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The Pursuit of Innovation: An Analysis of International Competitive Advantage in a Globalized Knowledge Economy

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Abstract

With the advent of the internet age, the way in which global society interacts with technology has changed dramatically. The instantaneous availability of information and connectivity, signal the rise of a knowledge economy. This is a system in which the most valuable resource, to nations and private enterprise, is knowledge. This thesis argues that value is created through knowledge flows, which result in innovation and technological advancement. This technological advancement is the primary determinant of a nation's global competitive advantage in a globalized knowledge economy. This thesis then posits that these innovations are fostered by institutional, social, cultural, economic, and governmental factors within a nation. These factors make up a nations' National Innovation System (NIS). Using case studies of the US, China, India, and the EU, this paper then attempts to deconstruct, compare, and contrast the innovation strategies of each country and what implications they might have for the future. Lastly, an analysis of potential trends attempts to forecast the global innovative landscape in the near future.

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Introduction

The Information Revolution and Its Consequences

The dynamics of the international economy are changing dramatically. The information revolution of the early 21st century fundamentally altered the way in which society understands and interacts with technology and information. Work that would have taken days can now be done in a matter of minutes. Information pings around the globe in a matter of seconds to create an amorphous cloud of productivity. The costs of processing, transmitting and searching for information have declined significantly.[1] There is now software to manage payrolls, to help doctors diagnose patients, to tally votes, to make music, etc.…[2] The answers to most everyday questions are available at the tips of our fingers. The way in which the world interacts with information has been fundamentally transformed by technology and the advent of the internet.

As far back as 1939, John Bernal introduced the idea of science being the driving factor behind large scale economic and societal shifts. He hypothesized that technological improvements are the basis for increases in the extent and value of life.[3] The technological shifts we have seen since the widespread adoption of personal computers in the 1980's have fundamentally changed the nature of work and the economy. The nature

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[1] Nye, Joseph S. "The Information Revolution and Power." *The Paradox of American Power*, 2003, 41-76. doi:10.1093/0195161106.003.0002.
[2] Drucker, Peter F. "Beyond the Information Revolution." The Atlantic. October 01, 1999. Accessed December 04, 2017. https://www.theatlantic.com/magazine/archive/1999/10/beyond-the-information-revolution/304658/.
[3] Bernal, John Desmond. "The Social Function of Science." Accessed December 04, 2017. https://www.marxistsfr.org/archive/bernal/works/1930s/socialscience.htm.

of value creation is now far less concrete than it has been in the past. Where value used to be based on physical components and the efficiency of creation, nowadays most of that value can be totally intangible.[4] A useful example is the automobile, the icon of past industrial innovation. "A new car today is less and less the product of metal fabrication and more a smart machine that uses computer technology to integrate safety, emissions, entertainment, and performance."[5] This increasingly amorphous nature of value creation has led to the advent of a *knowledge economy*. Essentially, this is an economy in which the key components of economic growth rely on intellectual capabilities rather than on physical inputs and natural resources.[6] Importantly, these changes are reflected in every stage of the production process. Marginal improvements in the development of products, from research and development to customer facing technologies exponentially increase productivity along every step of the value chain of production. This increasing reliance on knowledge -intensive activities leads to a constant and accelerated advancement of the frontier of technology, which in turn creates value.

With the nature of productivity changing so dramatically, countries must look to position themselves as best they can in order to flourish in the knowledge economy. With dramatic economic change comes the potential for a global reshuffling of influence. In order to maintain global economic power countries have to understand and adapt to the increasing importance of knowledge in global economics. The onus will be on governments to create policies that emphasize national innovation systems by creating an

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[4] Powell, Walter W., and Kaisa Snellman. "The Knowledge Economy." *Annual Review of Sociology* 30, no. 1 (2004): 199-220. doi:10.1146/annurev.soc.29.010202.100037.
[5] Ibid.,
[6] Ibid.,

environment in which the development of technology is incentivized. There is no one key to creating such a system; instead, the challenge will be to create a system in which highly skilled workers, private enterprise, higher education, and cultures of innovation all work together to position a country as best as possible in a global context.

That task will prove to be all the more complicated in a world in which physical borders prove increasingly less important in innovation. Globalization is generally thought of through the lens of inputs and outputs and their respective sources. The direct denationalization of these inputs and outputs, in other words, the increasingly distant relationship between location of production and market of sale, constitutes the basis of understanding globalization. The instantaneous nature of information transfer today makes knowledge an extremely ambiguous input. If knowledge inputs are coming from all over the world, it becomes difficult to track and maintain where value is being added. To navigate this, countries will have to navigate global knowledge exchanges just as they navigate global trade and the transfer of commodities and resources. In some cases, knowledge may be sourced locally, which can generate specialization and comparative advantage effects. For example, an interaction between a university and specific industry may result in proprietary innovation that positions that industry ahead of others in its field around the world. In other cases, knowledge will be increasingly internationalized and will allow for the rapid worldwide spread of technological advancements.[7] An example of this is the development of technology by large multinational corporations that spread their innovation across all of their constituent countries, creating positive externalities.

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[7] Dunning, John H. *Regions, globalization, and the knowledge-based economy*. Oxford: Oxford University Press, 2007.

Toeing this line and understanding which approach, or combination of the two, best suits their specific country is the challenge that world governments will face in the years to come.

A Comparison of Economic Revolutions

Radical changes in productivity and work promised by a transition to a knowledge economy are not unprecedented. The industrial revolution, sparked in the late 18th century by James Watt's steam engine, changed the nature of human productivity dramatically. The industrial revolution mechanized and streamlined previously laborious tasks, lowering costs and increasing output significantly. As a result, the textile industry, the dominant sector at the time, exploded with reduced manufacturing costs and increased efficiency. It didn't stop at textiles; the mechanization process began to seep into the entire realm of manufactured goods. The production of paper, glass, leather, cement, and iron became significantly cheaper and quicker. The advent of railroads allowed producers to carry these goods long distances, thus opening up previously unreachable markets and sparking rapid urbanization. The horizon of possibility was permanently expanded for most of society; physical distance was no longer the insurmountable barrier it had been.[8] A whole new realm of demand was tapped; suddenly factories were popping up around the world as countries understood that manufacturing was changing before their eyes. These dynamics resulted in the creation of a whole new class of workers, the industrial laborer. The skyrocketing demand for

[8] Drucker, Peter F. "Beyond the Information Revolution." The Atlantic. October 01, 1999. Accessed December 04, 2017. https://www.theatlantic.com/magazine/archive/1999/10/beyond-the-information-revolution/304658/.

goods led to an equal demand for low-cost factory labor. The nature of factory work shaped family and personal dynamics for most of the 19th century, as workers moved out of their homes and into the workplace. With broad economic upheaval comes equal societal change as the nature of work is fundamentally affected.

In fact, many parallels have been drawn between the advent of the information revolution and the industrial revolution. Where the steam engine was the symbol of industrial mechanization, the computer is the symbol of the information age. The industrial revolution steadily reduced the costs of large scale manufacturing. The same is happening in the information revolution. Intel co-founder Gordon Moore made the observation that "the number of transistors per square inch on integrated circuits has doubled every year since their invention."[9] The growth has slowed a little bit, but Moore's Law holds in that roughly every two years the performance of computer chips doubles. Not only are computers getting faster, but they are getting smaller and cheaper at the same time. This lowers barriers of entry and allows for more entrepreneurs and businesses to enter the technological ecosystem and create products. The horizons of productivity are exponentially changing all over the world as costs are plunging and possibilities are skyrocketing.

This paper seeks to understand the innovation systems and policies that countries must pursue in order to succeed in a knowledge-based economy. In an increasingly globalized economy, the countries that are able to best respond to advances in the cutting edge of technology will do the best. These responses will be the result of carefully tuned

[9] "Moore's Law." Investopedia. November 24, 2003. Accessed December 04, 2017. http://www.investopedia.com/terms/m/mooreslaw.asp.

institutions of innovation that include forward thinking immigration policies, emphases on the role of multinational corporations, institutes of higher education, and cultural institutions that incentivize technological advancement. Yet, the recipe for success is not the same for every country. Certain countries are better positioned to push the frontier of technological progress while others are better positioned to create entrenched comparative advantages. This paper will go on to look at case studies in order to understand institutional differences that could have a bearing on international success in a knowledge economy.

Chapter 1: What Is a Knowledge Economy And How Are We Transitioning To One?

A Theoretical Framework

Daniel Bell first introduced the concept of a knowledge economy in his analysis of a postindustrial society. He postulates that where an industrial society is centered around manufacturing and semi-skilled workers, a post-industrial society is based around services, "intellectual technology," and the increasing importance of information and computing. Bell posits "theoretical knowledge" as the key underpinning of a post-industrial society. Theoretical knowledge, he claims, is "the basis of increased productivity, and productivity has been the transforming fact of economic life."[10] He acknowledges that every society in human history has been dependent on knowledge, but emphasizes that this is the first time that a targeted effort in the accumulation and direction of theoretical knowledge 'has come to the fore as a directive force of innovation and change."[11] Importantly, Bell identifies a knowledge theory of value. He emphasizes that value is created through knowledge and not labor.[12] He postulates that the instantaneous nature of information processing and computing allows for society and technology to advance past the realm of human judgment. Computers can work exponentially harder than humans in processing and executing even minute operations. This realm of possibility explains why theoretical knowledge is so important in a

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[10] Bell, Daniel. *The Coming of a Post Industrialist Society: A Venture in Social Forecasting*. 1974.
[11] Kelly, Peter. *The Self as Enterprise: Foucault and the Spirit of 21st Century Capitalism*. Farnham: Taylor and Francis, 2016.
[12] Bell, Daniel. *The Coming of a Post Industrialist Society: A Venture in Social Forecasting*. 1974.

postindustrial society. The power of computing allows for the value added by knowledge to be multiplied exponentially by advances in technology. This pushes the frontier of productivity much farther than human judgement and work can.

Research into the knowledge economy remains varied, since its scope is so broad. Powell and Snellman argue that there are three distinct strands of research that fall under the broad umbrella of the knowledge economy. The first is the "rise of new science-based industries and their role in social and economic change."[13] This field echoes Bell, as it emphasizes the importance of theoretical knowledge as the driving force behind innovation. The second strand of research that Powell and Snellman identify posits that the knowledge economy operates fundamentally differently than existing economic structures. It investigates "whether new kinds of jobs and novel forms of work organization have emerged in recent years."[14] The third strand of research focuses closely on the means by which knowledge is transferred and codified. Imperative to this vein of research is that "some organizations appear to be particularly good at knowledge production and transfer, and researchers are interested in understanding why and whether these practices can be replicated."[15] These three strands of research are heavily interconnected and serve as a reminder that the knowledge economy can look very different at different levels of analysis.

