Germany’s National Innovation System: Characteristics, Advantages And Disadvantages

Introduction:

The purpose of the national innovation system of any country is to generate novel ideas and technologies and to communicate and implement these ideas into society as a whole. This transverse of ideas and technologies tends to involve the government, research institutes and industry in an inter-relationship model referred to as “The Triple Helix”, a concept first theorised by Henry Etzkowitz. The Triple Helix Model explores how these different sectors interact and influence the innovative environment within a country (Leydesdorff and Zawdie, 2010). Germany has a national innovation system that performs strongly on a global scale and has success in many industries, particularly in automotive manufacturing. Research is carried out in industrial settings, universities and independent institutes with overlapping relationships between these organisations and the government. Capital for research and business endeavours is both publically and privately sourced. The government itself is split into two divisions, with the Federal government presiding over decisions for the country as whole and regional (Länder) governments in charge of the running of Germany’s individual 16 states. Germany is a country that has survived much political unrest, culminating in the separation of the country into two separate states, East and West, from 1945-1990. Despite this, it has developed into one of the strongest economies in the world with a dynamic, robust national innovation system.

Metrics:

Germany is a country with a rich history of innovation, beginning with the printing press in the 1400s to more modern inventions such as smart cards, Levi jeans and adhesive tape. Central to the development of this innovation is the German Trademark and patent office (DPMA). It is the largest patent office in Europe and the “5th largest in the world”. 128,921 patents are registered with the DPMA in 2017 (Deutschland.de, 2018). Although there has been a decline in overall patent approval since the 1980s, possibly due to stricter regulations (Nuadé et al, 2017), Germany still has a high level of patent output (Deutschland.de, 2018). Trademarks also play an important role in Germany’s innovation system. Trademarks allow a company to identify themselves to consumers via slogans, symbols and images. Studies by Andreas Beilig carried out between 1999-2009 showed that trademarks had huge importance with regard to innovative progress in Germany due to their ability to communicate standards of quality and information about the product directly to the customer. Some of the biggest German brands such as BMW, Audi and Adidas are all easily identifiable via the trademarking of their goods and services (Guay et al, 2018). One of the driving forces in Germany’s innovation efforts is the automobile industry, with the lion’s share of patents filed being automotively associated. According to the German Trade and Invest, greater than 60% growth in R and D in Europe is generated by the automation sector. “20% of total domestic growth revenue” is generated by the motor vehicle industry with “78% of cars manufactured in Germany” exported abroad. Furthermore, 1 in 5 cars produced globally use German OEM suppliers. Germany is also developing innovative automation technology with regard to driverless vehicles, cars that are e-mobile and improving the energy efficiency of existing car engines. Keeping abreast of emerging developments and

the changing needs of consumers will allow the German automation industry to continue to dominate internationally (GTAI, 2018). In contrast, Germany's telecommunication and information technology sector performs poorly, with a global ranking of 31st in the world. This is due to the poor infrastructure currently in place for broadband systems that struggle to even get 3G signalling (Orth, 2018).

Overall, Germany's innovation system performs well globally, with a Global Innovation Index score of 58.20 ranking it 9th in the world in terms of innovative capability (The Global Economy, 2019). Germany also ranks highly with regard to its European compatriots, it ranks 9th in Europe for innovative development and growth, according to the European Innovation Scoreboard, with a score of 126.88. Due to Germany being seen as a country that generates and fosters innovation, Berlin has become one of the start-up hubs of the world, with a new start up being created "every 20 minutes". It is the second largest start up hub in Europe, after London (Steigertahl et al, 2018). Around 7.5% of innovative start-ups are based in Berlin, with 4% of these start-ups becoming a "gazelle company" (Kritikos, 2016), meaning they develop into high growth company that positively impacts the economic environment around them. The percentage of gazelle companies is lower than expected in comparison to start up figures but this may be due to companies moving on from Berlin, difficulties in securing capital, etc.(Kritikos, 2016). Berlin start up success stories include Omio, a multi-mode travel platform website with possible "unicorn" potential and Freighthub, a courier service that allows for the world-wide transportation of goods with over 1,000 sea and air consignors and offices in Berlin, Hamburg, Cologne and Hong Kong (Zech, 2019).

Overall, the successes of Germany's innovation system are due to the continual development of industries that are already strong, such as the automotive industry, creating a start-up friendly environment in Berlin and creating a culture that focuses heavily on research and innovation.

