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The Impact of Industrial Policy on Advancing Technological Innovation

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Abstract

Industrial policy is essential for fostering technological innovation as it provides focused assistance to key industries, encourages research and development (R&D), and tackles market inefficiencies. Historical examples from countries like the United States, Japan, and Germany demonstrate how industrial policy has contributed to the growth of advanced technology sectors such as artificial intelligence, biotechnology, and renewable energy. As Mazzucato (2013) contends in The Entrepreneurial State, proactive government involvement is vital in shaping markets and enabling breakthrough innovations that may be too risky for private firms alone. However, industrial policy is not without challenges; risks such as inefficiency, market distortion, and rent-seeking behavior must be carefully managed. Rodrik (2008) stresses the importance of strategic policy design and institutional strength to ensure adaptability and relevance to evolving technologies. Freeman (1995) also underscores the role of national innovation systems in maintaining long-term technological advancement. This paper explores the theoretical underpinnings, empirical findings, and real-world case studies of industrial policy's influence on innovation, offering insights for crafting effective innovation-led growth strategies.

Keywords: Market Failures, State Intervention, Collaborative Partnerships, National Innovation Systems, Economic Growth

1. Introduction

Technological innovation plays a pivotal role in driving economic growth, enhancing industrial competitiveness, and promoting societal development. In the context of an increasingly knowledge-based global economy, governments around the world have come to view innovation as a central element of national development strategies. As a result, industrial policy has regained prominence as a key mechanism for guiding structural economic transformation. Broadly, industrial policy refers to deliberate government interventions—such as subsidies, tax incentives, regulatory adjustments, and public-private collaborations—designed to address market inefficiencies and foster investment in research and development (R&D) (Lall, 2004). These efforts aim to overcome systemic barriers to innovation, including coordination failures, financial limitations, and insufficient support for high-risk ventures.

Such policy measures are particularly crucial in sectors characterized by high uncertainty and long innovation cycles, where private actors may hesitate to invest without state backing. By creating a supportive and predictable environment, governments can reduce barriers to entry and stimulate technological breakthroughs with far-reaching economic and societal implications. The need for effective industrial policy has become even more urgent in light of global challenges such as health crises, digital disruption, and climate change, which require coordinated public action to steer innovation towards sustainable and inclusive solutions.

The experiences of advanced economies demonstrate the transformative potential of well-executed industrial strategies. In the United States, public funding has driven innovation in key sectors such as information technology, biotechnology, and aerospace (Block & Keller, 2011). Japan's post-war industrial development was significantly shaped by the Ministry of International Trade and Industry (MITI), which played a vital role in fostering the country's automotive and electronics industries (Johnson, 1982). Similarly, Germany's innovation system—rooted in strong industry-academia collaboration—has contributed to continuous technological progress and global competitiveness (Edler & Fagerberg, 2017). These examples highlight the critical role of the state in supporting innovation-led growth.

Despite its potential, industrial policy is not without criticism. Critics point to the risks of government failure, resource misallocation, and the promotion of rent-seeking behaviors (Krueger, 1990; Pack & Saggi, 2006). A major challenge lies in accurately identifying the most promising sectors or technologies—a dilemma commonly referred to as the "picking winners" problem. These concerns underscore the need for evidence-based, transparent, and flexible policy frameworks capable of adapting to dynamic technological and market conditions.

Theoretical approaches offer valuable insights for shaping effective industrial policy. Nelson and Winter's (1982) evolutionary economics emphasizes the role of institutional learning, capability building, and the cumulative nature of technological change. Meanwhile, the National Innovation Systems (NIS) framework, advanced by Lundvall (1992), highlights the importance of interconnected relationships and knowledge flows among firms, research institutions, and government bodies. These perspectives suggest that industrial policy should prioritize collaborative learning environments and systemic innovation networks over isolated financial interventions.

Empirical research supports the positive influence of well-structured industrial policy on innovation outcomes. Government R&D initiatives have been shown to enhance patent activity, improve productivity, and generate breakthrough innovations (Aghion et al., 2015). Long-term investment in strategic domains—such as artificial intelligence, renewable energy, and digital infrastructure—has significantly strengthened national innovation capabilities and economic resilience (Mowery et al., 2010).