Innovation as a Driver of Efficiency

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[13] Powell, Walter W., and Kaisa Snellman. "The Knowledge Economy." *Annual Review of Sociology* 30, no. 1 (2004): 199-220. doi:10.1146/annurev.soc.29.010202.100037.
[14] Ibid.,
[15] Ibid.,

One recognized characteristic of the knowledge economy is that it does not come at the cost of industry and manufacturing, but instead blurs lines between previously distant industries. Amazon, for example, takes a factory-era warehousing and distribution business into the 21st century with its online retail business. On one hand, customers are ordering and receiving products in a fashion that has not changed since the advent of consumer delivery by Sears. On the other hand, Amazon now provides detailed recommendations based on past browsing history. You can see what people with similar tastes are buying, watching, reading, and even cooking. It takes each customer on a fully targeted journey from idea to interest to purchase to delivery, without them having to leave the platform.[16] It streamlines the customer process so much that customers are more likely to make fitting purchases and, as a result, increases satisfaction for the customer and revenue for the corporation. This is a prime example of the knowledge economy taking an entrenched preexisting industry and innovating to tailor it further toward its societal ideal. Amazon's Alexa system now allows consumers to make purchases simply by speaking to the device. Amazon is tearing down barriers between consumers and products. Where consumers used to have to get in a car and go to a store to browse for goods, those goods now come to them with nothing more than a single sentence spoken to an Alexa device. This drastic reduction of costs, both tangible and intangible, is the basis upon which economies can hope to increase their efficiency.

However, the effect of innovation on economic growth can be difficult to quantify. The fundamental effect of information technology on productivity is intangible.

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[16] Powell, Walter W., and Kaisa Snellman. "The Knowledge Economy." *Annual Review of Sociology* 30, no. 1 (2004): 199-220. doi:10.1146/annurev.soc.29.010202.100037.

How do you quantify an individual's ability to Google the answer to a burning question, or the increase in productivity that online banking provides to a small business? In truth, conventional metrics of labor productivity fail to capture the effects of technologically assisted productivity. Traditional macroeconomic theory only takes labor productivity and labor supply growth into consideration when quantifying growth. Importantly, "Labor productivity growth depends on growth in productive inputs such as capital intensity and labor quality."[17] The significant portion of 'productivity' that is not reflected in these productive inputs is known as the Solow residual and is generally characterized by changes in multifactor productivity. This represents the multiple by which inputs increase in value by the time they become outputs. These changes are the result of technological progress and improved efficiency.

Looking more closely at the firm, one can see the actual effects of this efficiency. A study of the top 600 firms in Fortunes top 1000 list offers some conclusions. It proves that the adoption of technology solutions, while having a positive impact on output in the short term, have an impact that is 2 to 8 times greater when measured after three to seven years.[18] This leads to the broader conclusion that technological innovation and computing power is the platform on which greater productivity can grow. Technological innovation, as a result, is only as powerful as the organizational restructuring and adoption that follows. The simple fact that a company has a strong IT network does not inherently make it tangibly more productive. The extent to which that company maximizes the technology at its disposal is the key driver of multifactor productivity.

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[17] Powell, Walter W., and Kaisa Snellman. "The Knowledge Economy." *Annual Review of Sociology* 30, no. 1 (2004): 199-220. doi:10.1146/annurev.soc.29.010202.100037.
[18] Ibid.,

The ability to translate available information technology into efficiency and output is the set of skills on which the knowledge economy is built. With information becoming increasingly ubiquitous, "the skills and competencies relating to the efficient use of information become more crucial."[19] This increasing importance of the tacit knowledge required to parse through codified knowledge frames the skillset that will provide the most value in the knowledge economy. It is a large part of the skillset that defines the 'knowledge worker'. If the access to information is a baseline resource, then the many minute innovations and advancements that are made with that resource are what constitute an advantage in the knowledge economy. Those who can manipulate information technology and squeeze out as much productivity as possible are bound to have both a long and short-term advantage over their competitors.

These increases in productivity are driven by large and small scale innovation in everyday processes. In this context, innovation is the improvement of a product, process, or technology that results in the creation of added value or productivity that might not have been present before. The OECD maintains that "innovation can take many forms including, incremental improvements to existing products, applications of technology to new markets and uses of new technology to serve an existing market." Innovation is not necessarily something as large and disruptive as the creation of ride-sharing apps or artificial intelligence. While these are certainly innovative, there is a far less visible side to innovation that constantly works to make every day processes and products more cost-efficient and profitable. This innovation is the result of an endless network of collaboration between researchers, designers, policy makers, and firms.

[19] "The Knowledge Based Economy." https://www.oecd.org/sti/sci-tech/1913021.pdf.

Innovation is driven by large-scale networks that aid in the diffusion and adoption of knowledge across industries, enterprises, and people. A 'network', however, is a term that lacks a clear consensus definition. Stein and Stren define it as "a spatially diffuse structure, with no rigidly defined boundaries, consisting of several autonomous nodes sharing common values or interests, linked together in interdependent exchange relationships."[20] They stress that a network consists of repetitive interactions among members with converging interests. A simpler definition might state that a network is the set of collaborative or productive interactions that one might have, both in person and over the internet. The key takeaway here is that networks aid in the dissemination of information through relationships. For example, an entrepreneur building a startup can draw on the experience of peers, mentors, teachers, researchers, business partners, and family to contribute experience and knowledge to the creation of value. Extrapolating this concept to the system as a whole, a network society is one in which a firm or individuals' socio-economic position is determined by their opportunity and capability to find, establish, and use knowledge-intensive relations.[21] Knowledge networks provide opportunities "to partner, exchange ideas, collaborate on the identification of problems, the shaping of the research agenda," and the ultimate execution of ideas and products.[22] As a result, innovation that pushes the production possibility frontier hinges on the proper accumulation and utilization of knowledge through these networks.

National Innovation Systems

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[20] Fitzgibbon, Joy, and Janice Gross. Stein. *Networks of Knowledge: Collaborative Innovation in International Learning*. University of Toronto Press, 2001.
[21] "The Knowledge Based Economy." https://www.oecd.org/sti/sci-tech/1913021.pdf.
[22]Ibid.,

The success of national economies thus depends on their ability to create and foster 'national innovation systems'. As mentioned earlier, innovation is the result of a diverse set of relationships contributing to incremental increases in productivity. "Innovation requires considerable communication among different actors – firms, laboratories, academic institutions and consumers - as well as feedback between science, engineering, product development, manufacturing and marketing."[23] The methods and channels in which knowledge flows between these actors make up a country's 'national innovation system'. Christopher Freeman first coined this term and described national innovation systems (NIS) as "the network of institutions in the public and private sectors whose activities and interactions initiate, import, modify and diffuse new technologies."[24] These institutions encompass all aspects of society, from top to bottom. From individual attitudes and family values to the political system in place, each country has its own specific concoction of these institutions that either aid or inhibit the creation of technology and flow of knowledge. This concoction is unique to each country and can be analyzed from the perspective of the individual, society or the state.

Understanding and prioritizing the development of an effective NIS is crucial in order to develop an international competitive advantage in the knowledge economy. "Countries differ in the ways in which knowledge flows are structured and the relative importance of different types of institutions… there is no doubt that there are countries in which institutional interactions occur more easily than in others."[25] Each country must look to position its NIS as best it can to highlight the strengths of its people, institutions

[23] "The Knowledge Based Economy." https://www.oecd.org/sti/sci-tech/1913021.pdf.
[24] "National Innovation Systems,"http://www.oecd.org/science/inno/2101733.pdf
[25] "National Innovation Systems,"http://www.oecd.org/science/inno/2101733.pdf

and governments. Some countries might be inherently better at pushing the forefront of technology forward, creating and researching the tools and processes that fundamentally change our interactions with data and products. Other countries may not have the resources or labor for that and will have to position their NIS to best respond to innovative processes developed elsewhere. China, for example, developed much of its economy by copying foreign technology until it developed the knowledge base to innovate on its own. In this vein, the extent to which countries understand their own strengths and implement policies to best allow for knowledge flows around those strengths will determine their success in the context of a developing and globalizing world economy.

In order to compare and contrast National Systems of Innovation, a framework for analysis is needed. In analyzing NSIs, Bengt-Åke Lundvall acknowledges that a common criticism is that a NSI can constitute almost anything within a nation. In the attempt to draw a line, Lundvall identifies a few core assumptions. He first assumes that firms and the way in which they organize themselves play the most important role in innovation systems. Second, he acknowledges that firms innovate in conjunction with other firms, as well as with the university system and other institutions of technology. Extrapolating this one step further, he finds that the *type* of innovation that firms pursue is dependent on "national education systems, labor markets, financial markets, intellectual property rights, competition in product markets and welfare regimes."[26] Lastly, he acknowledges that, within a nation, firms in different sectors may innovate, interact with knowledge and

[26] Lundvall, Bengt-Åke. "National Innovation Systems—Analytical Concept and Development Tool." *Industry & Innovation* 14, no. 1 (2007): 95-119. doi:10.1080/13662710601130863.

draw upon labor and financial markets very differently. His model of analysis identifies firms and firms' interactions with other firms as the 'core' of the innovation system. The 'wider setting' of the innovation system then consists of all the accessory institutions and markets that allow and facilitate these inter-firm interactions and innovations. For example, "national education systems, labor markets financial markets, domestic competition etc..." are considered under this 'wider setting'. Lundvall argues that the innovation systems of different nations can be compared and contrasted using this wider setting and its relation to core principles. [27]

While a useful framework, and one that touches on many important aspects of NSIs, Lundvall's conceptualization misses out on the cultural aspect of innovation systems. The attitudes of the constituents of a nation have a direct impact on the adoption and execution of new technologies. These attitudes could be the result of the nature of the regime in place, or the result of economic or historical factors. These attitudes are a pillar of innovation systems in themselves, and should be analyzed as part of the aforementioned 'core.' For example, the self-starting nature of a highly capitalist society versus the nationalistic collaboration championed by Karl Marx are two contrasting paradigms of innovation that highlight the importance of using a societal lens to analyze attitudes towards innovation.

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[27] Lundvall, Bengt-Åke. "National Innovation Systems—Analytical Concept and Development Tool." *Industry & Innovation* 14, no. 1 (2007): 95-119. doi:10.1080/13662710601130863.

