

Analysing the Relationship Between Value Added Manufacturing and Innovation: The Implications for UK Science and Industrial Policy

COMMUNICATION | EDITORIAL | SPECIAL FEATURE | PERSPECTIVE | REPORT | REVIEW

Yousuf Khursheed



Illustration by Altaf Shah, Pexels

ABSTRACT

In March 2023, former UK Prime Minister Rishi Sunak and former Technology Secretary Michelle Donelan announced a new strategy to affirm the country's spot as a "Science and Technology Superpower" by 2030. The strategy was associated with around £500 million of government funding. Furthermore, in November 2023 the UK Treasury announced £4.5 billion in funding for the country's manufacturing sector as part of the country's new "Advanced Manufacturing Plan". Despite these initiatives, industry experts have argued that over the last ten years there has been a lack of effective UK industrial policy. Consequently, despite strong UK public investments in R&D, the commercial benefits of technology development are increasingly occurring in other countries (IPPR, 2023). As the new Starmer led Labour government invites discussion on its proposed industrial strategy through the Invest 2035 green paper (GOV.UK, 2024), it is a critical moment to examine the relationship between innovation and industry in the UK.

SCIENCE ⇒ POLICY

Building on the back of academic literature discussing the catalytic relationship between production and innovation, this article uses descriptive statistics to investigate if a correlation exists between national levels of value added manufacturing and resident patent applications. Using resident patent application data as an indicator of innovation, the correlation is tested for in the UK plus numerous global technology “superpowers” such as the USA, Korea, Germany, China and Japan. Overall, a positive correlation between value added manufacturing and levels of resident patent applications was identified in 4 of the 6 cases. The data consulted suggests that regardless of increased R&D spending, the number of patent applications and innovation more broadly may experience weak growth unless there is a significant increase in value added manufacturing.

Though further analysis should be conducted to thoroughly understand the impact of external factors, this article indicates the importance of value added manufacturing as a driver of innovation. As a result, the article looks to the Labour government and calls for: 1) Closer integration between UK Government science and manufacturing strategies. 2) UK Government efforts to raise value added manufacturing levels through enhancement of the Catapult High Value Manufacturing Network’s workforce skills training and SME R&D capabilities. 3) Attention to ensure the UK Government is exercising long term planning and is not falling behind competitor nations regarding levels of public investment in industry and innovation.

Key Words

Innovation, Manufacturing, Invest 2035, UK Industrial Strategy

Background

During the 1970s and 1980s the global economy entered a period of enhanced economic integration. Spurred on by deregulation in western economies and the removal of barriers to cross-national capital mobility – global value chains emerged on a never seen before scale. Products began to become truly international with research, design, input sourcing and final assembly occurring in numerous countries (Gereffi, 2018). This pattern marked an increase in the popularity of “outsourcing” production to countries with cheap labour costs. In the UK, the emergence of global value chains occurred in tandem with financialization. The increased contribution made by banks, insurance companies as well as accountancy and professional services firms to UK economic output after the 1980’s was linked to a UK government prioritization of a new services based model (Davis and Walsh, 2015). Combined, outsourcing and government preference for services over industry led to largescale de-industrialization

across portions of the Midlands, Northern England and Scotland.

In recent years, however, Post-2008 economic stagnation and supply chain shocks like the Covid-19 pandemic and the Russia-Ukraine War have led researchers to emphasize the importance of domestic manufacturing. The developments above, alongside the blockage of the Suez Canal in 2021 have led governments to question the efficiency of having key products fabricated far overseas. Furthermore, the economic benefits of manufacturing experienced by countries across East Asia – has led western nations to further recognize the importance of possessing domestic industry (Foroohar, 2022). This has been demonstrated by recent policy developments in the United States. President Biden’s 2022 CHIPS Act commits \$76 billion in grants and tax credits for semiconductor manufacturing, research and corporate investment (Hufbauer and Hogan, 2022). This comes alongside Biden’s 2022 Inflation Reduction Act which dedicates \$110 billion in direct spending and \$269 billion in tax credits for net zero related

programs – with particular emphasis on clean energy production and electric vehicle manufacturing (Min et al, 2023).

