to reach technological development, bypassing the dependence on traditional providers.

In the last two decades, a resurgence of South–South cooperation[1] has moved once more to the centre stage of global affairs (Gosovic 2016; Gray and Gills 2016). Increasing international space cooperation among Global South countries is a critical indicator of the new wave of cooperation among non-western, developing nations. Developing nations have been building asymmetric associations with rising space powers. Africa's space policy highlights cooperation, technology transfer and the need for aid to face unsolved social and environmental problems (Froehlich and Siebrits 2019). Latin American space programmes

are diverse, involving asymmetrical cooperative interaction to develop domestic capabilities (Froehlich, Alonso, et al. 2020). In December 2019, Beijing launched the joint China–Brazil CBERS-4A observation satellite, the fourth achievement of a long-term partnership project between Brazil's National Space Research Institute (INPE) and the Chinese Academy of Space Technology. Years earlier (2014), Indian Prime Minister Narendra Modi had brought up the idea of launching a GEO communications and meteorology satellite for the South Asian Association for Regional Cooperation (SAARC), which would be launched successfully in May 2017. These cases present live examples of space cooperation within the Global South.

Space cooperation among Global South nations has grown in light of the rise of the post-Western world. It started in the middle of the Cold War but reached its peak in its last years. Space cooperation can be framed within the broader South–South cooperation in science, technology and innovation involving both bilateral and multilateral cooperation targeted at increasing capacity-building for development, transferring technology for mutual benefit and overcoming dependence from developed powers. The access to space has been widened for new developing actors, according to their growing needs. The developing countries' limited resources and technological development required new forms of international cooperation beyond the traditional partners, thus avoiding any patronisation over space improvements. At the same time, the South–South cooperation approach emphasises respect for sovereignty and for the principle of 'noninterference' in domestic affairs while avoiding economic and institutional conditionalities (Bergamaschi and Tickner 2017).

Satellite cooperation in the Global South is not only a way to diversify access to space and reach technological crossover, but also an alternative route to overcoming economic and technical structural limitations. An interesting approach involves assessing the situation, needs and potential strategies of developing countries by locating their position in the space technology ladder (Wood and Weigel 2014). The ladder offers two main features: it tracks the evolution of satellite programmes and identifies the next rungs of the satellite plans. The higher the position on the ladder, the greater the technological and economic needs. The space technology ladder has four steps from the bottom up: the creation of a national space agency, location of satellites in LEO and GEO, and launch capability. Regarding GEO satellite development, the authors introduce four GEO satellite sub-categories: locally built, built through mutual international collaboration, and built locally with outside assistance and procurement (Wood and Weigel 2012b).

There is no straightforward explanation for why space powers climb the ladder, but there are common elements, which can be drawn from the cited literature. On the one hand, there is a clear influence of regional and global geopolitical dynamics that can push for a military or civilian-oriented programme or provide incentives to look for new international partners. At the same time, economic development requires higher levels of innovation, which can be instrumented through the development of national capabilities or international cooperation, while the search for technological autonomy strengthens the political instruments vis-à-vis peer countries, in addition to providing potential economic gains.

In September 2019, two partially state-owned companies from Argentina and Turkey respectively, announced a deal to develop a joint project: a GEO communications satellite. Argentina and Turkey are examples of emerging space powers, which are partially dependent on global value chains from developed nations in terms of both materials and technology. In that sense, space policies in developing nations should adapt to global players' technology designs and to their regulations.

Argentina's space project: a route to economic development

Argentina has a deep-rooted civil space policy despite the recurrent financial crisis that paved the way to de-industrialisation and the erosion of productive capabilities. The country ranked high in research and development (R&D) for decades, which helped develop civilian technological projects based on previous military space activities. Moreover, Argentina has advanced nuclear and space technological institutions. The fundamentals of space-based technology in Argentina are centred in INVAP, a regional state-owned company, an acronym for *Investigaciones Aplicadas Sociedad del Estado* (Applied Research State Company). INVAP designs and builds complex technological systems for both the domestic market and export, developing state-of-the-art technology in different industrial, scientific and applied research fields such as nuclear applications and space. It is a provincial state-owned company established in 1976, in the Province of Rio Negro; the company is a byproduct of the national nuclear agency, the National Commission of Nuclear Energy (CNEA) (Thomas, Versino, and Lalouf 2008).