In today's fast-paced and complex global economy, industrial policy must be both strategic and adaptable. By drawing on past successes and embracing adaptive governance, governments can design effective policies that foster innovation, ensure sustainability, and support inclusive economic progress.

1.2 Statement of the Problem

Technological innovation is a major driver of national economic growth, productivity, and international competitiveness. In this regard, governments utilize industrial strategy as a strategic tool to guide economic activity and steer it toward growth fueled by innovation. There has been a continuous discussion among policymakers and scholars regarding the efficacy of industrial policy in promoting technological innovation. Although others believe that directed industrial policies have the ability to remedy market imperfections, induce R&D spending, and create innovation clusters (Rodrik, 2004; Aghion et al., 2011), others point to the dangers of government failure, inefficiency, and resource misallocation. Industrial policy in emerging countries such as India has experienced noteworthy changes, particularly with the assimilation of digital and innovation-facilitated agendas. Contrary to all sorts of policy initiatives like Make in India, Startup India, and Atmanirbhar Bharat, Indian industries' innovation output still continues to remain unbalanced with respect to the sectors and the regions (NITI Aayog, 2020; Dutz, 2007). There arise pertinent concerns regarding the reconciliation between industrial policy and innovation performance, specifically from MSMEs and high-technology sectors. In addition, there is a necessity for comprehension regarding how industrial policy helps (or inhibits) a Sophisticated technologies such as artificial intelligence, automation, and digital manufacturing to take root. modern technologies to establish themselves, such as digital manufacturing, robotics, and artificial intelligence. The effect of industrial policy on technological progress, especially in developing countries, and the unclear ways in which this happens show that there is a big gap in research. To find policies that can improve innovation and make industries more competitive, it's important to closely look at how industrial policy helps drive technical innovation.

1.3 Research Objectives

- To analyse how well industrial policy programs are working.
- To look into how projects that involve both government and private sectors are performing.
- To find out what challenges and problems industries are facing.
- To see if the government's money for research and development is effective.

2. Review of Literature

Cristina Pinheiro (2025) explores the use of relatedness and economic complexity (REC) as tools to inform industrial strategy. Typically, REC encourages support for initiatives aligned with a region's comparative advantages while discouraging unrelated activities. However, Pinheiro cautions against an uncritical application of REC in policymaking. Drawing on research into innovation and developmental states, she identifies two key concerns: first, diversification into unrelated sectors may be essential for economic and technological catch-up; second, REC tends to overlook demand-side factors and global competition by focusing solely on domestic supply. Additionally, she highlights conceptual and methodological limitations within the REC literature, such as overstating the importance of relatedness and neglecting the role of prior policy interventions in diversification outcomes. Her study concludes that while REC metrics provide

valuable insights into structural change trends, effective industrial policy requires considering other critical factors, including global supply-demand dynamics and environmental impacts of diversification strategies.

Josef Yap and John Faust Turla (2024) analyze the reinforcing feedback loops among production, exports, and investment that drive structural transformation. Their panel data research confirms a long-term reciprocal relationship between these variables but emphasizes that country-specific factors are crucial and cannot independently ensure growth. For example, the Philippines' progress was constrained by inadequate infrastructure investment and limited integration into regional industrial networks. In contrast, South Korea surpassed Malaysia by strengthening its innovation system, while Malaysia lagged due to insufficient domestic technological development.

Yuen-Ping Ho and Sarah Lai-Yin Cheah (2020) examine the success of open innovation partnerships between public research institutes and private firms, focusing on the role of industrial policy and public R&D funding. Using data from 153 public-private technology transfer projects within Singapore's biotechnology sector, their findings indicate that project funding has a significant positive impact on innovation collaboration outcomes. Furthermore, the effectiveness of funding is partially mediated by senior management teams' ability to manage project portfolios within public research organizations.