Recent large-scale government spending on domestic industry development has typically been associated with job creation and security concerns. However, there is another vital reason that has motivated countries such as the United States to invest so heavily in industry. Various scholars have highlighted the crucial importance of production within the innovation process. Chang and Andreoni (2020), for example, bring attention to the key notion of “learning by doing”. They argue that as research is commercialized and translated into real world products, having a high degree of technical manufacturing know-how is vital for success. Furthermore, as governments strive for nationwide economic growth and look to support the private sector through “entrepreneurial state” style policy, they must realize profitable innovation may struggle to occur without domestic production (Mazzucato, 2018).

For a country like the UK which has experienced de-industrialization, it is clear the government must recognize that much of its “learning by doing” ability has gone missing. Despite high levels of R&D occurring in the country there are consequently limits to the UK’s ability to transform this into innovative products and economic growth. Countries in East Asia such as Korea, Taiwan and China have experienced rapid economic growth and developed world leading innovative capacity whilst maintaining a high manufacturing base.

By comparing the UK’s performance in R&D, value added manufacturing and resident patent applications to some of the world’s most innovative countries – this article will test to see if the academic argument around “learning by doing” is supported by real data. The article will not conduct a regression analysis to test for a causal relationship between value added manufacturing and resident patent applications. This is due to the risk of omitted variable bias and the difficulty

associated with obtaining data on other factors impacting patent applications. Instead, this article will test for the presence of a correlation between value added manufacturing net output and resident patent applications. The objective is to open a debate on the impact of value added manufacturing on national innovation more generally.

Current Policy Landscape

During the run up to their July UK election victory, the Labour party highlighted the importance of R&D for creating economic growth. Since then the new Starmer led government has appointed Peter Kyle as Secretary of State for Science, Innovation and Technology and former Chief Scientific Adviser Sir Patrick Vallance as a Minister of State for Science, Innovation and Technology (BBC News, 2024). The appointment of Vallance was well received by The Campaign for Science and Engineering the UK’s leading independent organisation for Science and Engineering (d’Angelo, 2024). In October the Invest 2035 green paper was launched in a state attempt to engage with industry, higher education bodies and trade groups as a new 10 year modern industrial strategy is prepared (Financial Times, 2024). The green paper was followed by the first budget where Chancellor Rachel Reeves announced £975 million in R&D funding for the aerospace industry over five years and £2 billion in funding to support the UK automotive industry and assist the establishment of zero emissions vehicle manufacturing (GOV.UK, 2024). Following the budget, trade groups responded positively to the Chancellor’s focus on the manufacturing sector. A positive response was also given to her commitment to a long term industrial strategy, something which had been identified as missing under previous governments (Make UK, 2024).

The Sunak government’s 2023 “Science and Technology Superpower Strategy” was associated with around £500 million of government funding and placed key emphasis on increasing public and private

R&D spending, boosting the country's tech industry, establishing international partnerships, building associated infrastructure and attracting international talent and investment. This UK strategy committed to investment and prioritization around 5 target technologies: AI, quantum computing, bio-engineering, semiconductors and future telecoms (GOV.UK, 2023). Alongside this, the 2023 "Advanced Manufacturing Plan" committed to £4.5 billion in spending, targeting 8 specific sectors including automotive, aerospace, life sciences and clean energy production. The funds were planned to be rolled out between 2025 and 2030 with an aim to fuel economic growth and help industrial sectors achieve progress on key goals like the transition to net zero (GOV.UK, 2023).

Another recent initiative was the establishment of the Advanced Research and Invention Agency (ARIA) in January 2023. This new agency is modelled on the US's Defense Advanced Research Projects Agency (DARPA). DARPA is a US government organization which is focused on creating breakthrough technologies and is credited with playing a key role in helping establish the internet (Mazzucato, 2015). The UK's ARIA seeks to facilitate bold and long term research which can generate large national economic gains. ARIA has been given a £800 million budget and has been designed to operate as an independently run organization consisting of world leading scientists (GOV.UK, 2023).