INVAP is the centrepiece of Argentina's technological ecosystem. Its main client is the government, which requires nuclear reactors for power generation and for research purposes (Hurtado 2010). Among its main products are the PALLAS reactor (Netherlands), OPAL reactor (Australia), ETRR-2 reactor (Egypt), NUR reactor (Algeria), RP-0 reactor (Peru), RP-10 reactor (Peru), RA-6 reactor (Argentina) and RA-8 reactor (Argentina). At the same time, the company provides services for researching reactors, nuclear fuel manufacture facilities, radioisotope production plants, instrumentation and control, products and services for Nuclear Power Plants (NPP), other products and services, and siting evaluation. Regarding the space sector, it produced the SAC-A, SAC-A and SAOCOM satellites, SAC-B, SAC-C, SAC-D/Aquarius and Argentina Soluciones Satelitales (ARSAT),[2] and the radars *Radar Secundario Monopulso Argentino*, Argentine Primary Radar 3 D (RPA) and meteorological radars as well as computational simulators and maintenance. Other projects include renewable and clean energy such as wind turbines, robots and special machines, industrial developments and services, process simulation and chemical processes. For instance, in the last two decades it developed the Chihuidos Sur Eolic system, a hydrokinetic turbine, a steam injection plant, and the OPAL reactor reflector vessel (INVAP 2020).

Historically, Argentina has developed further space capabilities since the 1960s. President Frondizi (1958–1962) created the National Commission for Space Research (CNIE), functionally under military control. Several extraordinary goals were achieved, such as the rockets Alfa, Beta, and Gamma Centauro, the rockets Orion, Castor, Rigel and Tauro, and especially the Canopus II Rocket, with which a monkey was sent to space and brought back alive. Nevertheless, no clear policy about space field institutionalisation continued, and often there was a fuzzy line between civil and military activities (Blinder 2015b).

The flagship project of Argentinean space development was the Condor II, a medium-range missile developed under Air Force auspices to improve firepower especially after the Malvinas–Falklands War (1982). Its development began near the end of the 1970s and the beginning of 1980. It became a strategic project for the military aviation after Argentina was defeated in the Falklands War (1982) and the Air Force lost deterrent capability along with its aircraft and fighter pilots. Though Condor II received contributions from both European companies and other countries such as Egypt and Iraq, its development was classified. Due to its secretive nature and the reputation of certain countries supporting its

construction, the United States put pressure on Argentina to deactivate the project for the sake of limiting missile proliferation and stabilising international security.

The foreign policy of President Carlos S. Menem (1989–1999) radically changed the perspective of Argentine international relations, vis-à-vis the changes the world was undergoing with the dissolution of the Soviet Union fading the tensions of the Cold War. President Menem's administration proposed to change the foreign perception of the country, opening up to free trade and generating 'special' and close ties with the major world power. The government of Menem intentionally dismantled national industrial capabilities, allowing foreign corporations to compete with domestic ones. However, at the same time, special relations with the United States led Argentina to higher status in terms of international trust and access to technologies (Azpiazu, Basualdo, and Nochteff 1998), which had been denied before due to what American foreign policy officials considered an erratic space policy (Escudé 2018).

The arrival of a US-oriented government led by Carlos Menem linked the space policy development to a US-oriented foreign policy. After pressures from the US security establishment, Argentina cancelled the dual-use Condor II and started a civilian space policy by creating the National Commission of Space Activities (CONAE) and avoiding any military-related uses. Until then, the national space institution was under the Air Force umbrella for national security reasons. Consequently, the Menem administration reached strategic agreements with the American National Aeronautics and Space Administration (NASA). Space cooperation between the United States and Argentina materialised the launching of μSAT-1, the experimental satellite Victor in 1996, the SAC-B in 1996 to study the sun, the SAC-A in 1998 with experimental objectives, and the SAC-C in 2000 for earth observation.[3] The United States launched these satellites, sending a clear signal that Argentina would not develop its own dual-use missile capabilities. Nevertheless, due to solid space institutionalisation under the non-military CONAE, Argentina advanced its national space capacities and achieved international recognition.