Peerasit Patanakul and Jeffrey K. Pinto (2014) discuss how government regulations and policies can both facilitate and hinder innovation. Overly restrictive rules may stifle innovation, whereas well-crafted policies can substantially promote the development of new products and technologies. While many developed and developing countries have implemented innovation diffusion programs incrementally, there remains a lack of robust empirical evidence to evaluate their effectiveness due to poorly structured research questions. Their review suggests a need for more rigorous studies to understand how government policies influence innovation, particularly through factors such as organizational capacity, readiness, and the opportunity to adopt change. Advancements in innovation theory and practice have enhanced the ability to study government impacts on both incremental and radical innovations—insights crucial for policymakers and business leaders striving to foster sustainable innovation ecosystems.

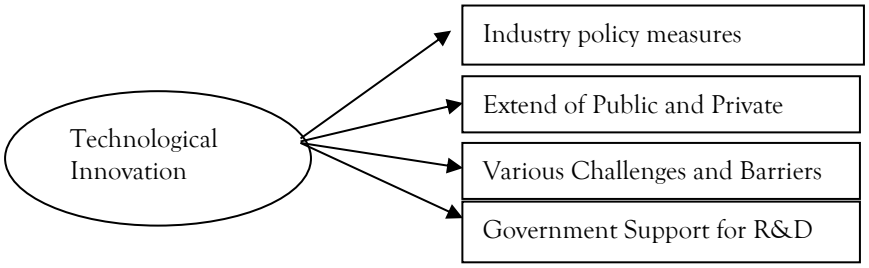


Figure 1: Industrial Policy and Technological Innovation

This study explores how different elements of industrial policy impact technological innovation, which serves as the primary dependent variable. Technological innovation is understood as the capacity of industries to create or adopt new technologies, enhance existing processes, and boost overall productivity and competitiveness. It is influenced by a range of policy and institutional factors.

A key independent variable is Industrial Policy Measures, which include government regulations, strategic programs, and policy actions aimed at fostering industrial development. These measures—such as infrastructure building, investment facilitation, and innovation incentives—help establish a supportive environment for experimentation, modernization, and technological advancement.

Another vital component is the Extent of Public-Private Collaboration, highlighting cooperation among government agencies, academic institutions, and private sector firms. These partnerships enable joint research, knowledge sharing, and technology transfer, thereby improving industry access to research infrastructure and expertise essential for innovation.

The framework also accounts for Challenges and Barriers faced by industries, including high costs of innovation, lack of skilled labor, weak intellectual property protections, and market uncertainties. Overcoming these hurdles is critical, as they can discourage firms from engaging in innovative activities.

Finally, Government Support for R&D plays a crucial role through funding grants, tax incentives, and institutional support that motivate companies to invest in research and development. This assistance reduces the risks associated with innovation, enhances firms' ability to explore new ideas, and expedites the commercialization of novel products and processes.

Collectively, these factors form the innovation ecosystem within industries, influencing both the speed and extent of technological progress driven by industrial policies, collaborative networks, and government support.

3. Research Methodology

This study employs a mixed-methods approach to explore the impact of industrial policies on technological innovation. By combining qualitative and quantitative research techniques, it aims to offer a holistic understanding of how these policies affect innovation outcomes across different economic contexts. The research framework is structured around four core components: recognizing policy limitations, gathering empirical data, and formulating a robust research design.

Research Design

This study adopts a comparative and analytical research design to investigate the influence of industrial policies on technological innovation. It combines a systematic review of relevant literature with empirical data analysis to assess theoretical frameworks and their real-world applicability. Case studies from countries such as the United States, Japan, and Germany are analyzed to demonstrate how varying industrial policy approaches have supported technological advancement.

3.1 Data Collection

Both primary and secondary data sources are utilized in this research. Secondary data is collected from peer-reviewed academic publications, government documents, policy reports, and industry analyses. Key sources include reports from major international organizations such as the World Bank, the Organisation for Economic Co-operation and Development (OECD), and the United Nations Conference on Trade and Development (UNCTAD), focusing on innovation and industrial policy. Quantitative metrics—such as research and development (R&D) expenditure, patent activity, and productivity growth—are extracted from authoritative databases, including the World Intellectual Property Organization (WIPO) and national innovation agencies.