Finally, it is crucial to note the UK's 7 Catapult High Value Manufacturing Centres which have existed as an integrated network since 2011, after they were connected by government agency Innovate UK. The Centres offer firms R&D support, access to cutting edge equipment, workforce upskilling and assistance in scaling production. Additionally, Catapult operates as a bridge between universities and the private sector, developing industrial clusters, connecting native firms and linking them to global supply chains. Although Catapult works with all firm sizes, the centres provide specialist support for SMEs (Catapult High Value

Manufacturing, 2024). Post-Brexit, the Catapult Network has been identified as a key driver for SME growth and maintaining national economic competitiveness (Lopez Gomez, 2017).

**Comparative Data: Value Added
Manufacturing, Resident Patent
Applications and R&D Expenditure in
the UK and Technologically Advanced
Economies**

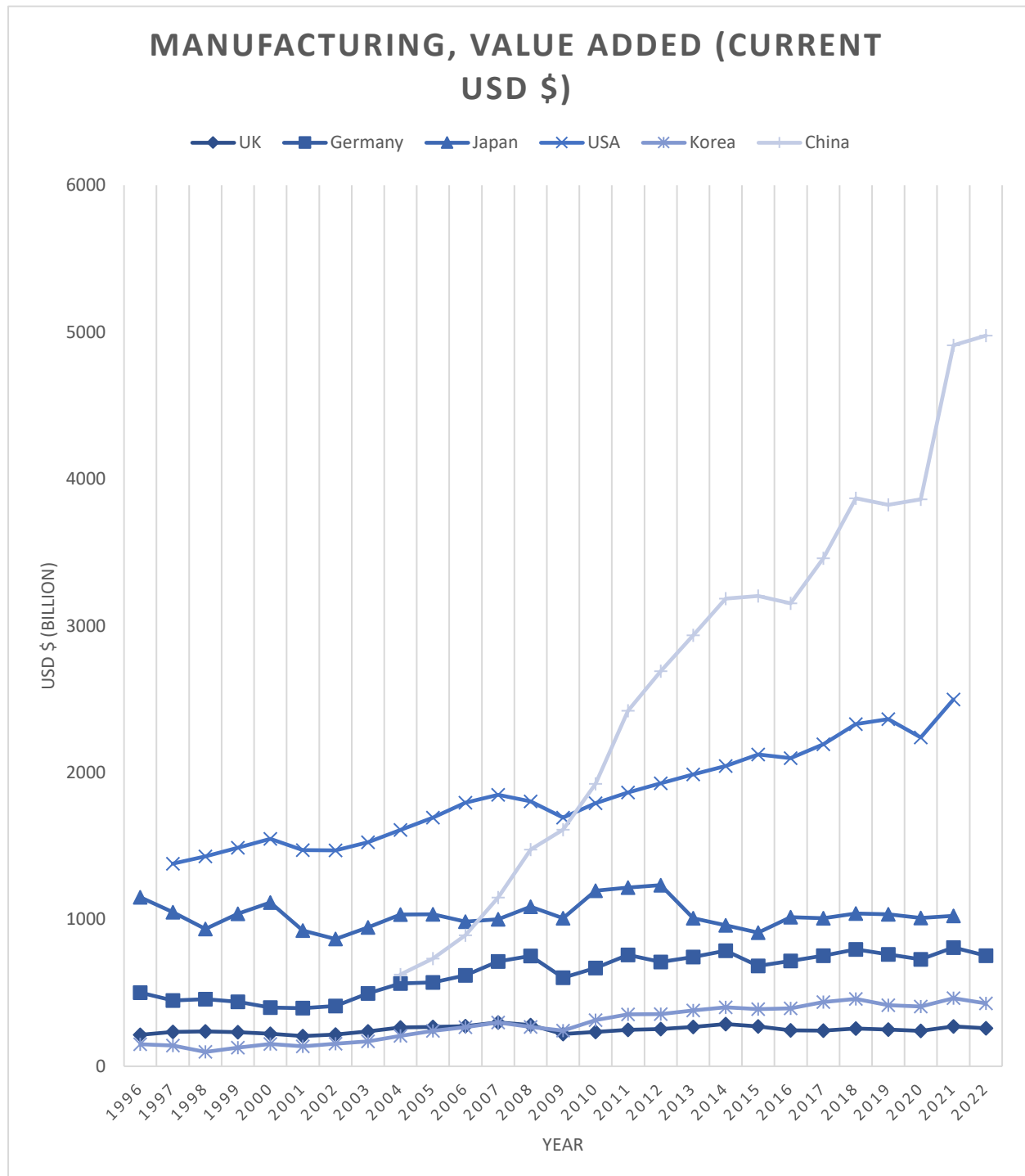


Figure 1: Change In Value Add of Manufacturing In Various Countries From 1996 to 2022
(Raw Data Source: World Bank national accounts data, and ECD National Accounts data files.)