The technological results – the crisis notwithstanding – proved fruitful, and results were obtained by 2006 under Kirchner's administration. The Kirchner administration started a strategic-industrial policy in 2003, releasing a series of demands from the productive sector and civil society. The demand for satellite images for productivity by the CONAE and the request for sophisticated communications led to the creation of a state-owned firm, ARSAT, to plan, design and manage GEO satellites for telecommunications. The state-run INVAP was involved in the design and construction of the satellites. Despite its initial purpose being telecommunications, ARSAT could be considered another institution indirectly tied to space policy (due to the production of satellites and management of space orbits). Created in 2006, its objectives are the domestic design and development of GEO satellites, and their orbital positions in the space assigned to Argentina by the International Telecommunications Union. The company, along with INVAP, constructed and operated two satellites. The first was launched in 2014 and the second in 2015, from French Guyana.[4]

ARSAT's main assets are its orbital positions: 71.8°W for Arsat 1, and 81°W for Arsat 2, covering South and North America. A technology ecosystem was created for ARSAT, increasing the value chain of the satellite market in Argentina. In 2013 the company CEATSA (High Technology Test Center) was started in Bariloche, as a partnership between the two-state owned high-tech companies INVAP and ARSAT; the companies were looking for sites to carry out satellite tests. As a result of the satellite programme, INVAP has been hired to develop

national radars to cover the whole national territory. In 2015, ARSAT expanded the company into the data centre business and open digital television (TDA).

While CONAE carried out the civilian effort, Gradicom did its part for the military side. The Argentine Ministry of Defense developed a missile project with a solid-fuel rocket both as deterrent weaponry and as a further civilian satellite launcher. The Gradicom rocket raised concerns on external and internal levels, including among diplomatic officials and CONAE members, who wanted to be explicitly separated from any activity qualified as military. This development stirred some debates within political and business circles linked to Argentine space policy around the proliferation issue because the government already had been researching and testing the Tronador 2 liquid-fueled rocket, opening a discussion about how a solid-fueled would affect the civil space project. Certainly, the continuation of Tronador depended heavily on external perceptions, especially on the US position and on Argentina continuing a strict non-proliferation policy.

In terms of international satellite cooperation, the US has been the traditional partner and technological provider, but Argentina also receives support from Italy, France, Denmark and Brazil. Among its main achievements are the LEO satellite SAC-C (terrestrial observation), the SAC-D (meteorological), SAOCOM series 1A and 1B (Argentine microwave observation satellites) and the GEO satellites ARSAT 1 and 2 (communications) which partially rely on instrumentation from Thales Alenia Space, Astrium and Honeywell. Regionally, the Kirchner administration supported the creation of the South American Council of Defense (CDS) in the Union of South American Nations (UNASUR). In 2011 they pushed forwards the idea of creating a multinational and regional space agency of South American states. However, the initiative did not succeed. Beyond cooperation with regional and western nations, in the last few years Argentina has been looking for non-western, alternative partners and has engaged in a series of diplomatic ties with the space powers of non-traditional allies such as China and Russia. The aim was to widen cooperation, resulting in only information transfer with China related to the establishment of a deep-space ground station in the Neuquén province, which delivers support for lunar and interplanetary missions with similar technical characteristics to the European Space Agency deep-space ground station in the neighbouring province of Mendoza (Blinder 2017b). This turn to new sources generated some concerns in the US Defense Department due to the perception that Beijing could improve intelligence-gathering capabilities in the region (Lodoño 2018). In the end, the changing goals in the Argentina space plan from the military to a civilian approach have been related to the country's democratisation trajectory and the geopolitical constraints.

Turkish space project: a route to strategic advantage

Turkey is rising not only as a regional power but also as a global player in various fields, including the space and defence industry. Some three decades ago, Turkey was a marginal player in the space industry. The country's plans started later than those of its more developed counterparts (Yilmaz 2016). However, a mix of mid-term planning and military and economic needs have launched Turkey to the forefront in the Eurasia region as an emerging space country. Nowadays, the country can be compared with middle space-powers like Argentina, Australia, Brazil, Chile, India, Indonesia, Malaysia, Mexico, Nigeria, Pakistan, South Africa, Taiwan and Thailand (Wood and Weigel 2012a).

Turkey's space-related activities were meagre between 1993 and 2004, but there has been an increase since 2005, matching rising military needs and requirements. The Syrian Civil War and the stress on Ankara's southern borders since 2011 pushed for greater autonomy on intelligence, surveillance, and reconnaissance (ISR) purposes. The development of space projects has become a critical instrument for Turkey's security and defence goals, particularly the development, production and operation of satellites. According to Ercan and Kale, 'satellites provide a major contribution to the security and defense sector with their advantages of flexible, cheaper, resilient and global coverage service capability' (Ercan and Kale 2017b, p. 9).