Porter's Framework of Competitive Advantage

Identifying innovation as the crux of international competitive advantage goes against the majority of conventional wisdom. According to Michael Porter, the generally accepted determinants of competitiveness amongst nations are labor costs, interest rates, exchange rates and economies of scale. For private companies those determinants are mergers, acquisitions, alliances, collaboration and globalization. Porter argues that these determinants are based on short-term appeal, and do not equate to sustainable competitive advantages. Essentially, focusing on these indicators allows companies and governments to maximize their bottom lines and create short term successes. The key to international success however, is in anticipating future markets and *continuing* to innovate in order to maintain advantages.[28]

A useful example is Japan's economic boom that began in the 1980s. Japan noticed a market for cheaper and more efficient consumer electronics. The resulting few decades cemented Japan as an economic force to be reckoned with, as companies like Sony, Hitachi, Toshiba, and Nikon established themselves as leading worldwide brands. The driver behind Japan's growth was the creation of extensive and efficient knowledge networks within the economy. Japanese *Keiretsu* were large business groups that linked "industrialists, banks, and trading companies through reciprocal ownership of stock and

[28] Porter, Michael E. "The Competitive Advantage of Nations." Harvard Business Review. August 01, 2014. Accessed December 04, 2017. https://hbr.org/1990/03/the-competitive-advantage-of-nations.

long-standing exclusive relationships."[29] These groups of businesses would cement their futures by cross-holding each other's stock. "Their mission was to gain market share rather than accumulate short-term profits, and they aggressively entered high-growth sectors with long-term potential."[30] The result of this was an economic juggernaut that revolutionized the automobile and electronics industry worldwide.

However, Japan's fairytale came to a quick end when it reached the absolute apex of its powers as the global leader in consumer electronics and other similar industries. During its "Economic Miracle," Japan's government did a stellar job of providing economic incentives to companies in sectors that had high growth potential. A combination of tax breaks, favorable exchange rates, and trade barriers allowed Japanese companies every opportunity to catch up with their western competitors. However, problems arose when they eventually caught up. The Japanese government no longer knew which sectors to funnel money into, or where the potential for growth and innovation lay. Japan wasted billions of dollars in industries that ended up falling flat. Magnetically-levitated trains, micro-machines and high-definition analog television are examples of misguided Japanese investments.[31]

The key takeaway here is that continued innovation is necessary in order to create sustained competitive advantages. In this case, Japan could not move any further once it

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[29] Crawford, Robert J. "Reinterpreting the Japanese Economic Miracle." Harvard Business Review. July 31, 2014. Accessed December 04, 2017. https://hbr.org/1998/01/reinterpreting-the-japanese-economic-miracle.
[30] Crawford, Robert J. "Reinterpreting the Japanese Economic Miracle." Harvard Business Review. July 31, 2014. Accessed December 04, 2017. https://hbr.org/1998/01/reinterpreting-the-japanese-economic-miracle.
[31] Ibid.,

arrived at the frontier of technology. Japan failed to continue innovating past its boom in consumer electronics and automobiles. Its methods were easily copied by Korean and, eventually, American electronics companies, and Japan lost a large portion of its market share, which at least partly contributed to its ongoing period of secular stagnation. While there are many factors that caused this economic decline, the writers of *Inside the Kaisha* point to a cultural tendency to "wait and see, and then go with the group."[32] According to Robert Crawford, a tendency to avoid embarrassment led the Japanese economy to put on a façade of innovation as it continued to follow quickly in the paths of others' innovation. Japan's failure to foster a system of sustainable innovation was a major determinant in its dramatic fall from grace. [33]

In light of examples like this, Porter developed a framework for analyzing the creation of competitive advantages as factors of innovation. Much like Lundvall, Porter argues that a country's competitive advantage is centered around the firm. The key to international success, as a result, is creating a National Innovation System that supports and maximizes the value of the firm. Porter develops an in-depth framework that posits that international competitive advantages are built by:

1. Factor Conditions: In a knowledge economy, nations are not blessed with plentiful natural resources to innovate in the information age. Instead they have to create resources such as skilled human capital or scientific infrastructure. Porter argues that the most important factors of production are those that require significant fixed investment. This fixed investment creates barriers to entry that

[32] Ibid.,
[33] Ibid.,

create and maintain competitive advantages. Even human capital can be outsourced or coordinated internationally by the firm. For a nation to succeed it must significantly invest in extremely specialized centers of innovation within specific industries. Porter gives the example of a specialized scientific institute or a pool of venture capital to fund software development.[34]

2. Demand Conditions: Here, Porter argues that, in a globalized economy, the home demand that a firm receives is the most crucial. The logic here is that home demand provides the best incentive and response for firms in their pursuit of innovation. A key takeaway here is that "local buyers can help a nation's companies gain advantage if their needs anticipate or even shape those of other nations—if their needs provide ongoing 'early-warning indicators' of global market trends." He uses the example of Denmark's focus on the environment leading to leaps forward in pollution-control equipment and windmills. Porter emphasizes that ideal home demand consists of incredibly picky and difficult to please consumers who demand innovation as a result of other social and economic factors.[35]
3. Related and Supporting Industries: This is the idea that the extent to which a company's supply chain and close collaborators are also global competitors influences its success. The proximity of suppliers and supporting industries offers a unique opportunity to create specialized knowledge networks that are constantly

[34] Porter, Michael E. "The Competitive Advantage of Nations." Harvard Business Review. August 01, 2014. Accessed December 04, 2017. https://hbr.org/1990/03/the-competitive-advantage-of-nations.
[35] Ibid.,

working to upgrade products and services at all stages of the value chain. This creates innovation far greater and more versatile than could be accomplished by one firm.[36]

4. Firm Strategy, Structure and Rivalry: This broad category encompasses the culture and structure that defines the firms in an economy. Managerial systems, the adoption of technology, cultures of work, cultures of collaboration, and structures of incentives shape this aspect of a NIS. Included here are rivalries between firms on a domestic level. Porter argues that domestic rivalries are important as they put firms in the same industry on a level playing field when it comes to regulation, access to resources etc.… Essentially, it takes the variation of being in a specific country out of play and forces firms to compete to be the most globally competitive, given the context of their industry. [37]

Porter's foray into the specific determinants of competitive advantage provides a framework for analysis that, when meshed with Lundvall's theories, creates a platform to understand how the pursuit of innovation is the driving force behind international competitive advantage. These frameworks identify that there are two broad buckets of factors that determine national competitiveness. The first are factors that are inherent to, and can be controlled by, the firm. The second are those that are inherent to the nation, such as the many societal, governmental and economic factors that may influence innovation and knowledge transfers. While included in the second bucket, in truth governmental policies are the underlying and indirect factor behind

[36] Ibid.,
[37] Ibid.,

all of these determinants of competition. The extent to which trade barriers are enforced, cultural values are emphasized, and investments are allocated are governmental factors that have massive implications on the innovation of private companies. As a result, this paper will go on to argue that the extent to which a country is able to compete in a globalized knowledge economy is determined firstly by the ability of a government to identify and work towards creating a functional and fitting National Innovation System and, secondly, the ability of firms to capitalize and continue to push the frontier of their innovative capabilities.

Chapter 2: A Case Study of the United States' National Innovation System

A Brief History

A major player in the worldwide creation of innovation, the United States has a big part to play in shaping global technological advancement in the years to come. However, this has not always been the case. For most of its relatively short history, the US has been behind European nations in pushing the technology frontier. The tipping point came along with the industrial revolution, when certain factors unique to the US propelled it to the forefront of technology and industry. First, the industrial revolution was built on economies of scale pushing out traditional craft. The US had a distinct advantage in this area. Massive consumer demand driven by its large population was one of the key drivers of success. Secondly, the US was a significantly newer economy than the U.K or Germany, and, as a result, did not have to dig up centuries of entrenched industries that adhered to the pre-industrial craft-based system.[38] An important underlying factor was the American commerce-centric attitude that permeates cultural institutions in the US. Calvin Coolidge encapsulated it well by saying that "the business of America is business."[39]

Yet, innovation was not a concrete goal for US firms until after World War II. For the years between the advent of the industrial revolution and World War II, US innovation was largely powered by small-time private actors and inventors. The coming

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[38] Atkinson, Robert D. "Understanding the U.S. National Innovation System." *The Information Technology & Innovation Foundation*, June 2014. http://www2.itif.org/2014-understanding-us-innovation-system.pdf?_ga=2.216129814.1045196774.1510541392-2061559145.1510541392.

[39] Ibid.,

of WWII created a broad national need for innovation that stemmed from the government and extended all the way into consumer technology. The advent of the war and the ensuing Cold War pushed the US government into a much more central role in the coordination of innovation policy. While the government still did not acknowledge innovation as a key economic goal, the economic post-war boom, the space race and the increased spending on defense R&D created spillovers that led to the establishment of large corporate innovation and research centers. This led to significant advancements in electronics, pharmaceuticals, and aerospace technology.[40]

The rise of global competitors in the 1970's spurred the first targeted attempts at innovation policy in the US. Japan underwent its economic miracle as countries like Germany and France started threatening US competitiveness. The result was a flurry of economic initiatives to spur innovation. Between the Reagan and Clinton administrations, a laundry list of policies was implemented to incentivize innovation. These were supplemented by federal incentives programs around science and research, including the National Science Foundation, the National Institute of Standards and Technology, and the National Technology Medal. [41]

Free Market Principles

Regardless, the US has a relatively laissez-faire approach to industrial R&D and commerce. This is a factor that must be used to frame any further analysis of the US NIS. A crux of US society is its adherence to capitalist principles of private sector growth and

[40] Ibid.,
[41] Ibid

individual entrepreneurship. The efficient allocation of resources based on market-led solutions is the key to US economic values, and, as a result, frames its NIS. A resurgence of this principle took place towards the end of the 1970's, when the American welfare state contracted in order to create private incentives for growth. In this vein, the US understood that "increasing incentives for work, investment, and risk taking could be achieved by deregulating labor, product, and financial markets."[42] The result was a society that was primed for entrepreneurship and private-sector growth at the cost of economic equality. This fundamental value spills over into the financial and labor markets of the US. Edward Conard writes that "The outsized gains of successful risk takers diminished the status of other talented workers, which increased their motivation to take risks." He continues, claiming that "with more wealth in the hands of risk takers, US investors underwrote more risk. Larger, more liquid US financial markets allowed investors to further parse risk and sell risks they were reluctant to bear.[43]" The establishment and adherence to these values set the stage for US entrepreneurship that eventually led to the technology boom at the turn of the millennium and the establishment of world technology leaders such as IBM, Microsoft, and Apple.