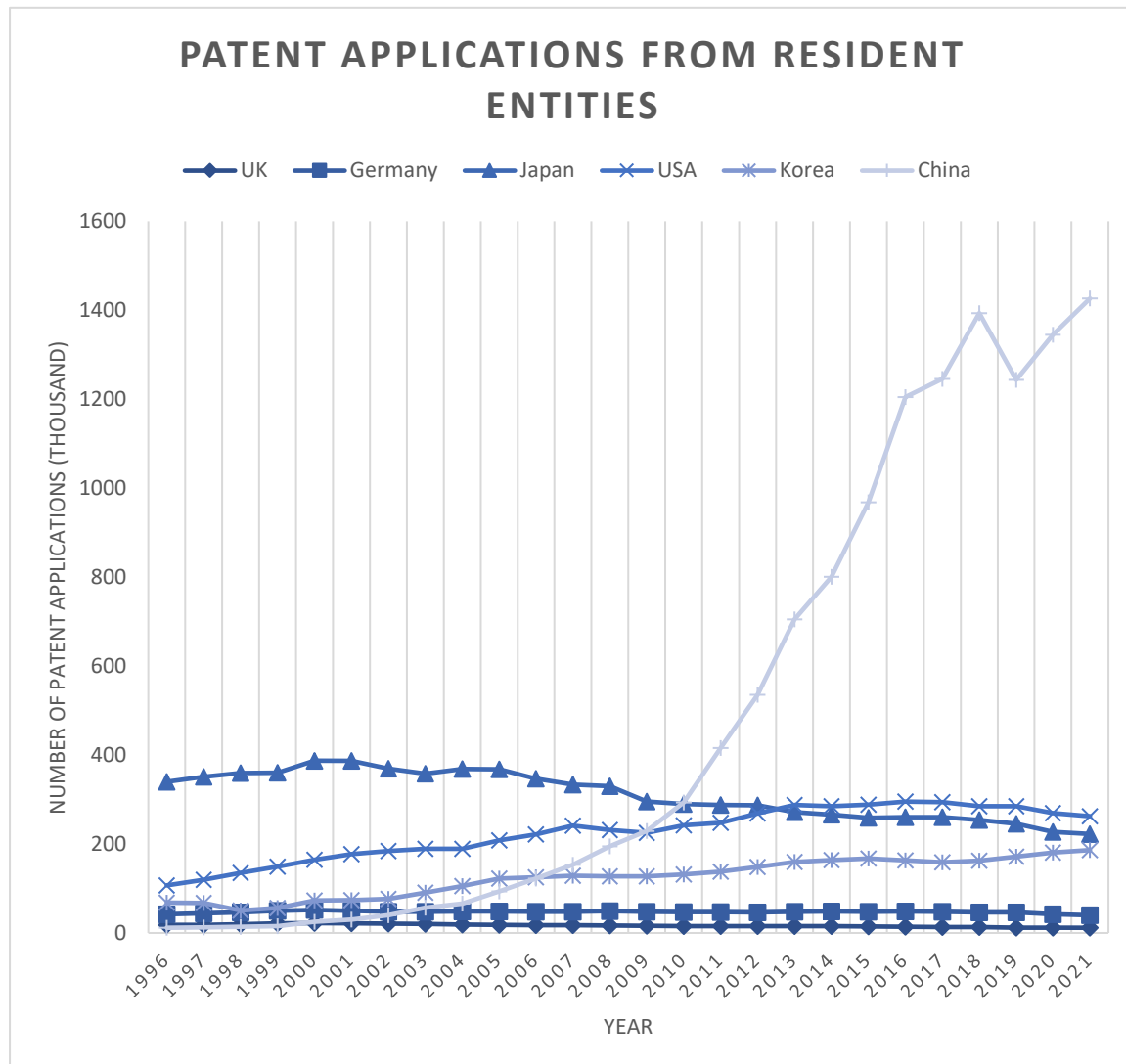


Figure 2: Number of Patent Applications from Resident Entities from 1996-2021 (Raw Data Source: World Intellectual Property Organization (WIPO), WIPO Patent Report: Statistics on Worldwide Patent Activity.)