In terms of space policy, after decades of being sidelined, the Supreme Council for Science and Technology (SCST) encouraged the Turkish space plan when, on February 1993, it approved the document 'Science and Technology Policy of Turkey: 1993–2003'. The main document for Turkey's technological development identified space as one of five priority areas that affect the economy overall, alongside informatics, nuclear technology, advanced technology materials, and biotechnology. Almost a decade later and despite the approval of a series of official initiatives and documents, it has not been able to reach the goal of establishing a centralised agency to coordinate all space activities. In 1999, Scientific and Technological Research Council of Turkey (TÜBITAK) drafted a study to prepare a national policy under the title 'General Framework for Turkey's National Space Policy' which did not become official. A couple of years later, the National Security Council approved the decision to establish a 'Turkish Space Agency', but the internal political changes with the arrival of the Justice and Development Party (JDP) hindered its implementation.

A year later, TÜBITAK would prepare the document 'Vision 2023 Project, Security, Aeronautics and Space Industry Panel Report', which called for the establishment of a National Space Program and a National Space Agency, in addition to boosting international cooperation (Halim and Medeni 2012; Özalp 2009). Step by step, all those goals were accomplished.

Firstly, Turkey signed agreements with the European Space Agency (2004) and Roscosmos (2009), became a founding member of the Beijing-based Asia-Pacific Space Cooperation Organization (APSCO) in 2008, signing also bilateral treaties on space cooperation with Ukraine, Hungary and Kazakhstan (Özalp 2009; Bicer 2019). Secondly, on March 2005, a 10-year National Space Research Program was approved by the prime minister with the main goal of establishing space R&D infrastructure and creating the necessary national mechanisms to maintain it under the coordination of TÜBITAK. Additional aims encompass mobilising and strengthening the Turkish space industry by improving its capacity and capability, encouraging and supporting research and technological development, developing new technologies and an integrated system, and generalising the use of space technologies and space-based services in society in order to create opportunities for industry, trade and services. From the establishment of the National Space Research Program to the creation of Turkey's Space Agency, there was a process of dual diversification of actors and projects.

On the one hand, the space environment had been traditionally state centred. Traditional space players include TÜBİTAK Üzay, Türksat, the Directorate General of Aeronautics and Space Technologies, and the Directorate General of Civil Aviation under the Ministry of Transport Maritime Affairs and Communication and the Under-secretariat for Defense

Industries (SSM) of the Ministry of Defense. However, more recently local companies and research centres within the R&D space activities had grown in relevance. As an example, TAI, Roketsan and a major Turkish rocket producer had become central in the development of a national space industrial ecosystem (Bakırcı-Taylor 2019).

On the other hand, the focus of the space development programme has been on satellites. Until 2010, Ankara's principal space assets were communication and remote sensing satellites; later on high-resolution earth observation became a crucial point. After a couple of decades, Ankara has been able to develop, produce and operate earth observation and communication satellites, in addition to CubeSats or miniaturised satellites (Kara and Kilic 2015). At the same time, around 75% of the National Space Research Program's budget had been oriented towards space systems infrastructure (Özalp 2009). The main products of the space industry includes GEO communication satellites (Türksat developed with jointly with Thales – 3A – and Mitsubishi – 4A & 4B), LEO earth observation satellites such as the reconnaissance satellites for military use (Göktürk-1 in cooperation with Telespazio and Göktürk-2 developed by Turkish institutions working alone) and remote sensing satellites (BILSAT-1 and RASAT), in addition to three CubeSats developed by the Istanbul Technical University for experimental purposes.

Finally, the Turkish presidency approved the creation of a Turkish Space Agency (TSA) on December 2018, a long-term aspiration from the entire space ecosystem. The Ministry of Industry and Technology Mustafa Varank summarised the achievement by saying 'our dream of 20 years has come true' (Daily Sabah 2018). According to Presidential Decree number 23, the agency will be under the Ministry of Industry and Technology, which seeks to formulate the National Space Program and other strategic plans with medium- and long-term goals, developing a competitive space industry, deciding on the use of rights under the national sovereignty and space coordination systems and the national sovereignty of spacecraft and space systems, and developing multilateral and bilateral cooperation (Turkish Presidency 2018). In sum, the Turkish presidency aims to become a global player in space technologies with its vision of indigenous technology and strong industry.