For the reasons above, the US stays away from facilitating and funding R&D within corporations, but maintains federal initiatives to foster innovation as a whole.

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[42] Howell, David R. "The Great Laissez-Faire Experiment." Center for American Progress. Accessed December 04, 2017. https://www.americanprogress.org/issues/economy/reports/2013/12/04/80408/the-great-laissez-faire-experiment/.

[43] Howell, David R. "The Great Laissez-Faire Experiment." Center for American Progress. Accessed December 04, 2017. https://www.americanprogress.org/issues/economy/reports/2013/12/04/80408/the-great-laissez-faire-experiment/.

Porter's first condition of national innovative competitive advantage is the creation of factor conditions. Or, in other words, the creation and funding of institutions that foster specialized knowledge. The US falls far behind other countries in its creation of knowledge networks that link the government and private sector. President Obama's National Network for Manufacturing Innovation is an example of such a network. However, this program is chronically underfunded and doesn't present much of an incentive for private firms to engage with it.[44] The crux of federally-funded innovation occurs in government labs for defense, energy and health. Many of these set-ups have contributed important technological processes and inventions that have then been applied to consumer markets. While this is an important aspect of the US innovation system, it is not a core component, nor is it one that will be pushing the forefront of US global economic competitiveness, since the demands of global economic markets have diverged from the goals of defense and energy spending.

Innovation Clusters

Where the US shines on an international level, in terms of specialized knowledge development, is in the creation and dissemination of research-institute based knowledge. "Compared to many nations, the United States has a highly developed and successful industry-research institute collaboration system."[45] Major research universities in the US are considered the best in the world and attract investment and talent from across the

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[44] Atkinson, Robert D. "Understanding the U.S. National Innovation System." *The Information Technology & Innovation Foundation*, June 2014. http://www2.itif.org/2014-understanding-us-innovation-system.pdf?_ga=2.216129814.1045196774.1510541392-2061559145.1510541392

[45] Ibid.,

world. However, the quality of universities and research, while important, is not the driving factor behind the success of the US in this field. Instead it is the incentive structures and cultural attitudes behind the partnership between industry and academia that create an ideal system for technological progress. US universities view collaboration with industry as a useful tool for advancing knowledge, rather than "something that sullies the purity of basic research."[46] In addition, US universities have less hierarchical barriers to industry collaboration. Many countries have structures that only incentivize full professors to work with industry, which cuts out a large intellectual knowledge force.[47]

These collaborative institutions are part of a larger network of innovation clusters that drive US knowledge flows. Investment in innovation clusters is a key driver of national productivity. Innovation clusters can best be defined as "regional concentrations of large and small companies that develop creative products and services, along with specialized suppliers, service providers, universities, and associated institutions."[48] These clusters are crucial, since they create close-knit networks in which knowledge can be easily disseminated and ideas can reach execution much quicker than usual. The general idea is that much of human knowledge exists in a tacit form, or one that is difficult to codify. The result is that personal interaction then becomes necessary to properly transfer knowledge in a productive manner.[49] The North Carolina research triangle and Silicon

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[46] Ibid.,
[47] Ibid.,
[48] "Overview: The New Federal Role in Innovation Clusters." January 01, 1970. Accessed December 04, 2017. https://www.ncbi.nlm.nih.gov/books/NBK115046/./
[49] Rickne, Annika. *Innovation governance in an open economy: shaping regional nodes in a globalized world*. 2012.

Valley are prominent examples of the benefits of these clusters. The United States has not historically directly contributed to building such clusters. A combination of private entrepreneurship and state and local governments have driven innovation clusters in the US.

In recent administrations the government has taken a more central role in the development of innovation clusters. In 2007, Congress passed the America COMPETES Act with bipartisan support, authorizing the development of innovation clusters.[50] This marked the beginning of increased public sector support of private sector growth in innovation. A large driver for these talks has been the success of foreign economies in quickly building productive clusters of their own. The Asian Tigers, for example, have spent considerable amounts of government money to fund the creation of science 'parks' that "promote synergies among business, governments and university research programs in their regions."[51] These clusters by no means do the job on their own. For them to succeed there has to be combination of quality R&D, an efficient and forward-looking private sector, and an economic culture that promotes the dissemination of information. The innovation infrastructure that these countries have built greatly speeds that process, providing the 'soft infrastructure' that allows innovative development to occur.

One of the first US initiatives for a similarly accelerated innovation cluster was the National Institute of Standards and Technology's Rapid Innovation and Competitiveness Initiative. Established in 2007, the project involved $200 million of

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[50] "Overview: The New Federal Role in Innovation Clusters." January 01, 1970. Accessed December 04, 2017. https://www.ncbi.nlm.nih.gov/books/NBK115046/./
[51] Ibid.,

federal funding that set up four distinct nanotechnology research centers around the US. The initiative emphasizes that the roadmap for research should be established and driven by private sector organizations. The result was a host of large companies such as Texas Instruments, AMD, Freescale, and Micron Technology that help to shape and drive research. This approach aligns with general US policy to allow the private sector to drive growth. In fact, this initiative is a good indicator of the path forward for the US. Creating synthetic and command-oriented research centers like its Asian competitors is not the US mentality. Instead, allowing innovation clusters to be sparked by government funding and driven by firms is the general federal strategy for innovative development. The pressing question is whether this largely hands-off role will be enough to compete with economies such as China, that are investing heavily in research parks that cater to every inch of innovative development and receive much more direct streams of government funding.

The Power of Silicon Valley

However, the fact that Silicon Valley, the US's major innovation cluster, was the nucleus of the information revolution, gives the US a huge advantage in the development of technology. Firms like Apple, Google, and Microsoft essentially drove the consumerization of information and allowed the United States to establish itself, at least initially, as the nucleus of worldwide innovation. The question now is whether the US position at the helm is slipping. In order to answer this question, it is necessary first to analyze how America's technology powerhouses were established, and then to identify the benefits they represent to the US today and in the future.

The organic growth of Silicon Valley has created a fertile cluster of entrepreneurship, venture capital, and business that sits at the forefront of world innovation. Silicon Valley is by no means a leader in the field of cutting edge R&D. While there have been important technological inventions in the area, the true business of Silicon Valley is "the *development* of technology and its *market applications* by firms."[52] Its success in this area can be traced back to the NIS under which it operates. Firstly, as mentioned earlier, US business regulations incentivize entrepreneurial risk-taking and company creation. Failure in Silicon Valley is not culturally or economically denoted as the end of the road. An entrepreneur is shielded from the risks of failure through generous bankruptcy laws that allow companies to absorb most of the loss. On the other side, there are laws in place that allow entrepreneurs to receive a share in companies to which they provide value. As a result, a system of large-scale rewards and mitigated losses allows for a culture of failure and learning. That constant cycle of reinvention is one of the many cultural and regulatory keys that maintain Silicon Valley's vitality.[53] In addition, the deep integration of venture capital allows for a credit inflow that sustains the Valley's innovation. These venture capital firms exist solely to capitalize on the huge upside that startups have. As a result, they know exactly how to engineer their portfolios to mitigate the risks associated with investing in startups. Startups thus have easier access to capital than they would in a system in which financial integration was not as deep.

Lastly, Silicon Valley is a proud meritocracy that allows companies to tap into talent that has been largely overlooked by more traditional industries. "In the Valley,

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[52] Lee, Chong-Moon. *The Silicon Valley edge a habitat for innovation and entrepreneurship*. Stanford, CA: Stanford Univ. Press, 2006.
[53] Ibid.,

talent and ability are king…ethnicity, age, seniority and experience are not what dictate opportunity or responsibility."[54] This system benefits immigrant workers more than anyone else. In the Valley, immigrants have an effective land of opportunity in which to apply their potential. In fact, many key Silicon Valley firms were founded by, or are being led by, immigrants. As a direct result, Silicon Valley gains access to skills and technologies from other countries, a huge driver in its establishment and continued productivity.[55]

The productive and innovative nature of Silicon Valley is in many ways, a microcosm of the US NIS as a whole. Perhaps one might even consider Silicon Valley the apex of the American entrepreneurial mentality. A culture of risk taking, merit-based responsibility, and private inflows of capital epitomize the manner in which the US emphasizes the role of the individual and the firm in the creation of wealth.

US Multinational Corporations

These factors have led to the growth of juggernauts like Apple, Google, and Microsoft, which have led US innovation globally. However, the extent to which these MNC's constitute a competitive advantage for the US is much less apparent. There is no doubt that the presence and creation of these companies have had massive positive impacts on the US economy and its competitive advantage. However, in a globalizing world economy in which capital, physical goods, and information flow across borders

[54] Ibid.,
[55] Ibid.,

easily, there are diminishing marginal advantages to being able to manage them well. [56] Solvell and Birkinshaw point to an important evolution of competitive advantage when it comes to MNCs. They claim that "the ability to apply, adapt, or transfer practices on a worldwide basis is what separates the successful MNEs from the less successful."[57] An important distinction they make is between a firm's activities and practices. The activities of a MNC are *what* the firm does. For example, a firm's factories, marketing, physical stores, and supply chain constitute its activities. Its practices, on the other hand, are *how* it operates these activities. Practices are the intangible principles and processes that drive a firm's decision-making and operational drive. "A firm's capacity to deploy resources … to affect a desired end" are practices that are both firm-specific and "developed over time through complex interactions" within the firm. [58] Solvell and Brinkshaw argue that we are seeing a shift from an emphasis on activities to practices. With increasing globalization and the liberalization of trade barriers, the value added from improving firm-wide practices is the key to international competitiveness. A firm whose activities are less than competitive can outsource them to firms better-suited to compete both domestically and internationally. In a knowledge-based economy, the firms that are best suited to adopt technology and capitalize on productivity gains are those that will succeed internationally. Globally leveraged practices, as a result, are taking on an increasingly important role in global competition.