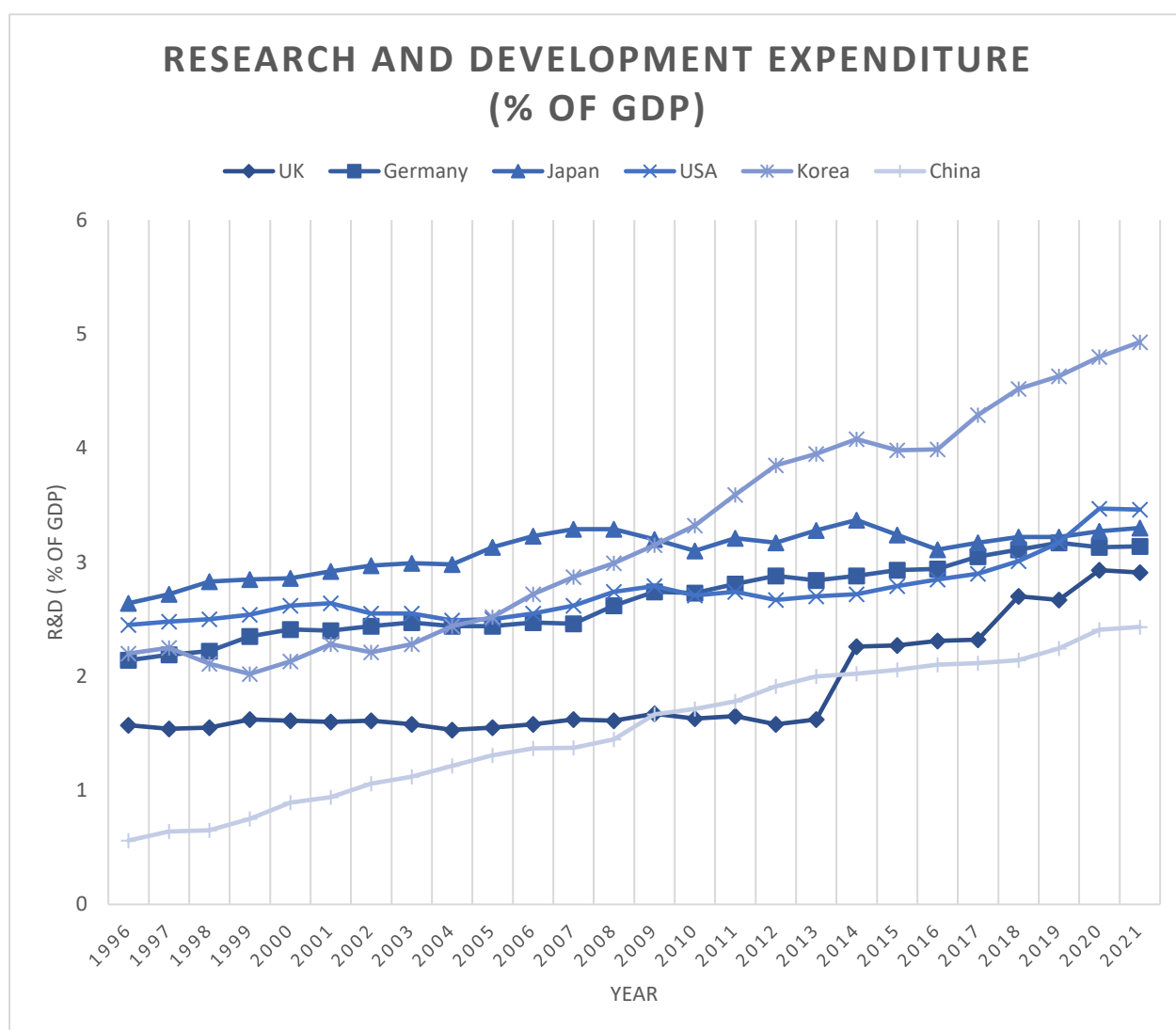


Figure 3: R&D Expenditure of Various Countries as a % of GDP 1996-2021 (Raw Data Source: UNESCO Institute for Statistics (UIS). UIS.Stat Bulk Data Download Service. Accessed November 27, 2023)

Key Trends: The Relationship Between Industry and Innovation in the UK and Technologically Advanced Economies

Overall, the data broadly demonstrates a positive correlation between value added manufacturing (Figure 1) and resident patent applications (Figure 2) - in four out of the six country cases. This correlation exists despite increases in R&D expenditure (Figure 3) occurring in all countries. The data demonstrates that for China, Korea and the USA there is a positive correlation between strong growth in value added manufacturing and strong growth in resident patent applications. Alongside the nations mentioned above, Japan also presents a positive correlation where decreasing levels of value added manufacturing have existed alongside shrinking levels of resident patent applications.

Germany presents the clearest exception to the observed relationship between significant growth in value added manufacturing and significant growth in resident patent applications. Despite an overall rise in value added in manufacturing from 1996-2022, resident patent applications have experienced a marginal decline. Interestingly, although value added manufacturing levels rose strongly in Germany overall from 1996-2008, they experienced very limited growth from 2008-2022. It is possible that this may provide an insight into why German resident patent applications experienced a marginal decline. The case of Germany however, also suggests the importance of external factors (such as the great recession and subsequent euro debt crisis) and emphasizes the requirement for further research.

In the UK from 1996-2021 there has not been an overall positive correlation between value added manufacturing levels and resident patent applications. Levels of value added manufacturing in the UK have increased marginally by 20% from 1996-2021. Although this does not equate to the decline that Japan has experienced it does not match the stronger increases experienced by China and Korea. It also does not compare to the USA – where levels of value added

manufacturing grew by 81% from 1997-2021. Interestingly, between 1996 and 2021 levels of value added manufacturing in the UK peaked in 2007. This may provide some explanation as to why resident patent applications in the UK have fallen by 36% from 1996-2021. During the 1996-2021 period R&D expenditure increased by 85% from 1.57% of GDP to 2.91% of GDP. These figures suggest that despite the strong increase in UK R&D spending, innovation - in the form of resident patent applications has decreased.

Although there was not a positive correlation between UK value added manufacturing and UK patent applications over the 1996-2021 period, the fact that value added manufacturing levels peaked in 2007 suggests the subsequent industrial stagnation may have contributed to the trend of declining patent applications. Compared to nations such as Korea, China and the USA, the UK's industrial trajectory is significantly less positive and it's innovation trajectory is clearly negative and warrants further research and a well-crafted government response.