As an institutional turning point, Turkey has gone through the first eight steps of the space technology ladder while procuring to climb the next three steps: a domestically built GEO satellite, launching autonomy and a bi-nationally built GEO satellite (Wood and Weigel 2012b). First, Türksat and TAI built Türksat 5A at the Satellite Assembly Integration and Test Facility with the assistance of Airbus Defense and Space and launched it on a Falcon 9 rocket in January 2021. Ankara has invested broadly in the development of defence research activities, particularly in 'space infrastructure in the areas of space-based remote sensing systems such as electro-optical and Synthetic Aperture Radar (SAR) systems, ground systems, and related subsystems for carrying out intelligence, reconnaissance and surveillance', trying to establish a 'non-dependent space capacity by boosting its defense industry and research institutions' (Özalp 2009, 231). The new institutional centralisation highlights the relevance of both the space development itself and the boost to the local defence industry. The military sector supported the creation of the TSA despite it not being under the Ministry of Defense. In terms of space military capabilities, Turkey has become

> one of the 30 countries who have and operate their own LEO and GEO satellite/s in orbit/s, one of the seven NATO nations who have their own military X Band SATCOM payloads, the only other country, after France, that has developed national STANAG 4606 compatible X Band frequency hopping SATCOM modems, one of the two North Atlantic Treaty Organization (NATO)

> countries who have successfully initiated and completed processed extremely high frequency (EHF) R & D project, and one of the several countries who have their own class 100,000 Assembly, Integration and Test (AIT) center. (Ercan and Kale 2017a, 3)

Additionally, Ankara has tried to push for a domestic launch capability project. Rokestan and the Turkish Presidency of Defense Industries (SSB) agreed in 2018 to develop a Satellite Launch System (MSLS) to LEO that will allow the country to gain independent access to space (Rokestan 2020). Up until now, Turkey has relied on developed nations including the United States, Russia and members of the European Union, to launch her satellites. Finally, Turkey is developing a GEO satellite in cooperation with the Argentine state-owned INVAP. President Recep Tayyip Erdogan announced these goals in February 2021, as part of an ambitious TSA National Space Program, which aims to make its first contact with the Moon in 2023 (Anadolu Agency 2021). Turkey has incorporated the special sector as an emerging dimension of new strategy to gain technological military advantage as the regional context becomes increasingly confrontational.

The bi-national GEO satellite: goals, scope and dimensions

The case of Turkish–Argentine satellite cooperation is located in the second sub-category of the GEO technology ladder since both countries had developed GEO with foreign assistance, but further steps required international cooperation. Even if both pursue technological development, the motivations are alike. Buenos Aires's space plans changed from a military-based project in the late 1980s towards one driven by developmental goals, including the need to obtain external revenues. In the case of Ankara, the increasing strategic and military engagement in the Middle East and Central Eurasia required communication and intelligence capabilities in which the satellite industry is critical.

Despite having different paths and development trajectories, Argentina and Turkey crossed paths in early 2019 when they reached an agreement based on their technological and economic needs and after identifying a market niche that had not been explored for cooperation between two space powers. This partnership was surprising since political relations between Turkey and Argentina had been turbulent since the mid-2000s due to a series of diplomatic incidents related to the Armenian question (Gonzalez Levaggi and Donelli 2021). However, there was a clear niche market that had not been covered and in which they could be very competitive should they develop a small electric GEO satellite. Argentina is experienced in exporting national production of high-tech nuclear reactors to a variety of countries, while it also has expertise in GEO satellite development. Turkey is proficient at exporting space-related products and had been developing GEO satellites too. In the context of a growing worldwide telecommunications market, a joint project was an opportunity to climb the technological space ladder without relying on traditionally developed powers.

As GSATCOM's chief executive Luis Genovese states:

> We believe it is strategic for our countries […] this is one of the most important reasons. It is not only a commercial operation, doing business, but developing capabilities that will allow us to really support our countries for more autonomous development. (quoted in Henry 2019)

The joint project began as an Argentine exploration – a search for partners domestically and overseas. In 2015 INVAP carried out a market study to find an empty niche from which it began developing the concept of a small electric geosatellite. The state-owned company

undertook the calculations for budgeting and the design. A senior official source at INVAP specified,

> In 2016 we strategically decided to develop it; as INVAP did not have the money to face this investment, we went out to look for financing or partners in Argentina. In 2017, when we failed to find financing locally, we went out to look for a foreigner partner and client. We saw that there was a lot of interest from customers on that type of satellite. But finding partners was not easy. We were negotiating with various stakeholders to partner up in development during 2017. Finally, we did not reach an agreement with anyone. In March 2018 we met with senior TAI executives at an international congress on satellites, and we told them about INVAP's capabilities, we invited them to meet us. Shortly after, they hired us to do a consultancy, and then we began to talk about setting up a new company. Fortunately, they had plans to develop a similar product. TAI is a company very similar to ours in its history and in its corporate composition, and immediately we both saw the potential of partnering to carry this out. INVAP is more experienced in designing, testing, constructing and putting satellites into orbit. But the TAI had the money and the ambition to learn. (Interview with INVAP Official 2019)

