

# Strategic R&D of Government in AI Innovation

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## Extended Abstract

Artificial intelligence (AI) has rapidly emerged as a transformative technology with the potential to revolutionize numerous industries and applications [3]. From healthcare and transportation to finance and beyond, AI is being increasingly harnessed to automate tasks, analyze data, and make decisions [4]. As a result, the development and deployment of AI technologies has become a major focus of organizations around the world, ranging from private companies and academic institutions to government agencies and organizations.

The involvement of government organizations in AI-related R&D and innovation is particularly noteworthy, given the potential societal and strategic implications of AI. Governments around the world have invested heavily in AI R&D, often with the goal of driving economic growth and competitiveness, improving public services, and addressing national security challenges. Similar to other previous innovations, governments play a significant role to shape the direction and governance of AI development through innovating by themselves, and funding various R&D projects and initiatives.

However, the R&D strategy of government in AI innovation via different approaches — especially funding vs. inventing — has not been understood systematically and empirically. When do governmental organizations decide to fund R&D projects, rather than inventing by themselves? Reversely, when do they decide to invent by themselves? By either considering the research projects funded by government organizations and those invented by government organizations together[1] or only focusing on government-funded projects[6], existing studies on government involvement in innovation have been limited to examine the strategic approach of government in innovation.

Here, we enlighten the strategy of government in AI innovation by analyzing the AI patents funded and invented by government organizations. Using the Artificial Intelligence Patent Dataset (AIPD) [2, 5] and *PatentsView* datasets, we analyze the temporal and technological trends as well as citation patterns of AI patents funded and invented by government organizations, compared to those by private sector. By matching the AIPD records with *PatentsView*'s datasets — which contains the assignee and government funding information of patents — we classify the granted patents into three groups: The patents funded and invented by private sector, the patents funded by governmental organizations and invented by private sector, and the patents (funded and) invented by governmental organizations.

Our result shows three key findings. First, there exists the homophily in citation across all types of patents, although the patents by private sector have higher chance to be cited by other patents in the absolute number, due to its overwhelming proportion. As shown in Fig. 1B, Government-funded patents are 10 times more likely to cite other government-funded patents (19.9%) than those funded by private sector (2.1%), while government-inventing patents have more than 45 times higher chance to cite other government-inventing patents (9.3%) than those invented by private sector (0.2%). The homophily pattern in citation implies that each type of patent has its own taste and expertise, which has been developed and accumulated over time through previous inventions.

Second, while the temporal and technological trends of AI patents among three types of patents are quite distinctive, those “funded” by governmental organizations play a mediating role between those of private sector and those invented by governmental organizations. Both in the distribution of AI patents across WIPO technology classes (Fig. 1C) and the patterns in the citation network measurements (Fig. 2A–D), government-funded patents are located in the middle of the two groups, which allows us to infer that the governmental organizations may utilize the funding strategy to mediate the gap between the direction where private sector aims and the direction where government organization wants to go.

Third, across all types of AI patents, the patents granted in early years (1970s and 1980s) become a cornerstone of AI innovation, while the AI patents that are mostly cited and linking existing ideas are invented in 1990s. As shown in Fig. 2, the patents granted in 1970s and 1980s have the highest PageRank centrality regardless of their patent types, implying that the patents in these years have the highest impacts in the AI innovation. In the meantime, the patents granted in 1990s have the highest betweenness centrality, which indicates that the patents in this period play a key role in connecting the ideas and technologies across different patents. It is also worth noting that different types of patents show a similar pattern in the network measurements, which provide an evidence of a universal path in innovation.

While the general role of government in innovation has been widely discussed, the systematic examination of how government organizations utilize different strategy to innovate in AI is still lacking. Our work provides a comprehensive analysis of the strategic approach of governmental organizations in innovation, especially in the AI field, which is a transformative technology with the potential to revolutionize numerous industries and applications.