Future Policy Considerations

The overall correlation demonstrated between value added manufacturing and level of resident patent applications suggests productive capabilities are important to successfully catalyse national innovation. Furthermore, the concerning decline in UK patent applications generates the need for a change in government strategy:

- The data consulted suggests a need for a more cohesive and interconnected approach to UK science and manufacturing policy. Closer integration may involve fostering stronger ties between industry and universities.
- Through the Advanced Manufacturing Plan and the Science and Technology Superpower Strategy, the previous UK Government committed to largescale public

spending on industry and technology. However, the UK must ensure it is implementing long term strategy and not falling behind competitor nations in the levels of government funding provided.

- The UK Government must raise investment in the HVM Catapult Network, increasing the capacity for conducting R&D for SMEs and providing workforce skills training. This network provides a promising pathway for increasing growth and scale up amongst domestic manufacturing SMEs. The data above suggests this can create spillover effects for larger success within national innovation.

References

- [1] Advanced manufacturing plan (2023) GOV.UK. Available at: <https://www.gov.uk/government/publications/advanced-manufacturing-plan> (Accessed: 11 February 2024).
- [2] Autumn Budget (2024) GOV.UK. Available at: <https://www.gov.uk/government/publications/autumn-budget-2024> (Accessed: 13 November 2024).
- [3] Autumn Budget 2024: Key Insights and Impact | Make UK (2024). Available at: <https://www.makeuk.org/news-and-events/news/autumn-budget-2024-key-insights-and-impact> (Accessed: 13 November 2024).
- [4] Billions of investment for British manufacturing to boost economic growth (no date) GOV.UK. Available at: <https://www.gov.uk/government/news/billions-of-investment-for-british-manufacturing-to-boost-economic-growth> (Accessed: 5 February 2024).
- [5] Business groups back new IPPR blueprint to end flip-flopping and to get serious about green industrial growth (no date) IPPR. Available at: <https://www.ippr.org/media-office/business-groups-back-new-ippr-blueprint-to-end-flip-flopping-and-to-get-serious-about-green-industrial-growth> (Accessed: 5 February 2024).
- [6] Chang, P.H.-J., Andreoni, D.A. and Kuan, M.L. (no date) 'International industrial policy experiences and the lessons for the UK'.
- [7] Davis, A. and Walsh, C. (2016) 'The Role of the State in the Financialisation of the UK Economy', *Political Studies*, 64(3), pp. 666–682. Available at: <https://doi.org/10.1111/1467-9248.12198>.
- [8] Foroohar, R. (2022) *Homecoming: The Path to Prosperity in a Post-Global World*. Crown.
- [9] General election 2024 results in maps and charts (2024) BBC News. Available at: <https://www.bbc.com/news/articles/c4nlegege1o> (Accessed: 4 September 2024).
- [10] Gereffi, G. (2018) *Global Value Chains and Development: Redefining the Contours of 21st Century Capitalism*. Cambridge University Press.
- [11] Hufbauer, G.C. and Hogan, M. (2022) 'CHIPS Act will spur US production but not foreclose China'. Rochester, NY. Available at: <https://papers.ssrn.com/abstract=4261113> (Accessed: 11 February 2024).
- [12] *Industrial Policy in the 21st Century - Chang - 2020 - Development and Change - Wiley Online Library* (no date). Available at: <https://onlinelibrary.wiley.com/doi/full/10.1111/dech.12570> (Accessed: 11 February 2024).
- [13] *Invest 2035: the UK's modern industrial strategy* (2024) GOV.UK. Available at: <https://www.gov.uk/government/consultations/invest-2035-the-uks-modern-industrial-strategy/invest-2035-the-uks-modern-industrial-strategy>