In August 2018 the formal negotiations started, and, finally, in March 2019 the two companies agreed to create GSATCOM, a bi-national company to design, manufacture and market a new kind of fully electric small GEO satellite. GSATCOM become a joint venture between INVAP and TAI aiming at the development and commercialisation of a next-generation electrically powered communications satellite. It also aims to develop a flexible type of communications system. Officially, GSATCOM offers a range of telecommunications solutions from the new satellite family. The satellite's payload capabilities are based on digital control solutions providing flexibility with custom designs, adaptive frequency reconfiguration, coverage and power allocation.

On the Turkish side, the TAI 'Vision 2023 Document' pushes the company to participate actively in the satellite world market. The Space Systems Deputy General Office was responsible for implementing this approach (Donanım 2020). The chief executive officer of TAI, Temel Kotil, emphasises the small satellite concept and bilateral cooperation as a unique solution for the geographic telecommunications market (Ertaş 2019), while the Deputy General Manager, Selman Nas, underlines that the small GEO possess an optimal relation between quality and price, while opening a new stage for TAI from 'making our own satellites with domestic sources' to 'developing competitive satellite systems locally and selling them abroad' (Yeni Şafak 2019). In every public discussion, the Turkish officials repeat as a mantra the commercial advantages of the joint venture project and the potential in the global satellite market.

According to the INVAP senior official we interviewed, 'this kind of satellites constitutes the state of the art in communication satellites and puts Argentina and Turkey at the forefront of technology' (Interview with INVAP Official 2019). The platform has full electric propulsion, both for the satellite to be lifted into orbit and for maintenance during its 15-year design life. In technical terms, it will have 2000 kilograms, which integrates payloads consuming up to 7 kW and a capacity of up to 50 Gbps (GSATCOM 2020). The GSATCOM modular and scalable concepts provide a more straightforward payload–platform integration due to market needs relating to supporting a wide range of payload types (GSATCOM 2020). The satellite will be produced in equal parts, providing each country with half of the components. Then, after setting the final engineering, the satellite was planned to be delivered in 24 months, around 2021 (Latam Satelital 2019).

However, the financial constraints in Argentina due to the economic crisis since 2018 – further deepened by the COVID-19 crisis – adds on serious weaknesses. In 2019 the government of Argentina had a debt to INVAP of 700 million pesos and some of its workers had received only portions of wages and these generally late. Regarding the absence of payments, INVAP went to look for cash for capitalisation between projects. Among the company's clients are CONAE, ARSAT, the Air Force, the Secretary of Hydrology, the National Agency of Commercial Flights and the nuclear agency CNEA (Interview with INVAP Official 2019). This put INVAP in a very difficult situation, triggering some options for a company that considers its projects to be strategic.

Despite being a strategic project supported by both states, the governments did not intervene; their agreement is based purely on the commercial interest of both companies to capture the international market and become leaders in that small GEO satellite niche (Wood and Weigel 2012b). However, both sides have benefitted from broader state support. Regarding the Argentine state, INVAP led a collective effort involving the Ministry of Foreign Affairs, the Argentine Embassy in Turkey, the Ministry of Science and Technology, CONAE and ARSAT, which also have experience producing this sort of satellites. According to the vice-president of INVAP, Vicente Campenni, this kind of national project is crucial because it 'allows us to develop capabilities that are later capitalized and gives us the ability to negotiate internationally' (quoted in Alonso 2019). Regarding Turkey, the Ministry of Foreign Affairs and the Turkish Embassy in Argentina played a key role, in addition to the space-related institutions that have been supporting the TAI's international efforts.

Even if there had been a different set of factors at play, the case study shows a pre-eminence of concerns regarding geopolitical and technological autonomy behind Turkish space policy due to its attempts to become independent from the traditional western providers, while innovation plus autonomy have been influencing the Buenos Aires decision makers. This means that the South–South cooperation in the space arena can be presented as a broader narrative, which can contain heterogeneous approaches and motivations to develop space policies. Finally, Turkish–Argentine satellite cooperation provides a new route to achieve national space goals by overcoming the constraints of the geopolitical context and of the lack of available resources, both economic and technological.

