

Innovation Under Pressure: Politics and Technology

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Abstract

This study delves into the connections between politics, such as sanctions, tariffs, and industrial policies, and local technological innovation, using endogenous growth theory as a guide. These interventions aim to shift strategic power or correct market imbalances. However, their impact on innovation may change depending on the situation. The paper provides both historical and current examples from Iran, China, and the United States to show how political limitations can first lead to a decline in domestic innovation, and second, cause domestic innovation to rise.

For example, sanctions can limit access to foreign capital and the flow of knowledge, but they can also spur local R&D and self-reliance. Industrial policies work differently as they are implemented by state support for strategic sectors, steering enterprises toward long-term innovation. The China-U.S. trade war is referred to as a case study from which the process of how escalating restrictions reshape national innovation strategies in practice can be tracked. The paper concludes by proposing the Strategic Innovation Buffering Mechanism (SIBM), a policy framework designed to shield innovation systems from external shocks and sustain long-term endogenous growth.

This paper asks: how do political instruments such as sanctions, tariffs, and industrial policies reshape the foundations of domestic technological innovation? Sanctions restrict capital, inputs, and labor, sometimes forcing R&D but reducing competitiveness.

Consistent with modern endogenous growth perspectives, human capital investment and innovation, through research spillovers, remain central to sustained economic growth (Akçigit, et al. 3477). Political interventions restrict knowledge flows, alter incentives, and redirect capital, shaping whether innovation contracts or adapts. This paper traces these mechanisms through case studies of Iran, China, and the United States, highlighting evidence such as patents in Iran, upgrading in China, and the surge of U.S. semiconductor investment following the CHIPS Act.

Historical and Current Context

Political interventions have shaped innovation trajectories in diverse ways, depending on how they alter access to capital, knowledge flows, and talent. This section compares Iran, China, and the United States to show how political tools reshape innovation.

Since 2006, sanctions have restricted imports of medical devices, aerospace parts, and semiconductors while cutting international collaboration. These constraints pushed the expansion of parks like Pardis, hosting 3,600 biotech and ICT firms.

Between 2010 and 2020, Iranian inventors filed over 8,000 patents in pharmaceuticals and medical devices, yet applications fell by 12% after renewed U.S. sanctions in 2018 (“World Intellectual Property”). While biotech clusters like Pardis Technology Park expanded, the aerospace and semiconductor sectors show gaps, with outdated machinery raising costs by 40% (“Iran Economic Monitor”). China, by contrast, has leveraged industrial policy to redirect innovation inputs. The Made in China 2025 plan expanded subsidies and tax incentives by 29%

annually between 2018 and 2022, covering half of corporate R&D in priority sectors (“Made in China 2025”). This helped China surpass the U.S. in EVs, batteries, and nuclear power. Even under U.S. export controls, Huawei’s 2024 Kirin 9020 chip with domestic 5G components shows resilience through self-reliance. Between 2019 and 2023, China’s semiconductor patents grew 45%, and it reached 35% of global EV exports, surpassing Japan (“Global EV Outlook 2024”).

The United States illustrates how political tools reinforce innovation through both defense spending and contemporary industrial policy. Cold War investments seeded industries such as semiconductors and aerospace, while the CHIPS and Science Act of 2022 allocated \$52 billion to boost domestic semiconductor production. By 2024, over 30 semiconductor facilities were under construction, with private investment above \$200 billion (“2024 State of the U.S.”). Early indicators suggest domestic chip output could rise from 12% of global supply in 2020 to over 20% by 2030, though skilled labor shortages remain a constraint. In 2024, U.S. semiconductor R&D reached \$62.7 billion (“2024 State of the U.S.”), while electronics manufacturing spending hit \$135 billion annually, signaling rapid build-out (“US chip construction”). Unlike Iran and China, U.S. interventions build on deeper capital markets and research networks, letting state measures amplify rather than substitute innovation.

Theoretical Framework: Endogenous Growth Theory

Recent extensions of endogenous growth theory emphasize that long-term prosperity depends on the accumulation of human capital, R&D intensity, and knowledge spillovers within an economy (Akçigit, et al. 3477).

Political instruments can be mapped onto these theoretical variables. Sanctions constrain international knowledge spillovers and restrict access to advanced capital goods, reducing research productivity, though they may push firms toward local substitutes. Tariffs alter the

relative returns to domestic versus imported inputs: they can stimulate domestic supply chains and encourage R&D reallocation, but also risk reducing efficiency through higher costs. Industrial policies, e.g., R&D subsidies, public-private partnerships, and targeted education, reshape human capital and reduce long-term risks, deepening knowledge and spillovers.

The endogenous growth model measures whether policies expand human capital, spillovers, and R&D incentives or reduce them by limiting access to inputs.