- strategy (Accessed: 13 November 2024).
- [14] Keir Starmer appoints cabinet after landslide general election victory (2024) BBC News. Available at: <https://www.bbc.com/news/articles/cw0yg50zy5vo> (Accessed: 4 September 2024).
- [15] Mazzucato, M. (2015) 'The Innovative State: Governments Should Make Market, Not Just Fix Them', *Foreign Affairs*, 94(1), p. [xiii]-68.
- [16] Mazzucato, M. (2018) 'Mission-oriented innovation policies: challenges and opportunities', *Industrial and Corporate Change*, 27(5), pp. 803–815. Available at: <https://doi.org/10.1093/icc/dty034>.
- [17] Min, Y. et al. (2023) 'Effects of Renewable Energy Provisions of the Inflation Reduction Act on Technology Costs, Materials Demand, and Labor'.
- [18] Our history - High Value Manufacturing Catapult (no date) HVMC. Available at: <https://hvm.catapult.org.uk/who-we-are/our-history/> (Accessed: 21 February 2024).
- [19] Plan to forge a better Britain through science and technology unveiled (no date) GOV.UK. Available at: <https://www.gov.uk/government/news/plan-to-forge-a-better-britain-through-science-and-technology-unveiled> (Accessed: 4 February 2024).
- [20] Research agency supporting high risk, high reward research formally established (no date) GOV.UK. Available at: <https://www.gov.uk/government/news/research-agency-supporting-high-risk-high-reward-research-formally-established> (Accessed: 22 February 2024).
- [21] Reuters (2023) 'UK's Hunt commits 4.5 billion pounds to manufacturing investment', 18 November. Available at: <https://www.reuters.com/world/uk/uks-hunt-commits-45-billion-pounds-manufacturing-investment-2023-11-17/> (Accessed: 5 February 2024).
- [22] Semiconductors, geopolitics and technological rivalry: The US CHIPS & Science Act, 2022 (no date). Available at: <https://www.tandfonline.com/doi/epdf/10.1080/00131857.2022.2124914?needAccess=true> (Accessed: 11 February 2024).
- [23] UK Innovation Strategy: leading the future by creating it (2023) GOV.UK. Available at: <https://www.gov.uk/government/publications/uk-innovation-strategy-leading-the-future-by-creating-it> (Accessed: 22 February 2024).
- [24] UK Innovation Strategy: leading the future by creating it (accessible webpage) (no date) GOV.UK. Available at: <https://www.gov.uk/government/publications/uk-innovation-strategy-leading-the-future-by-creating-it/uk-innovation-strategy-leading-the-future-by-creating-it-accessible-webpage> (Accessed: 22 February 2024).
- [25] UK's post-Brexit economy hinges on SME innovation (no date) The Manufacturer. Available at: <https://www.themanufacturer.com/articles/uks-post-brexit-economy-hinges-sme-innovation/> (Accessed: 20 February 2024).
- [26] What might recent political appointments mean for R&D? (no date) CaSE. Available at: <https://www.sciencecampaign.org.uk/analysis-and-publications/detail/what-might-recent-political-appointments-mean-for-rd/> (Accessed: 4 September 2024).
- [27] Williams, J. and Foster, P. (2024) 'The race to shape UK industrial strategy', *Financial Times*, 13 November. Available at: <https://www.ft.com/content/c6de2703-2cfe-4ea4-af96-90b2685ec7ad> (Accessed: 13 November 2024).

[28] World Bank Open Data (2024) World Bank Open Data. Available at: <https://data.worldbank.org> (Accessed: 11 February 2024).

About the Author

Yousuf Khursheed is a Business Development Officer at the National Manufacturing Institute Scotland (NMIS).



Prior to joining NMIS in October 2024, Yousuf was a Master's student in Development Studies at the University of Cambridge. A member of Downing College, Yousuf completed his MPhil thesis titled: Deglobalization, reshoring or friendshoring? Covid-19 and the post pandemic shocks to global value chains. Yousuf holds a First Class Honours undergraduate degree in Politics from the University of Strathclyde through which he examined innovation and industrial policy. He has volunteered as a Monthly Newsletter Editor for NGO Classrooms for Malawi since January 2022. Alongside his studies Yousuf has worked in various roles within the hospitality sector and has spent time living abroad in Finland.

The Author would like to thank and acknowledge Camila Bertranou and Allison Scott for their valuable feedback on earlier drafts of this article.

Corresponding

yousufkhursheed@gmail.com

address:

Conflict of interest: Yousuf began his role at NMIS after the initial drafts of this paper were drafted in the first half of 2024. This article represents his own independent analysis.