Final remarks

What can we learn from this case study about the role of economic, geopolitical or innovation-based motivations for middle powers in space? We found out that they may decide to climb the space technology ladder, driven by geopolitical or economic innovation. However, the two are amalgamated: creative destruction occurs in a geopolitical context; geopolitics provides the context for political or economic agents to concur in the space economy. Great space players will compete with the newcomers, either in the technological offer or in the rules of the game. Thus, countries of the Global South will have incentives to seek market niches and a robust diplomacy to be able to achieve their objectives in terms of technological developments.

R&D of developing players in the space arena is not triggered for competing in a global market, or achieving the state of the art of technology, but mostly for geopolitical concerns, the development of autonomous technology and the quest for innovation. The cooperation between Argentina and Turkey began with exploring technological frontiers regarding GEO

satellites for a marketable niche in which traditional players have several advantages, such as a robust national innovation scheme, and productive capabilities developed within a national security environment.

While both countries have been climbing Wood and Weigel's technological scale (2012b) (see Table 1), their pathways to development have been significantly different. Turkey has developed her satellites with heavy foreign involvement and had managed to produce her

Table 1. Space Technology Ladder in Argentina and Turkey.

Technology ladder	Argentina	Turkey
13 Launch capability: satellite to GEO	–	–
12 Launch capability: satellite to LEO	Cóndor II** (1982), PCX-900 Gradicom I* (2009), PCX2 Gradicom II* (2011), Vex-1A/Vex-1B (Tronador II)*	Space Launch System (Uydu Fırlatma Sistemi)*
11 GEO satellite: build locally	ARSAT 1 (2014), ARSAT 2 (2015)	Göktürk 2 (2012) TurkSat-3USat (2013) ITUpSAT1 (2009)
10 GEO satellite: build through mutual international collaboration	–	–
9 GEO satellite: build locally with outside assistance	–	Göktürk-1 (2016)
8 GEO satellite: procure with training services	–	Türksat 1B (1994), 1 C (1996), 2A (2001), 3A (2008), 4A and 4B (2011)
7 LEO satellite: build locally	SAC-B (1990), SAC-A (1998), SAC-C (2000), Pehuensat-1 (2007), SAC-D (2011), CubeBug-1/CubeBug-2 (2013), SAOCOM 1A (2018), SAOCOM 1B (2020)	RASAT (2011) UBAKUSAT (2018)
6 LEO satellite: build through mutual international collaboration	–	BILSAT-1 (2006)
5 LEO satellite: build locally with outside assistance	–	–
4 LEO satellite: build with support in partner's facility	Lusat-1 (1990), Ñusat 1 (2016), Ñusat 2 (2016), Ñusat 3 (2017), Ñusat 4 (2018), Ñusat 5 (2018), Ñusat 7 (2020), Ñusat 8 (2020)	–
3 LEO satellite: procure with training services	µSAT-1 Víctor (1996), BugSat-1 (2014)	–
2 Space agency: establish current agency	Comisión Nacional de Actividades Espaciales (1991)	Turkish Space Agency (2018)
1 Space agency: establish first national space office	Comisión Nacional de Investigaciones Espaciales (1960)	Turkish National Space Research Programme (2005)
Endnote	Argentina has had a long tradition regarding launch capabilities that dates from the mid-1940s. Among the main launchers are Tábano (1950), Martín Fierro (1956), Alfa Centauro (1961), Beta Centauro (1961), Gamma Centauro (1963), Prosón M1 (1963), Orión 1 (1965), Orión II (1966), Canopus I (1966), Rigel (1967), Orión II: Belisario Mouse Test (1967), Canopus II: Monkey Juan Test (1969), Castor (1973), Tauro (1981), Cóndor I (1982).	

*Experimental. **Experimental, cancelled in 1990.

own by the beginning of the twenty-first century, with the LEO and GEO linked to a flourishing military–industrial complex. Argentina has embarked on a winding path of technological climbing. The South American country set up her first space agency in the 1960s, in the field of launchers; among those, the successful experimental launches of two live animals stand out. The Condor II interrupted further development, along with international cooperation. On the one hand, international pressures for reasons of missile non-proliferation led to the creation of a new space agency strictly oriented to the satellite industry. On the other hand, a public telecommunications company placed two GEO satellites in orbit. Argentina continues to research and develop new launch vehicles, based on the knowledge accumulated in past decades strongly tied to INVAP's institutional experience related to the nuclear industry.