Mechanisms of Political Influence on Technological Innovation

Sanctions, tariffs, and industrial policies reshape innovation by altering capital, knowledge, and talent flows. The theoretical model of endogenous growth points to a contradiction: development depends on spillovers; however, political restrictions are the norm.

Restrictions hinder companies from getting the necessary capital goods and from accessing the global market. Along with these restrictions, less scientific collaboration may occur, which could lead to a decrease in knowledge spillovers. In Iran, post-2006 sanctions on pharmaceuticals and semiconductors increased input costs by more than 40%, with 5-7 year delays in acquiring components (“Iran Economic Monitor”). While this spurred biotech and nuclear R&D, gains came at a higher cost and lower efficiency.

Tariffs and trade wars reshape incentives by raising the price of imported inputs and blocking critical technology transfers. After U.S. export controls in 2019, China accelerated semiconductor self-sufficiency: domestic chip output rose by 33% between 2020 and 2023 (Allen). Yet Huawei’s effort to produce a 7nm chip domestically lagged global leaders by nearly four years and entailed a 20-30% higher cost. The policy spurred innovation but also exposed inefficiencies.

Industrial policies lower innovation risk by reducing entry barriers and boosting spillovers. South Korea's semiconductor strategy elevated R&D expenditure from 2.6% of GDP in 1990 to 4.9% in 2020, the highest in the OECD ("Main Science"). The aid shortened the innovation process, thus Korean companies became leaders in the global market within twenty years, though at a cost. To be concise, interventions in the political arena do not merely "help or hinder" innovation. They bring about measurable costs, such as delays, inefficiencies, and fiscal burdens, which must be considered alongside the strategic advantages of self-reliance. The theory of endogenous growth is the framework for such an assessment: the unrestricted knowledge exchanges offer the greatest growth potential; however, the political limitations imposed in order to achieve the desired level of security are the ones most often restricting openness.

Case Focus: The China-U.S. Trade War and Its Innovation Aftermath

The China-U.S. trade war shows how politics shapes technology. The United States introduced tariffs on Chinese goods worth more than \$500 billion and disallowed the export of sensitive technologies such as semiconductors and 5G equipment to China (Bown). These policies blocked China from obtaining advanced chips and software necessary for the development of technology, thereby cutting off knowledge spillovers and high-value inputs.

Subsequently, China turned to the state and considerably raised the funding for the sectors considered to be of strategic importance. They increased subsidies and created state-backed innovation consortia. The National Integrated Circuit Industry Investment Fund typifies this policy; it has heavily invested through R&D and production in the semiconductors industry ("Made in China 2025"). These interventions raised chip output 30% between 2020 and 2023, though with delays and higher costs (Allen).

This incident from the viewpoint of endogenous growth theory, reveals how limitations reduced the spillovers at a global level but at the same time incited the substitution activities that increased returns on the domestic R&D. Sanctions had the same effect on Iran as they did on China, i.e., they forced it into inefficiency and self-reliance mode whereas, on the contrary, U.S. industrial policies energize private-sector innovation like it has done to the trade war (Chen et al. 102734).

Policy Recommendation: Strategic Innovation Buffering

The Strategic Innovation Buffering Mechanism (SIBM) aims to preserve innovation capacity during shocks like sanctions or trade wars. The idea takes inspiration from examples like stabilization funds and mission-oriented programs such as DARPA or Horizon Europe. Similarly, an SIBM would establish publicly funded innovation reserves that could be rapidly utilized when access to foreign technology or knowledge is interrupted.

In the real world, this could be supported by allocating a portion of a country's R&D budget to the project. Government agencies and independent boards would manage it. Areas to be targeted are the STEM pipeline, R&D subsidies, and the university-industry partnership, which are both vulnerable and pivotal to long-term innovation.

When it is put in the context of endogenous growth theory, the SIBM deepens the fundamental drivers of sustainable development. It also funds research during crises, thereby maintaining knowledge production and spillovers; and by reducing risk for firms, it keeps R&D incentives that are the main sources of innovation cycles, even if there are external pressures.

As we all know, any such mechanism does not come without its challenges. The risks in question may include inefficient allocation, political capture, or crowding out private investment. To

reduce these risks, governance could be characterized by independence and transparency, having outcome-based funding criteria and periodic external assessments. With safeguards, SIBM could provide resilience without rigid protectionism.

Conclusion

Political interventions, sanctions, trade wars, and industrial policies significantly shape innovation, though unevenly. The case of Iran under bizarre political circumstances depicts that puncture pressure leads to a very expensive replacement; in China, politics is the main factor that determines the country's innovation paths; in the U.S., instruments are the means by which existing advantages are further affirmed. The theory of endogenous growth is the explanation for the results by institutional capacity rather than by instruments. Ensuring this capacity requires strong mechanisms like SIBM, which can both cushion disruptions and channel political interventions into future resilience.

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