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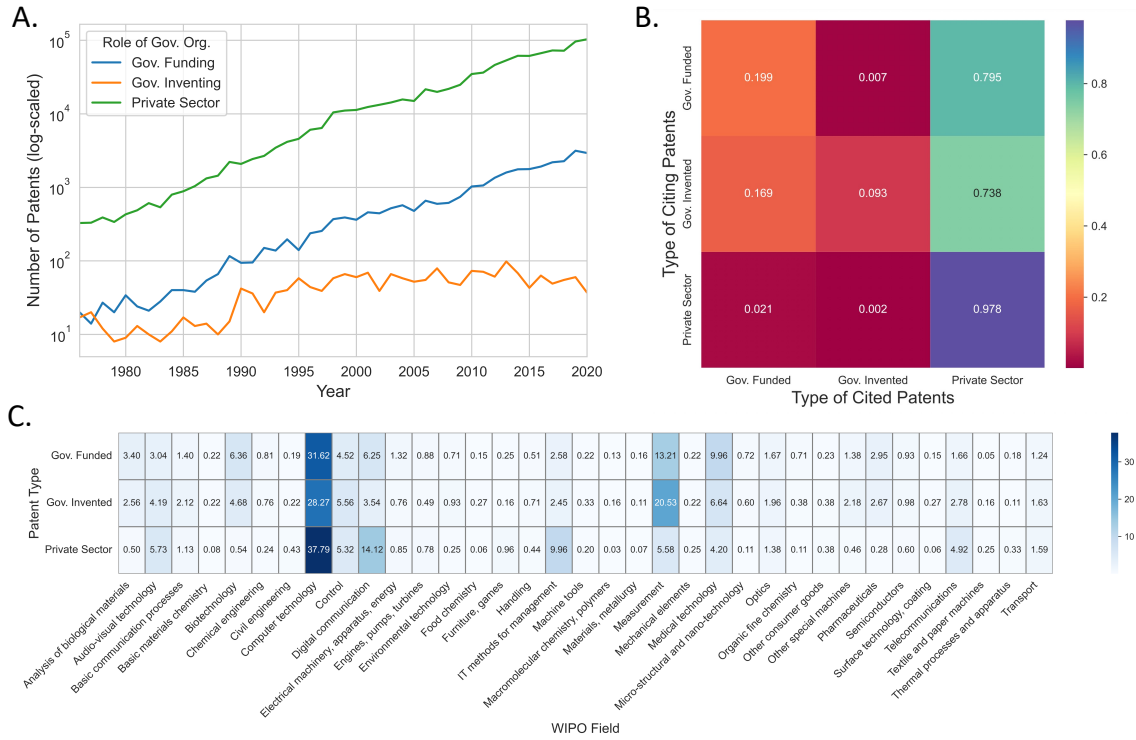


Figure 1: **A.** Number of AI patents funded and invented by private sector, governmental organizations, and universities over the decades from 1976 to 2020. **B.** Proportion of citation of AI patents for each type of patents (normalized by row) **C.** Distribution of AI patents across WIPO technology fields for each type of patents

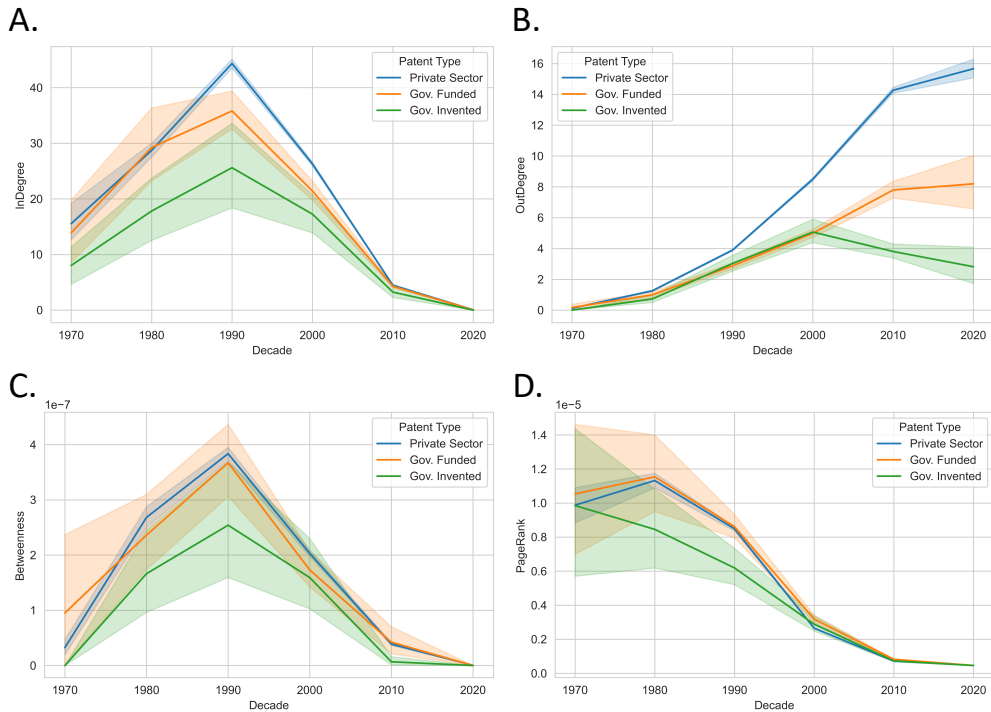


Figure 2: In-degree (A), Out-degree (B), Betweenness Centrality (C), and PageRank score (D) of the AI patents funded and invented by private sector (blue lines), funded by governmental organizations (orange lines), and invented by governmental organizations (green lines) over the decades from 1976 to 2020