3.2 Limitations

Although the study strives to provide a comprehensive assessment, certain limitations must be acknowledged. First, the availability and reliability of data vary across countries and sectors, which may affect the consistency of comparisons. Second, it is methodologically challenging to isolate the effects of industrial policy from other economic, institutional, and technological variables. Lastly, the dynamic and evolving nature of technological innovation limits the ability to establish clear, long-term causal relationships between policy measures and innovation outcomes.

4 Data Analysis and Interpretation

4.1 Descriptive Statistics

Table 1: Descriptive

	TI	IPM	EPP	VCB	GSRD
N	366	366	366	366	366
Missing	0	0	0	0	0
Mean	3.31	3.40	3.73	3.88	3.30
Std. error mean	0.0540	0.0451	0.0467	0.0527	0.0695
95% CI mean lower bound	3.20	3.32	3.64	3.78	3.16
95% CI mean upper bound	3.42	3.49	3.82	3.98	3.44
Median	3.00	3.00	4.00	4.00	3.00
Mode	4.00	3.00	4.00	4.00	5.00
Sum	1211	1246	1366	1420	1208
Standard deviation	1.03	0.863	0.894	1.01	1.33
Variance	1.07	0.746	0.799	1.02	1.77
IQR	1.00	1.00	1.00	2.00	3.00
Range	4	3	3	4	4
Minimum	1	2	2	1	1
Maximum	5	5	5	5	5
Skewness	-0.0775	0.0669	-0.280	-0.790	-0.107
Std. error skewness	0.128	0.128	0.128	0.128	0.128
Kurtosis	-0.809	-0.651	-0.650	0.179	-1.17

Table 1: Descriptive

	TI	IPM	EPP	VCB	GSRD
Std. error kurtosis	0.254	0.254	0.254	0.254	0.254
Shapiro-Wilk W	0.902	0.875	0.871	0.855	0.885
Shapiro-Wilk p	<.001	<.001	<.001	<.001	<.001

Note. The CI of the mean assumes sample means follow a t-distribution with N - 1 degrees of freedom

Interpretation:

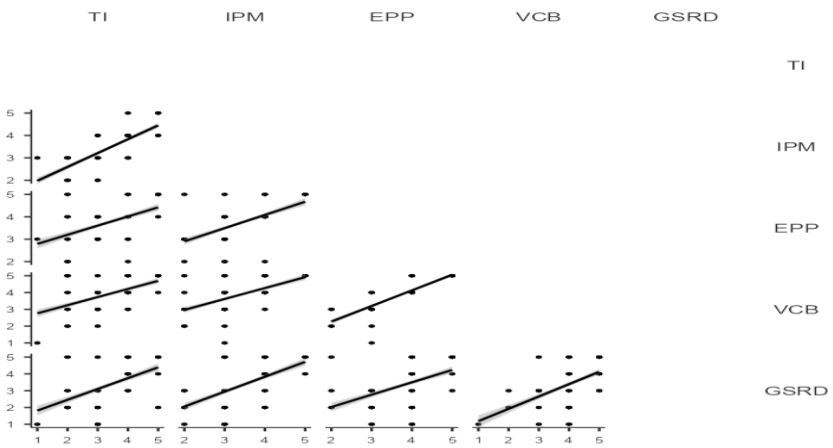
The descriptive statistics reveal the respondents' understanding of the respondents' perceptions of the important factors driving MSME transformation. The mean scores of the variables—Technological Innovation (3.31), Industry Policy Measures (3.40), and Extent of Public and Private Participation (3.73)—indicate that respondents moderately agree on the significance and existence of these factors in their business environment. The highest mean is seen for Barriers and Challenges (3.88), confirming a strong agreement with the MSMEs facing obstacles. By contrast, Government Support for R&D (3.30) was rated relatively more neutrally, with varying views among the respondents. This variation in replies is also noted from the standard deviations, from 0.86 (IPM) to 1.33 (GSRD), with GSRD having the largest spread. Median and mode values confirm the central tendency of the means, while interquartile range and range values suggest that the majority of the responses were bunched between 3 and 4.