Two elements are critical for assessing the Argentine–Turkish joint satellite project. First, the purpose of cooperation between Argentina and Turkey seeks to gain a commercial place in a strategic industry. On one hand, from INVAP's point of view the agreement opens new marketable horizons, thus helping to internationalise the local technological achievements and circumscribe financial constraints. For Turkey, on the other hand, this cooperation creates an opportunity to compete in the global markets while improving its industry, strengthening know-how and enriching the geopolitical and technological autonomy of a NATO member that depends upon Western technology. Domestic development is part of Ankara's broader diversification strategy in several areas, particularly national security-related issues. Second, while the immediate motivation for partnership is defined by widening customer pool for profits, there is a divergence in the ulterior goals since Argentine's space project is basically civilian oriented while Turkey has a particular interest in improving its strategic–military means for its national security.

What lessons can other countries take from this experience? This case provides interesting clues to look at the sources and goals of cooperation between two non-traditional space players. Moreover, in developing countries with certain industrial and technical capabilities, specialised organisations and public companies can undertake projects not driven by the central government. Despite the two countries having in common space development while seeking technological autonomy, their motivations are different. In this regard, having differing motivations does not mean that cooperation is unachievable. On the contrary, the case for cooperation between Argentina and Turkey offers an example where both countries aim to climb the technological ladder. Finally, the consequences of the project are not only technological improvement and empowerment of national innovation systems, but foreign policy in a rising multipolar world.

As a middle space-power with geopolitical relevance regarding its location for strategic and military reasons for policymakers, the Turkish space programme demonstrates how important autonomous capabilities are. Space technology contributes to the defence system as well and the science and technology ecosystem in Argentina. Nonetheless, the driver presents a Schumpeterian view of the economy, in which space spin-off drives other concomitant enterprises. Since Argentina dismantled its military industry through its process of state reform of the 1990s, the Turkish example could pave the way for leading a virtuous cycle of high-tech re-industrialisation for national security. Finally, Argentina shows how an entrepreneurial state can boost a niche that could impact positively in the creation of new technologies, from the commodity chain to the international market.

Disclosure statement

No potential conflict of interest was reported by the authors.

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Notes

1. Despite different conceptualisation and approaches, the article understands South–South cooperation as the processes, institutions and arrangements designed to promote political, economic and technical cooperation within the Global South (Can Gürcan 2019, 4).
2. INVAP, the main contractor for space development in Argentina, has established partnerships to manufacture the satellites with other companies such as VENG or CEATSA. This information illustrates the complexity of the space development ecosystem in Argentina. This information is introduced just as an example and does not constitute this paper's main objective. It does show, however, the sector's growth in the last few decades. The capabilities developed in nuclear projects are related to satellite production. Scientists and technologists, who initially virtuously developed a robust nuclear sector in a country of the Global South, had a learning process that shaped a technological ecosystem. It was a company in which qualified nuclear workers learned to make space technology, radar and more recently unmanned aerial vehicles, among other developments. The company also has experience, with government support, in nuclear cooperation. Due to that synergy there was also learning of internationalisation of relationships, which allowed cooperation with other global players. Unlike Argentina, Turkey does not have a decades-long tradition of developing and managing nuclear technology. For more information see M. Versino, Trayectorias de empresas productoras de 'bienes complejos' en el ámbito latinoamericano: los casos de INVAP S.E. y EMBRAER S.A., Anuario Centro De Estudios Económicos De La Empresa Y El Desarrollo (2017) no. 6, http://ojs.econ.uba.ar/index.php/CEEED/article/view/1063; D. Hurtado, "Semi-Periphery and Capital-Intensive Advanced Technologies: The Construction of Argentina as a Nuclear Proliferation Country," *Journal of Science Communication* (2015), vol. 14, núm. 2. http://jcom.sissa.it/archive/14/02/JCOM_1402_2015_A05.

3. While initially disconnected from the space policy, from the beginning of the 1990s the Menem administration decided to promote 'the business' of satellite communications. After some initial steps, in 1995, the Ministry of Communications supported the creation of the first national satellite communications company, NahuelSat.
4. The National Commission for Space Activities (CONAE in Spanish) is the Argentine state-owned space agency. The Plan Espacial Nacional has never included telecommunications satellite projects. Although is a has a different institutional frame and scope, ARSAT SA is a public limited company whose capital is in the hands of the nation state; it operates ARSAT 1 and 2. INVAP is the main contractor for satellite projects in Argentina.

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