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[56] Sölvell, Örjan, and Julian Birkinshaw. "Multinational Enterprises and the Knowledge Economy: Leveraging Global Practices." *Regions, Globalization, and the Knowledge-Based Economy*, 2002, 82-106. doi:10.1093/0199250014.003.0005.
[57] Ibid.,
[58] Ibid.,

The changing role of MNCs becomes even more apparent in the internet age, in which the value-added of many consumer goods is largely intangible. The makeup of a traditional technology company is increasingly driven by assets such as brainpower, organization, public opinion, and brand awareness, as opposed to supply chains and distribution networks. To this extent, and in accordance, with Solvell and Brinkshaw's argument, US MNCs are only a source of competitive advantage for the US if they are able to maintain their place at the forefront of innovation through globally applicable business practices. The competitive advantage for these companies, as a result, lies in the incentive structures within their NIS that encourages innovation in business practices. Continuing from this train of thought, the benefit that the US receives from having so many powerful giants of technology is not from the tangible current value that they hold, but from the competitive environment they create, which forces each company to continue to innovate. [59]

The presence of these locally clustered MNC's, along with the domestic demand conditions in the US represents a large global competitive advantage. As MNC's around the world evolve to operate as efficiently and productively as possible, US MNCs will have the advantage of having strong domestic competition that forces them to push the envelope. This leads to clusters of innovation and knowledge advancement that build off the progress that these companies make, creating knowledge spillovers that benefit domestic firms. In addition, US competitive attitudes are well-positioned to foster innovation in business practices. Strong antitrust laws and an adherence to market forces

[59] Sölvell, Örjan, and Julian Birkinshaw. "Multinational Enterprises and the Knowledge Economy: Leveraging Global Practices." *Regions, Globalization, and the Knowledge-Based Economy*, 2002, 82-106. doi:10.1093/0199250014.003.0005.

allow these MNCs to compete for and develop technology that can benefit the economy as a whole.

The US economy also has a demanding and forward-thinking consumer base, a key ingredient in the development of technology. Porter explains that countries that have demanding domestic demand are best suited for groundbreaking innovation. While this is a difficult concept to quantify, the US has a large and relatively well-off consumer base that allows for productive competition between firms. In addition, the US has high levels of financial inclusion and access to the internet, which allows for informed and capable consumers.

Flaws In The System

This market driven approach employed by the US is under pressure from failing democratic institutions and proposed policies that are antithetical to innovation. There are many areas of innovation policy in which there is bipartisan support for action, "STEM education, manufacturing technology support programs, FDI attraction programs (e.g., Select USA), funding for technical skills training, and increased resources for trade enforcement,"[60] are a few examples. However, many of these issues find themselves pushed to the sidelines as an increasingly polarized political landscape makes passing the most basic of legislation difficult. In addition, innovation policy is by no means a strong priority of the government. It is possible for the government to maintain their hands off

[60] Atkinson, Robert D. "Understanding the U.S. National Innovation System." *The Information Technology & Innovation Foundation*, June 2014. http://www2.itif.org/2014-understanding-us-innovation-system.pdf?_ga=2.216129814.1045196774.1510541392-2061559145.1510541392.

philosophy in tandem with government programs to enhance entrepreneurship and innovation. This would involve policy and spending that allows free market enterprise but ushers American innovation in the right direction. Additionally, an unsettling fact is that the general American populace and government do not prioritize American innovative growth. With so much scrutiny on where American tax dollars are going, "there is little evidence that American voters are willing to sacrifice additional current income and consumption for investments in the future."[61]

Along the same lines, there has been a rise in neo-ludditism within the US.[62] Much of the population, buoyed by media fear mongering, are adopting a worrying attitude against innovation and new technologies. For example, large swathes of working class America are against automation. The general belief is that A.I and robotics could lead to mass unemployment. While it is true that many jobs will be displaced, only the very lowest skilled jobs will be automated. This will allow for large pieces of the US working force to be freed up to pursue further vocational training and education, thus raising the productivity of the workforce as a whole. However, few workers who stand to lose their jobs see these long term benefits of automation. In addition, there is an ongoing struggle between consumers and large companies over data. As A.I develops and gains prominence, the gathering and use of data becomes further and further incentivized. Many US citizens find large corporations, such as Google and Facebook for example, to be faceless machines bent on using consumer data for nefarious purposes. The truth is somewhere in the middle. The use of big data to create productivity and artificial

[61] Ibid.,
[62] Ibid.,

intelligence is crucial in order to push into the next generation of the information revolution. Yet, there have to be laws preventing companies from accessing data that is too sensitive or personal as there is an inherent profit motive to do so. Without these laws and assurances, the US is saddled with a worried population unwilling to embrace crucial advances in big data and A.I.

Another worrying trend is a rising xenophobia that could potentially derail the thriving innovation clusters within the US. As mentioned earlier, foreign immigration is a crucial pillar to the creation and growth of the US NIS. President Trump, however, has pushed an agenda to gut the US H1b system. This visa system allows high skilled foreign workers to immigrate to the US if sponsored by a company. This allows for an influx of talented workers who perform crucial roles within US technology companies and the economy as a whole. This agenda, along with a general turn of public opinion against immigrants, is resulting in foreign talent going elsewhere. "In recent months, foreign governments and tech industry leaders have sought to capitalize on the uncertainty in Silicon Valley."[63] Brad Duguid, the minister for economic development in Ontario said that, "while it's unfortunate that the US is looking more internally, far be it from us not to take advantage of that."[64] In fact, Canada has implemented a visa system similar to H1b that is far more inclusive and features blazing fast approval times. Wang Huiyao, founder of the Center for China and Globalization mentions that "China is shifting from attracting

[63] Semple, Kirk, and Ian Austen. "America's Competitors Angle for Silicon Valley's Business." The New York Times. August 02, 2017. Accessed December 04, 2017. https://www.nytimes.com/2017/08/02/world/trump-h1b-visa-silicon-valley-immigration.html

[64] Ibid.,

foreign capital to foreign talent, The US is losing out."[65] This is worrying for the future of US innovation policy as the ability to attract top quality talent remains an important pillar of building a competent NIS. With foreign talent, comes foreign capital, worldwide experience, and an affinity for global growth. President Trump's insular policies promise to renege on decades of growth that have established the US as a leading destination for foreign talent.

The FCC proposal to gut net neutrality is another worrying sign that the US NIS is trending away from progress. If passed, the absence of net neutrality would severely hamper the prospects of small businesses and entrepreneurs in America. With an increasingly difficult business environment, and an unforgiving immigration environment, there appear to be fewer and fewer incentives to foster businesses within the US. More importantly however, the repeal of net neutrality signals a larger disregard for the US NIS. The transmission of information and development of business practices, in any country, use the internet as a central conduit. The fact that the US is taking such a large step back on such a crucial pillar of its NIS signals an environment in which the US spirit of capitalism and profit motive might have failed. It is possible that the rent seeking behavior incentivized by US policy and culture has reached a point where it is harmful to the population as a whole. While the situation with net neutrality has not fully panned out, the very existence of this issue signals a darkly worrying turn for the US entrepreneurial spirit.

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[65] Ibid.,

Chapter 3: A Case Study of China's National Innovation System

China's Planned Economy

A useful case to examine alongside the US is the innovation system that China has employed during its period of economic growth. China's innovative growth has been exponential since its commitment to economic reform in the 1970s. The growth of Chinese industry since then has been significant. In four decades, China has succeeded in establishing itself as a manufacturing powerhouse that has created a massive trade surplus for itself. The result has been large scale economic progress and an increasing relevance in the global economy. In the late 1990s, innovation was identified as a key driver for Chinese development. The implementation of the National Middle to Long Term Plan For Science and Technology Development 2006-2020 (MLP) established innovation as a central goal for China. It explicitly states that becoming a leader in worldwide innovation is a key goal for the nation.[66]

China's approach to innovation policy can best be described as driven by top-down governmental selectivity. In sharp contrast to the US, China bases its growth strategy on *plans*. Everything is planned out, from the creation of innovation clusters to providing strategic tax benefits, the manner in which science and technology blossom is carefully curated. The adherence to such policy is influenced by the commanding and controlling nature of Chinese government to an extent. However, it is also partly

[66] Liu, Xielin, Sylvia Schwaag Serger, Ulrike Tagscherer, and Amber Y. Chang. "Beyond catch-up—can a new innovation policy help China overcome the middle income trap?" *Science and Public Policy* 44, no. 5 (2017): 656-69. doi:10.1093/scipol/scw092.

explained by the Chinese economy's need to 'catch up' with developed economies. When many of the roots of China's innovation policy were established, China was far behind world leaders in the pursuit of technology, foreign investment, and innovation. As a result, an efficient command economy was the proposed method of supercharging Chinese growth in order to compete on a global scale.

This command economy has been influential in transitioning China to a globally competitive middle income country. Beginning in the 1990s, the Chinese government focused on science and technology as "a necessary condition for turning investments in science and technology into successful products and services, for driving sustainable economic growth, and for providing solutions to societal challenges, such as pollution, resource scarcity, and an ageing population."[67] Innovation, as a result, was viewed as a fast track to global competitiveness for China. Between 2000 and 2014, Chinas R&D expenditure as a percentage of GDP increased from 0.83 percent to 2.04 percent, surpassing the EU average.[68] In 2012, China accounted for 20% of the world's R&D expenditure, trailing second behind only the US. [69] The distribution of these funds is extremely targeted. Under the MLP, China identified sixteen priority sectors that, according to Chinese leadership, were most in need of technological advancement. The vehicles that were chosen to spearhead these technological advancements were Chinese Government Research Institutes (GRI), as well as select national universities. Another government mechanism to spur innovation is the direct funding and preferential treatment

[67] Liu, Xielin, Sylvia Schwaag Serger, Ulrike Tagscherer, and Amber Y. Chang. "Beyond catch-up—can a new innovation policy help China overcome the middle income trap?" *Science and Public Policy* 44, no. 5 (2017): 656-69. doi:10.1093/scipol/scw092.
[68] Ibid.,
[69] Ibid.,

of Chinese State Owned Enterprises (SOE). These enterprises receive the majority of government funding that has been allocated to enterprise development since they represent priorities and goals that are central to the MLP. In addition, the government and a few GRIs, choose a yearly list of the "most innovative" Chinese companies. These are companies that align their goals with the Chinese government and show requisite net spend on R&D.[70] Making it onto this list is considered an accomplishment in itself since inclusion comes with substantial tax benefits and preferential treatment. In this way, China makes sure that the progress of technology continues to align with its long-term goals.