The data also reflect some skewness, primarily negative, particularly in VCB (-0.79), suggesting a bias toward higher ratings. Kurtosis values for all variables are negative or near zero, suggesting flatter distributions than a normal curve. The Shapiro-Wilk test outcomes for all the variables (p <.001) support the fact that data substantially vary from normality. The non-normal distribution indicates that there might be a requirement of non-parametric statistical techniques for subsequent analysis. Overall, results show that respondents tend to concur on innovation being important, support from policies, and co-participation being significant, in addition to reiterating real problems MSMEs encounter as well as divergent perceptions regarding support from the government for R&D.

4.2 Correlation Analysis

Table 2: Correlation Matrix

	TI	IPM	EPP	VCB	GSRD
TI	—				
IPM	0.741	—			
EPP	0.472	0.570	—		
VCB	0.496	0.557	0.825	—	
GSRD	0.500	0.576	0.494	0.557	—



Interpretation:

The correlation matrix provides useful insights into the cross-relationships among the variables determining MSME transformation. A significant positive correlation of 0.741 between Technological Innovation (TI) and Industry Policy Measures (IPM) indicates that better government or institutional policy guidelines are highly linked with increased adoption of technology by MSMEs. This therefore means that enterprises operating in better policy environments will be more prone to technological innovation. Likewise, TI is moderately positively correlated with Extent of Public and Private Participation (EPP) at 0.472, Different Challenges and Barriers (VCB) at 0.496, and Government Support for Research and Development (GSRD) at 0.500, suggesting that these factors also have an enabler's role to play in innovation promotion, but not as intensely as with policy interventions.

In addition, Industry Policy Measures (IPM) show moderate to high positive correlations with EPP (0.570), VCB (0.557), and GSRD (0.576). This trend indicates that good policies not only drive innovation but also encourage public-private collaboration, assist in solving problems, and increase government support for research and development. These links highlight the fact that a comprehensive and equitable industrial policy framework supports various dimensions of MSME development. The positive relation between IPM and GSRD shows that when policy support is high, there is also likely to be greater government investment in research and development endeavors.The highest correlation throughout the entire matrix is observed between EPP and VCB at 0.825, demonstrating that higher public-private participation is highly correlated with the challenges and inhibitions MSMEs face.

This may indicate that while cooperation opens doors to opportunity, it brings difficult operation or regulation challenges. GSRD has moderate correlations with all the other variables from 0.494 to 0.576, meaning government R&D assistance is related to policy, innovation, involvement, and even obstacles. Generally, the matrix indicates that MSME transformation is not a single factor but a mix of supportive policies, collaborative action, and strategic innovation, all of which are moderately to strongly interrelated.

5 Conclusion

The study concludes that industrial policy occupies a crucial position in generating technological innovation. The robust positive connection between measures of industry policy and technological innovation verifies that when governments have well-designed and supportive policies, they establish an enabling environment for adopt and innovate new technologies. Such policies facilitate the alleviation of regulatory costs, provide financial support, stimulate skill development, and foster R&D efforts, all of which are essential drivers of innovation. In addition, the research identifies that industry policy is not an isolated phenomenon—it greatly affects, as well as gets almost equally affected by, other major variables including government research support, public-private participation, and issues confronting. The interdependence of these factors emphasizes the necessity for holistic policy frameworks to address infrastructural, financial, and institutional lacunae, besides fostering cross-stakeholder partnership and collaboration. Industrial policy thus acts both as a foundation and a driving force for innovation. Essentially, the research findings indicate that to improve technological innovation and policymakers need to formulate inclusive, responsive, and adaptive industrial policies. Policymakers need to formulate such policies that not only facilitate technological development but also fit into the operational environment and innovation capabilities. An effective industrial policy framework, when implemented strongly, can turn into innovation-driven firms, which can result in sustainable economic development and industrial modernization.

Declaration of Competing Interests

The authors declare that they are not aware of any competing financial interests or personal relationships that may have influenced the work described in this document.

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Ethical considerations

The article followed all ethical standards appropriate for this kind of research.

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