German Innovative Institutions and Workforce:

Germany prides itself on being an innovatively focused nation with 3.02% of its GDP spent on r and d innovation in 2017 (Eurostat, 2019). This research is enabled by many establishments and includes universities, federal and state institute, companies and independent research institutions. As of 2018, there are currently 428 higher educational institutes performing research in Germany, with 106 of these being universities (Wilde, 2018). The "Excellence Initiative" now renamed the "Excellence strategy" grants extra government funding to institutes based on their innovative potential, creating real incentive for institutes to produce research. It has created some discrepancy between colleges with the emergence of "elite" universities but has helped to push German innovation forward (Guag et al., 2018). Along with university generated research, non-university research institutes also play a role in innovation. The Max Planck Society is an independent institution that aims to carry out scientific research in areas that are of societal interest. The institute takes an interdisciplinary approach when it comes to research, allowing universities use of their equipment and infrastructure (Allen, 2015). It consists of 86 institutes and receives public funding mainly from the federal and state governments, acquiring 1.8 billion euros in 2019 (MPG.de, 2019). Other independent research institutes include The Hermann Von Helmholtz Association of Research centres, The Fraunhofer Society, The Leibniz Science Association and The Centre for Advanced European Studies and Research (CAESAR) Foundation. The benefit of these independent institutes is they can explore topics universities do not have the resources to, with medical research taking a large

share of the budget (Guag et al., 2018). The strength of Germany's economy is no doubt due to the high level of research generated by various institutions as well as academics liaising directly with industry, allowing for a high level of autonomous research (Guag et al.,2018).

Germany also has a highly skilled workforce in both labour orientated and academically focused employment which complement its innovative institutes. Apprentices undergo the dual training vocational program, known as "VET" which combines theoretical classroom training along with hands on work experience. Half a million apprentices pass through this system each year, with more than 80% of large companies hiring apprentices. This allows for a highly trained vocational work force that can then be used to implement innovative changes (Hockenos, 2018). A huge level of educational training is also received in academic spheres with 501,734 individuals completing a university degree in Germany in 2017. Furthermore, according to the OCED, over 30,000 Germans achieved a PHD in 2014, the 2nd highest rate in the world (OECD, 2016). The combinational effect of both a highly skilled and highly educated workforce, along with Germany's focus on the development of research institutes; creates an environment which both creates innovative ideas and then implements them at a grass roots level. Additionally various funding sources exist that allow for these innovative ideas to become a reality.

Public and private funding:

The funding system in Germany is multi-faceted, with funding coming from the Federal and regional government, industrial sources, private funders and the EU. With regard to research institutes, the German Research Foundation or Deutsche Forschungsgemeinschaf (DFG) and the German Academic Exchange Service (Deutscher Akademischer Austauschdienst, DAAD) act as key figures as to the direction of resources to specific institutes. DFG is the main government funding body for research in Germany, with funding coming from both the Federal and Länder governments. It primarily supports research within university settings. (Allen, 2015). In 2018, the DFG invested 3.4 billion euros into 33,200 new and existing projects (DFG, 2019). Therefore, the DFG plays a critical role in supporting and nurturing German innovation. The German Academic Exchange Service (Deutscher Akademischer Austauschdienst, DAAD) provides governmentally funded scholarships to international students, allowing them to study or perform research in Germany and provides funding for German citizens to undertake research and study abroad. In 2017, the organisation had a budget of 552 million euros (DAAD, 2018). This allows Germany to create international research connections and allows the transfer of ideas from those of different cultures and backgrounds. Other sources of research funding include Horizon 2020, which is an EU backed funding initiative that finances research projects in different EU states using money from the overall EU budget. Between 2014-2016, 16% of research applications from Germany were successful in securing funding from Horizon 2020. Furthermore, 16.7% of the Horizon 2020 budget is funded by Germany, with Germany investing more than most EU states (European Commission, 2018). Criticism levelled at Horizon 2020 centre around the possibility that countries that can afford to invest most heavily in the initiative reap the majority of the benefits. However, the enterprise has provided ample funding to German research and has resulted in Germany contributing to the research of other countries also (European Commission, 2018). Overall, the public sector in Germany funds over 30% of research carried out in Germany in both universities and non-university affiliated research institutes. The remainder of funding comes from the German private sector. In 2017, 69 billion euros was privately invested into research, with the majority of funding directed towards innovation in the automobile industry (Federal Ministry of Education and Research, 2019).