Drawbacks of a Planned Economy

The implementation of this top down economy has certain pitfalls that affect the continued development of China's NIS. An important argument here is that top down strategizing "will often lead to an emphasis on 'large-scale ... and numerical accomplishments, with a preference for grandiose plans', rather than changes in institutional or framework conditions."[71] Essentially, China will innovate in certain areas but fail to cultivate a sustainable organic innovative drive amongst smaller businesses and areas of industry not favored by the government. Another adverse effect of this policy is that the emphasis on R&D being conducted by GRIs and national universities results in poor industry-research institute collaboration systems. These GRIs, along with a few national universities, bear the most responsibility when it comes to research and development. As a result, the majority of innovation is accomplished in a theoretical or

[70] Ibid.,
[71] Ibid.,

scientific setting with little opportunity for practical industry output. Conversely, in the US, the majority of R&D is accomplished by private firms which allows for innovation to transmit into consumer and product markets much more efficiently. In fact, the ten Chinese institutions that hold the most patents in high tech industries are all GRIs or universities, not a single private firm is included.[72]

To further this analysis, it is prudent to inspect the differences between top-down innovation clusters and those that are organically created. Johansson and Ylinenpää find that the creation of RIS is rarely a linear process, and thus a linear and rigid plan for expansion is not ideal.[73] They go on to argue that governing bodies should act as facilitators, rather than planners, in order to allow market induced initiatives to take center stage. A large portion of the benefits of innovation clusters are the interactive learning processes that arise from bottom up growth. A planned RIS, often bypasses these crucial learning experiences and could result in unsustainable growth. A counter argument brought up is that central planning, as China has attempted, allows for prioritization of goals which could be beneficial in the long-term. This characteristic constitutes the most unique characteristic of the Chinese NIS. With the ability to target long-term goals, China can decisively and strategically innovate in a way that democracies find more difficult.

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[72] Ibid.,

[73] Rickne, Annika. *Innovation governance in an open economy: shaping regional nodes in a globalized world*. 2012. https://ebookcentral.proquest.com/lib/claremont/reader.action?docID=957209&ppg=223

It is possible that China's current model of economic development is losing validity and in order to compete, it must pivot its long term goals. A system that picks the winners through budget allocation is inherently vulnerable to corruption. In China, it is known that currying favor with government officials is more valuable to prominent scientists and researchers than actual innovation. In a similar way, SOEs which receive streams of funding are provided with little incentive to innovate. To innovate is to risk failure and to fail is to risk funding. In addition, metric based preferences towards the 'most innovative' companies create incentives that favor short term success rather than slow growth long term breakthroughs. These are just a few examples of backwards incentive structures that Chinas command model creates.[74] While a command economy of this nature may have been useful in bringing China forward to the fringes of innovative competitiveness, in order to close the gap between other large world players, China has to reevaluate its NIS and the incentive structures within.

Benefits of the Chinese Innovative Model

Yet, there are a lot of positives within the Chinese NIS that hold promise for future global competitive advantage. The first is the success of China's internet services industry. Alibaba and Tencent, for example, are world leaders in innovative and efficient internet products. This is largely because the internet industry was largely ignored in Chinas MLP. Since it was not subject to heavy scrutiny, regulation, and intervention, the internet industry was allowed to evolve and now competes with the best around the

[74] Liu, Xielin, Sylvia Schwaag Serger, Ulrike Tagscherer, and Amber Y. Chang. "Beyond catch-up—can a new innovation policy help China overcome the middle income trap?" *Science and Public Policy* 44, no. 5 (2017): 656-69. doi:10.1093/scipol/scw092.

world. Alibaba, the Chinese e-commerce giant, is now the world leader in the sector, having surpassed Amazon. As China's middle class grows, so does Alibaba, and that has propelled the company to double the value of its stock this year.[75] In many ways, Alibaba is a reflection of Chinas growing economic power as a function of its booming consumer demand. China has 560 million internet users that spend on average 20 hours a week on the internet; this is double the size of the US market. As a result, China's internet economy is filled with competition from small firms who can create businesses easily and without much fixed cost expenditure. This results in a vibrant and booming market that has direct access to a massive consumer market.

Tencent's WeChat is an example of Chinese internet innovation that has led to a nationwide culture of technological integration. WeChat, which started off as a messaging service, has evolved into much more. Today, it is a portal to an ecosystem of apps and services that reside *within* WeChat. Small time developers can make apps that reside within WeChat and thus, can reach a much larger audience than as a standalone service. Users can then set up payment details that allow them to transact with these apps and other service providers. Through WeChat payments, users can pay for everything from housekeeping services, to groceries, to dinner at a restaurant. In addition, the tagging of users to social media profiles in relation to businesses allows for productivity that seems alien to the western world. Since "WeChat official accounts are not limited to the content-constrained construct of a social network, they can deliver experiences that are more personalized, interactive, and ultimately have a higher chance of converting to a

[75] Bosa, Deirdre. "Alibaba vs Amazon: The race to $500 billion." CNBC. September 01, 2017. Accessed December 04, 2017. https://www.cnbc.com/2017/09/01/alibaba-vs-amazon-the-race-to-500-billion.html.

transaction."[76] Additionally, companies can create private communities housed within WeChat that "create reference training materials, document sharing tools, business request approval workflow processes, content management systems, frontline sales interfaces, and more. Even kindergarten schools become tech-savvy with such tools."[77] This level of integration between social identity, business, and community is largely unheard of in other developed countries.

As a result, China has taken a step forward in the integration of society and technology that speaks volumes about its future potential for innovation. With such a large, and accessible, user base that is receptive to advances in mobile technology, Chinese innovation has a strong base for future growth. Porter mentions that a receptive and demanding consumer base is imperative for continued innovation. If services such as WeChat and Alibaba have flourished as a result of a lack of top down directives, a Chinese economy that understands its strengths and pivots its national policy to take advantage of them could be very powerful. Breznitz and Mcmurphee argue that a large portion of China's innovation is not reliant on R&D; instead Chinese firms excel at adapting existing technologies to the Chinese market and leveraging the massive reserves of consumer demand available.[78] This component of Chinas NIS bodes well for future growth. As Porter mentions, the true innovative capacity of a country lies in its firms.

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[76] Chan, Connie. "When One App Rules Them All: The Case of WeChat and Mobile in China." Andreessen Horowitz. Accessed December 04, 2017. https://a16z.com/2015/08/06/wechat-china-mobile-first/.
[77] Ibid
[78] Liu, Xielin, Sylvia Schwaag Serger, Ulrike Tagscherer, and Amber Y. Chang. "Beyond catch-up—can a new innovation policy help China overcome the middle income trap?" *Science and Public Policy* 44, no. 5 (2017): 656-69. doi:10.1093/scipol/scw092.

Since China has large scale productive firms that excel at innovating within China, the productivity increases that China could see in the future are set to be significant.

Cultural and Policy Shifts

In fact, China has already seen major changes in its innovative culture that has begun to challenge US innovative hegemony. There are indications that China and its booming population are outgrowing the strict control of the planned economy. The Chinese entrepreneurial hub of Shenzhen is an example of an organically forming innovation cluster. Since 1980, Shenzhen's real GDP has grown at an average rate of 22% while its R&D spending has grown to 4% of GDP. This is double the average of the rest of China.[79] The exponential growth of Shenzhen came largely from the bottom up. Early reformers who settled in Shenzhen "pushed ahead with unauthorized investment deals with non-mainland companies and retroactively developed the legal framework needed to protect foreign firms."[80] As these endeavors came to fruition, "grassroots innovators hit on better ways of doing things, even though strictly speaking they were not permitted."[81] When these risks proved successful, Chinese government leaders happily took credit for the innovative boom that resulted and accepted their transgressions. These actions set the stage for China's grassroots entrepreneurial activity that is proving to be very successful.

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[79] "Shenzhen is a hothouse of innovation." The Economist. April 08, 2017. Accessed December 04, 2017. https://www.economist.com/news/special-report/21720076-copycats-are-out-innovators-are-shenzhen-hothouse-innovation.
[80] Ibid.,
[81] Ibid.,

Shenzhen's startup scene is a prominent example of relaxing government innovation policy that has trickled down to entrepreneurs, business owners, and consumers. "Between 2014 and 2016, China attracted $77 billion in venture capital investment, compared with just $12 billion in the preceding two years."[82] This veritable startup boom signals a government policy shift that understands the value of grassroots innovation as a crucial component of global competition. Chinese banking regulatory bodies turned a blind eye as Tencent and Alibaba developed Payments and Alipay respectively, allowing hordes of Chinese consumers to progress towards a cashless society. Another Shenzhen-based company, Da Jiang Innovations, is the undisputed global leader in commercial drone technology, and is one of the first Chinese startups to veritably conquer the US market. The innovation boom in Shenzhen, as a result, is an indication of the potential that China has for large-scale entrepreneurship. It is entirely possible then, that this wave of innovation signals the creation of China's own bottom up innovation system to rival the US.

In fact, there is evidence that a changing attitude exists towards innovation policy amongst government elites. In 2015, the Central Committee of Communist Party issued a document entitled "Decisions on deepening the institutional and mechanism reform, to accelerate the implementation of innovation-driven development strategy."[83] The document details the government's plan to attempt to distinguish the role of the

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[82] Chandler, Clay. "Why China Is Emerging as a Tech Superpower to Rival the U.S." Fortune. Accessed December 04, 2017. http://fortune.com/2017/11/21/china-innovation-dji/.

[83] Liu, Xielin, Sylvia Schwaag Serger, Ulrike Tagscherer, and Amber Y. Chang. "Beyond catch-up—can a new innovation policy help China overcome the middle income trap?" *Science and Public Policy* 44, no. 5 (2017): 656-69. doi:10.1093/scipol/scw092.

government and the private sector. Many of the policies outlined are aimed at addressing the largest market failures that currently stand in the way of Chinese innovation. These include, fostering transmission networks between industry and academia, promoting entrepreneurship across the entirety of the Chinese population, and accepting input from the private sector in government policy.[84] These policy goals show that China understands its shortcomings and the potential drawbacks of its economic system. It also shows a commitment from elites to address and improve on the current state of its NIS. If these policies emerge to be effective, and the early indicators suggest that they will be, China could be on its way to setting the stage for the accelerated growth of a bottom up NIS similar to that in the US. This system, if developed to fruition, would have significant advantages over its US counterpart, as it would have similar methods of knowledge dissemination and innovative flow, while being carefully nurtured and funded by the government.

An important future challenge will be for Chinese firms to expand their operations globally. Since China has such an enormous domestic consumer base, large Chinese firms have expanded globally less than their foreign competitors. The specific niche character and pure size of the Chinese market also makes it difficult for Chinese firms to find widespread success internationally. This is being challenged by a few successful Chinese companies, however, that look to be operating at the forefront of global innovation. Huawei, for example, brings in more revenue abroad than from within China. Its strategy has been to pour a huge amount of money into R&D in order to compete with entrenched companies in the telecom space such as Samsung and Google. Huawei is

[84] Ibid.,

heavily favored by the Chinese government and the administration supports its endeavors. This, however, has actually led to negative consequences associated with international perception of the Chinese government. To many consumers abroad, and especially in the US, Huawei represents an arm of the Chinese government, and carries the stigma associated with it.[85] This is further proof that Chinese companies are on the right track to push the envelope in global markets, but must escape from under the veil of the government. In the US, competition amongst MNCs leads to innovations on a global scale and positive knowledge-related externalities. However, in China, this competition is stifled amongst high-performing MNCs in order to benefit the current winners. These vices mean that Chinese firms will have a difficult time matching the rate of internationalization accomplished by their US counterparts.

A Comparison with Japan

An important comparison to address is the similarities between China's current economic boom and Japan's progress in the 1980s. While they are similar in the sense that both countries burst onto the international scene with innovative growth that took entrenched players by surprise, China is unlikely to face a decline similar to the one that threw Japan into years of stagnation. Firstly, China's cultural attitudes towards innovation are far more conducive to growth. Where Japan fostered a culture that was afraid of failure, Chinese entrepreneurs have a strong intrinsic propensity to take risks. George Yip, a professor at Imperial College, emphasizes that "the Chinese aren't afraid

[85] Volodzko, David. "How 'Made in China' Became a Stigma." The Diplomat. July 16, 2015. Accessed December 04, 2017. https://thediplomat.com/2015/07/how-made-in-china-became-a-stigma/.

of making mistakes and their willingness to take risks is what's driving many new initiatives."[86] Additionally, at the time of Japan's economic growth, it was at a different stage of development than China is now. In the 1980s, Japan was already wealthy and boasted a high per capita GDP. China, on the other hand, is still very much a middle income country as a result of its massive population, and therefore has a lot of room to grow.[87] China's burgeoning middle class proves that there is a significant amount of economic productivity to be captured, and that the country is nowhere near its production possibility frontier. As a result, China is unlikely to find itself hitting a wall as Japan did.

[86] Singleton, Laura. "Risk taking and creativity are boosting China's economy says Imperial academic." Imperial College London. June 03, 2016. Accessed December 04, 2017. http://www3.imperial.ac.uk/newsandeventspggrp/imperialcollege/newssummary/news_3-6-2016-15-46-43.

[87] Yao, Aidan. "China isn't about to have a Japan-style lost decade." South China Morning Post. August 30, 2017. Accessed December 04, 2017. http://www.scmp.com/business/article/2108821/china-isnt-about-have-japan-style-lost-decade.

Chapter 4: Comparing and Contrasting the American and Chinese National Innovation Systems

Porter's framework of competitive advantage provides a useful tool to further analyze the balance of power between China and the US. Going through Porter's four determinants of competitiveness, this paper will attempt to identify which country has the upper hand now, and which likely will in the future:

1. **Factor Conditions:** The US has a current advantage in terms of factor conditions solely because of its stellar innovation clusters and knowledge dissemination devices. US universities are world leaders and their relationships with industry are fostered by the US capitalist spirit. In addition, the bottom-up growth of many of these clusters works to foster and disseminate innovation far better than their Chinese equivalents. While the US has an advantage now, the fact that China has a targeted plan to nurture and create innovation clusters means that sheer volume and expenditure could, in the future, eclipse a US system that doesn't seem to have much focus on innovation policy.
2. **Demand Conditions:** Here, China has a significant advantage. A growing consumer base, and a society that is willing and able to adopt technology, means that innovation coming out of China will be adopted at greater rates. As mentioned above, the rate at which actors within a country *adopt* new innovative processes is the rate at which innovation has a direct impact on output. In this regard, the Chinese economy is better set up to adopt and adapt new efficient processes. The US does have an advantage in that it is a more developed

economy, so consumers will demand products that are closer to the innovation frontier than in China. This is an important factor, and provides the US a current competitive advantage. However, if China proceeds as it has over the past few decades, this balance of power could change. Conversely, the cultural and attitude-based factors mentioned above are deeply entrenched and unlikely to change significantly.

3. **Related and Supporting Industries:** Here, the US has a current advantage as well. Porter argues that the extent to which a firm's supply chain and supporting industries are innovators, creates an innovation-multiplier effect of sorts. The quality of small businesses and suppliers in the US is high because of strong competition. Using the smartphone industry as an example, many parts of Apple's new iPhone X are sourced from innovative businesses within the US. Lumentum, a supplier of 3D sensors, has a $3.5 billion market capitalization, and is at the forefront of its industry. Its chips have been incorporated into the new iPhone. Other leading companies in the fields of touchscreens, flash memory, and micro-optics are also based in the US. As a result in 2012, Huawei, China's most innovative smartphone maker, sourced a large portion of its processing chips and other components from Broadcom, Qualcomm, and Avago technologies, three California-based companies.[88] The fact that these companies are based not only in the US, but in California, where Apple is headquartered, allows Apple to have

[88] Walsh, Larry. "Huawei Spends $6B with U.S. Suppliers." Http://www.channelnomics.com. September 12, 2014. Accessed December 04, 2017. https://www.channelnomics.com/channelnomics-us/news/2365735/huawei-spends-usd6b-with-us-suppliers.

input in the creation and innovation of the products that they incorporate into their phones. This network is incredibly valuable, and lends the US a competitive advantage. Huawei has since attempted to remove itself from a dependency on foreign suppliers, and has largely succeeded. Today, Huawei makes its own chips and develops many of its smartphone components internally, signaling that Chinese companies are trending towards capitalizing on the large-scale economic and innovative changes within China. Additionally, another area in which China has an advantage is manufacturing. The efficiency and price at which China can manufacture goods means that firms can work far closer to their supply chain and, as a result, out-compete foreign goods that might be made in China as well.

4. **Firm Strategy, Structure, and Rivalry:** This determinant of competitiveness is won hands-down by the US. As mentioned earlier, when it comes to incentive structures and cultures of work and competition, the US excels. In addition, the multitude of successful MNCs in the US, and the inherent competition among them, creates an environment of competition that keeps US companies at the forefront of worldwide innovation. Chinese innovative deregulation has been effective for small-scale entrepreneurship, but there is still a heavy-handed governmental approach to the best of the best. The logic behind this is that, if a private company were to get too large on their own, they could pose a threat to the government. As a result, all of China's heavy-hitting corporations are helped to their perch, at least in part, by the government. This paradigm seems unlikely to shift and could pose long-term problems for Chinese competitiveness at the elite forefront of technology.

Observations and Predictions

In many ways, the national innovation systems of the US and China are polar opposites. The US has a strong entrepreneurial spirit, level playing field, and incentive structures that foster innovation. Yet the US lacks the directive and motivation from the government to maintain and foster its capabilities. China, on the other hand, has all the directive and top-down government planning, but, as a result, has created poor incentive structures, poor market demand transmission methods, and an unequal playing field. US consumers are wary of technological advancements, while Chinese consumers are far more receptive to the use of their data and the economic and social integration of technology. This stark difference represents a larger ideological difference in the two countries. In the scale of the world economy, China operates with the biggest surplus, while the US has the biggest deficit. China makes, while the US consumes; China is driven by its institutions, while the US is driven by its consumers. Similarly, US democratic and capitalist values are deemed inefficient by Chinese authorities, who stamp an authoritative command over Chinese institutions and citizens. Their respective innovation systems, as a result, represent two ends of a spectrum with regard to competitive advantage.

Important to note is that the US is trending downward, while China is trending upward. As of now, it is safe to say that the innovation system fostered by the US is the worldwide gold standard. The presence of Silicon Valley, the quality of research institutions and universities, and the sheer power of US-based MNCs is evidence to that. As of now, middle income countries look to the US as an example of a successful

innovation system. However, the polarized political climate, increasing insularity, neo-ludditism of the populace and diminishing entrepreneurial output signal a decline in the efficacy of the US NIS. China, on the other hand, addresses many of the problems in the US system, such as a lack of directive, investment, and political gridlock. While this creates its own set of problems for China, as discussed extensively above, it is clear that China is on its way upward in innovation development and policy. It is not perfect, nor is it ideal, but China has made leaps and bounds over the last three decades and has reduced a gaping margin to a much less prominent innovative gap. China still has its work cut out for it. In approaching the next few decades, China will have to work to avoid the middle income trap, which would result from the increasing invalidation of current institutions and frameworks, as well as diminishing marginal returns to government investment.

While not perfect, Porter's framework allows for a few conclusions to be drawn about the current and future state of global competitive innovation. While the US is currently in the lead, the heavily-planned nature Chinese economy, along with the governments' concrete plan to continue to emphasize innovation, means that China could make considerable progress over the next few decades. For this reason, and the Chinese markets' willingness to adopt technology, China is a far more versatile innovator with a higher innovative ceiling.

Chapter 5: A Case Study of India and the European Union

Catching-Up Economies

As far as successful systems of innovation go, the strongly contrasting nature of China and the US create a useful framework for understanding the visions and potential of other economies that are in 'catch up' mode. In many ways, every economy is in a state of perennially catching up relative to the US. The question then becomes whether the US is doing enough to maintain its lead. This paper will go on to place other nations and their systems of innovation within a scale that has organically growing industries and democratic capitalism at one end, and a carefully planned command economy at the other. It will then attempt to prognosticate where some of these economies may succeed or fail relative to the two aforementioned heavy hitters of worldwide innovation.

There are certain pitfalls that catching-up economies may be prone to in the pursuit of innovation. First, it is tempting for these economies to imitate policy and innovation clusters from countries that may be already successful in the area. "A consequence is that variations in national characteristics between countries are often not taken into account."[89] These national characteristics are the root determinants of carving out competitive advantages in a globalized economy. In addition, with the increasing internationalization of MNCs, competing directly with more powerful economies is extremely difficult, as any innovation can be easily replicated, bought, or muscled out of the market by a more powerful competitor. The key, then, is to create a competitive

[89] Varblane, Urmas, David Dyker, and Dorel Tamm. "How to Improve the National Innovation Systems of Catching-Up Economies." *Trames*. http://www.kirj.ee/public/trames/trames-2007-2-2.pdf.

advantage based on factors that are indigenous and unique to each nation. Important in the creation of this advantage is to base the development of national policy on these unique qualities.