Germany also has various funding sources for start-up companies, with different funding sources for different stages of growth for the company. The governmentally supported EXIST programme and the Technology Founder Grant aims to fund pre-seed start-ups set up by students, recent graduates and former research assistants who want to turn a research or technologically focused idea into a viable business. As companies progress to the seed stage of funding, investment switches to more privately sourced funding eg. the High Tech start- up fund gives funding of up to a million euros to tech companies less than three years old. Government initiatives have also been created where the government works in tandem with venture capitalists such as the INVEST – Grant for Venture Capital ((INVEST – Zuschuss für Wagniskapital), which gives investors a return on the amount they invest. The European Angels Fund is where the government invests capital equal to that of an angel investor. Companies that have shown sufficient growth can also apply for more “classical” promotional loans from banking organisations. Other support enterprises such as the German Accelerator system helps young entrepreneurs in the technology and life science sector get a foothold in the American marker (Federal Ministry for Economic Affairs and Energy, 2019). Despite these resources, German start-ups can still struggle to find capital. This is due to innovative companies having to rely on financial banking systems and private equity firms such as Triton, Caption, Odewald & Companie, etc. which are traditionally risk adverse. Although these firms have raised a high level of capital (1.8 billion in the first half of 2016), (Vaidya, 2019), Germany still lags behind other countries such as the USA and China in terms of its investment in emerging industries (Nuadé et al, 2017).

Ultimately, Germany is a country that provides many funding sources for start-ups and entrepreneurs, especially if the business or product is commercially focused, but is still a somewhat risk adverse nation.

Advantages and Disadvantages:

Germany’s National Innovation system performs strongly in many respects. Its multi-institutional approach to research allows for a flow of ideas between both university and non-collegiate associated organizations. The emergence of two different research systems allows for greater movement of ideas as some of the institutes such as the Max Planck Society have facilities abroad (Allen, 2015), as well as allowing certain organisations to specialise in specific areas and invest more heavily in areas other organisations cannot afford to or take a more commercial approach to research, etc. (Allen, 2015).Germany’s universities and research institutes also have not led to the growth of many small companies, with Berlin as the breeding ground for start-ups rather than academic settings. Germany has a specialised educational system, with students early on being placed in very specific educational routes. Furthermore, many students undertaking a tertiary education tend to undertake mechanical and engineering focused degrees. This both benefits Germany’s innovation system as there is a highly trained work force but may hinder it also. The German work force is increasingly specialised in particular fields and this further contributes to Germany’s somewhat narrow focus on manufacturing sectors (Naudé et al, 2017).

Germany also has many avenues available with regard to financing research and start-up businesses with a large number of private equity firms based in Germany and various government grant funds. However, many of these resources are funnelled into the automotive industry and other manufacturing sectors such as machinery, equipment and pharmaceuticals.

This results in Germany being a leader in certain markets but falling behind other countries such as the USA, Japan and other EU states with regard to high tech industry (Guag et al.,2018). There has been some reduction of r and d impact on economic growth observed across Europe recently and in Germany's case this is no doubt due to the stagnation in technological innovation (Nuadé et al, 2017). Lack of funding in the technology sector means Germany has never created a Google or Facebook like model. Focus needs to turn to this sector as the world becomes more and more dependent on technology.

Smaller companies can struggle to secure financing from private investors that fund a large amount of research and development. Germany has a somewhat risk adverse attitude, as can be seen by its huge investment in tried and tested industries such as the aforementioned automobile sector and a bias towards financing larger companies. However, government funding has somewhat circumvented this issue by supplying funds and grants for less commercial research and smaller businesses. However, larger financial institutes should be financing riskier business and research ventures in order for Germany to continue to be an innovatively viable country. (Guag et al, 2018).

Germany is split into a series of regions that are self-governing as well as an overall Federal government for the whole country. This can result in an uneven distribution of resources with greater innovative activity seen in more metropolitan areas. As well as this, the East-West mentality still exists in the country to a certain extent. Greater innovative activity is consistently seen in the Western half of the country; with Eastern regions struggling to keep up in more modern R and D focused areas. The amalgamation of the two halves of the country has led to a somewhat uneven innovative system with the Federal government needing to do more to rejuvenate innovative development in the East. (Guag et al, 2018).

Furthermore, as is the case in many other Western countries, Germany has an ageing population, with the possible future of a smaller work force and a larger number of people requiring health care and pensions. Germany has attempted to rectify this problem by increasing migrant populations in the country. This comes with its own risks and difficulties due to cultural differences and racial issues. However, it could also be an innovative opportunity for the development and communication of new ideas (Kluge, 2013)

Ultimately, the German national innovation system has its strengths and weaknesses. There is a certain reticence towards risk and creativity and the ageing population may pose problems in the future. However, Germany is strong in several manufacturing and innovative research areas and is a country that has proven throughout history it can survive great political hardship to become an economic force to be reckoned with.