Yet, strategies that imitate and emulate the success of leading countries can be successful if paired with sound long-term policy. Reinert argues that for a nation to successfully achieve higher economic status within the world order, it *must* emulate others in order to develop a comparative advantage. Important in this theory is that the timing of the switch from emulation to competitive advantage is the biggest determinant in the success of a nation. [90] Without emulation, the asymmetry in knowledge and technology is almost insurmountable. Emulation allows catching-up economies to insert themselves at a stage of technological production that is sustainable according to their specific NIS. They can then innovate from that point onwards and develop their economy, institutions, and policy accordingly. Reinert argues that some level of protectionism is important in the infant stage of technological development in order to allow industry to blossom. Continuing along this vein of thought, if one were to assume the capitalistic nature of world economic competition, then the development of innovation is a rent-seeking behavior. The natural course of any rent-seeking behavior is to first capture the economic surplus granted by innovation, to have that surplus chipped away and diluted by imitators, and eventually, for the space to be innovated on once again.[91] If this is the lifecycle of growth, then it follows that emulation is indeed

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[90] Reinert, Erik S. "Emulation versus Comparative Advantage: Competing and Complementary Principles in the History of Economic Policy." *Industrial Policy and Development*, 2009, 79-106. doi:10.1093/acprof:oso/9780199235261.003.0004.
[91] Ibid.,

imperative in order to innovate on the current status quo. In fact, for many years China was considered a cheap copycat of US technologies. Only recently has it developed a fertile innovative landscape of its own. That would not have been possible without years of infrastructure growth that followed emulation. For catching-up economies, as a result, a balancing of emulation with the development of effective long-term strategies is crucial in the pursuit of international competitiveness.

A Case Study of India's NIS

An analysis of the Indian national innovation system is useful because it blends aspects of the American and Chinese approach. The very fact that India is the largest democracy in the world means that it combines the democratic institutions and regulations of the US, with the booming population and growth potential of China. India's large and diverse population lends it a unique position in the world economy. With such a diversity of skill and thought India has the potential to compete on a global level, but must resolve fundamental institutional and cultural obstacles.

A major determinant in the trajectory of India's growth is the fact that it was slower than China in opening itself up to foreign direct investment and, as a result, did not receive the same magnitude of foreign knowledge and technology transfer. China opened its borders to FDI more than ten years before India did. China thus was able to harness the power of its massive workforce in relation to foreign investors far better than India did. This resulted in a snowball effect that saw Chinese manufacturing and technology transfer skyrocket, while India lagged behind. In addition, there are better transportation networks and less red tape in China, which means that, from the

perspective of a foreign firm, China is a far safer investment.[92] Given the technology transfer, China was able to make the all-important switch from emulation to competitive advantage earlier than India. A large part of this can be attributed to government structure, as China was able to liberalize its trade barriers and pivot the course of its economy when it needed to. It follows that there are a few institutional factors at play that affect India's ability to compete relative to China.

One of the major factors that stands in the way of Indian growth is the widespread proliferation and normalization of corruption. "Indian politicians and bureaucrats enjoy high discretionary powers" and there therefore exists an incentive to take away independent power from "entities that are not inherently dependent on the government for their existence."[93] This leads to massive market failure, since those organizations that are willing and able to take illegal paths to success, such as bribery and preferential treatments, have an inherent advantage. Bureaucrats also have an incentive to favor the organizations and companies that line their pockets rather those that perform the best. This political atmosphere is not conducive to innovation. The hallmark of the US innovation system is its level playing field that allows free market forces to pick winners. This is the biggest benefit of a democracy and capitalist system in relation to innovation. Indian corruption thus circumvents one of the key benefits of the political system with bribery and kickback schemes. This factor, as well as India's inferior efficiency in

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[92] Dahlman, Carl J. "Growth and Development in China and India: The Role of Industrial and Innovation Policy in Rapid Catch-Up." *Industrial Policy and Development*, 2009, 303-35. doi:10.1093/acprof:oso/9780199235261.003.0012.

[93] Shah, Rajiv, Zhijie Gao, and Harini Mittal. *Innovation, entrepreneurship, and the economy in the US, China, and India* .

relation to China, means that India is not taking full advantage of the innovative benefits of its political system and population.

India's Competitive Advantage

However, India has managed to carve out a niche for itself in the global information economy, with its effective knowledge-intensive service sector. Controversially, Jawaharlal Nehru, during his critical reign as the first Prime Minister of India, established a system of education focused on the elite. He set up the seven elite Indian Institutes of Technology in order to set the stage for a generation of high-powered individuals capable of leading Indian technology.[94] These were eventually the basis of the equally elite Indian Institutes of Management and several analogous institutions across the country. The controversy arose from the fact that he largely neglected basic mass education. This has resulted in massive inequality in India, and a working and rural poor whose levels of education are very poor. Conversely however, India is also producing world class engineering, business, and technical talent that can speak English. This has established India as a hub for knowledge-intensive activities. It has pivoted itself to serve as a backbone of worldwide internet technology service. In a globalizing economy, India's next challenge is to harness its considerably talented internet-enabled workforce to support indigenous Indian innovation, and transition away from providing support services to foreign MNCs. In many ways, India's current IT power is emulative to foreign

[94] Dahlman, Carl J. "Growth and Development in China and India: The Role of Industrial and Innovation Policy in Rapid Catch-Up." *Industrial Policy and Development*, 2009, 303-35. doi:10.1093/acprof:oso/9780199235261.003.0012.

capabilities. The time is ripe for India to transition this significant resource into a bona-fide global competitive advantage.

There has been a concerted government effort to promote indigenous innovation, but its effects are unclear. Prime Minister Modi has established that his overarching policy regarding the private sector is to remain hands off. However, there have been a number of initiatives under him to promote Indian startup activity. Digital India, for example, specifically targets transitioning Indian productivity to a more knowledge-intensive nature. The large-scale goals are to provide internet access and mobile connectivity to all Indian citizens as well as to spark the digitization of many public infrastructures. For instance, the initiative plans to create platforms that encourage online political engagement, online signature authentication, and publicly available Wi-Fi hotspots. Theoretically, this initiative is estimated to provide a 20-30% increase to India's GDP by 2025.[95] This directive was legitimized by the large-scale demonetization program that India implemented in 2016. The program, which deemed a large portion of India's currency in circulation invalid, was proposed to attempt to transition the country to a cashless society as well as reduce the amount of "dirty money" in circulation. Early results seem generally positive, as there has been a 33% increase in the volume of digital transactions initiated. While there was, and still is, widespread discontent with the massive upheaval and damning effect on India's rural poor, demonetization and Digital India are steps in the right direction towards the formalization of the Indian economy, a key step if it is to further compete on an international level.

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[95] "Digital India: Unlocking the Trillion Dollar Industry." Deloitte. https://www2.deloitte.com/content/dam/Deloitte/in/Documents/technology-media-telecommunications/in-tmt-digital-india-unlock-opportunity-noexp.pdf.

Lofty Goals

These initiatives, while they have lofty and admirable goals, have drawn criticism for their lack of concrete results. For example, part of the government's new Startup India directive is to introduce tax breaks for small growing businesses for the first five years of their life. Padmaja Ruparel, President of Indian Angel Network, counters that "since very few companies churn out profits in the first few years, it is debatable how positive present tax reforms could be."[96] In addition, startups have to go through an application process in order to gain startup status and be eligible for tax benefits. In the first six months of Startup India's life, only 10 out of two hundred and eight startups were accepted.[97] This is largely symbolic of Indian business policy, which erects unnecessary political barriers to economic activity. In addition, surface-level policies like Digital India are unlikely to have an impact unless they are accompanied by significant institutional and cultural shifts. In the Indian innovation system, a systemic "challenge is the shortage or absence of support mechanisms, including research funds, venture capital funds and start-up capital."[98] In addition, there are relatively poor links between university systems and industry, as the prevailing culture among research institutes in India is that research for

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[96] Thomas, Anu. "Startup India: Policies abound but limited impact on ground." The Economic Times. March 08, 2017. Accessed December 04, 2017. https://economictimes.indiatimes.com/small-biz/policy-trends/startup-india-lots-of-policies-and-not-much-evidence-its-helpful/articleshow/57529755.cms.

[97] "After lukewarm results, Startup India policy set to be revamped." Moneycontrol. Accessed December 04, 2017. http://www.moneycontrol.com/news/business/startup/after-lukewarm-results-startup-india-policy-set-to-be-revamped-2273429.html.

[98] Sharma, Pankaj, Srinivasa B. S. Nookala, and Anubhav Sharma. "Indias National and Regional Innovation Systems: Challenges, Opportunities and Recommendations for Policy Makers." *Industry & Innovation* 19, no. 6 (2012): 517-37. doi:10.1080/13662716.2012.718878.

research's sake is the most noble of academic pursuits. These issues are systemic, and fundamental to the national innovation system. Surface-level initiatives like Digital India, while steps in the right direction, will not be nearly as effective as they could be if deeper institutional issues were to be addressed.

A Comparison with China

Analyzing the growth and development of India's economy and NIS is valuable, as it represents many of the free market characteristics of the US and applies them to a catching-up economy closer in development to China. Returning to Reinert's hypothesis, the two main stages of development that propel an economy to global competitiveness are emulation, followed by competitive advantage. The development of China and India is similar in that both economies were able to emulate certain aspects of knowledge economy successes. China played the imitation game and welcomed the foreign direct investment that was attracted by cheap labor conditions. India also liberalized its trade policies and began to develop a key strength in knowledge-related services. The key difference is that China was able to adapt its position in the world economy with its growing advantages, and eventually pivoted to create a comparative advantage now embodied by a relentlessly-targeted entrepreneurial spirit and receptive consumer base. India, however, has remained on the cusp of developing a competitive advantage in IT services, but government policies and shaky institutions have not established a strong enough NIS to take the next step that China did. This is the fundamental benefit that China's planned economy offers. It allows a country to nurture

and capitalize on competitive advantages in a way that a democracy would find it much more difficult to.

A Case Study of the EU's Innovation System

In this analysis of innovation systems, it is important to keep in mind that innovation systems do not necessarily have to be delineated by national boundaries. In most cases however, differences in institutional frameworks, long term goals, and economic policy mean that national boundaries do indeed separate national innovation systems. The European Union is a prominent example in which that is not the case. The nature of consolidation, monetary union, and an intermingling of fortunes mean that knowledge flows and institutional policy within the EU have the potential to be far stronger than anywhere else in the world. As a result, the EU consists of two different levels of innovation systems. On one level, there are the institutions and policies that make up each country's NIS, as has been discussed earlier. However, there is another larger innovation system that connects all the members of the European Union. This innovation system is unique as it attempts to balance the specifics of each economy with the goals of the EU as a whole.

Benefits from Economic Integration

There are certain advantages that countries stand to gain from the integration of monetary, immigration and economic systems. Lundvall, in his development of the NIS framework, identifies that innovation "may be seen as an intricate interplay between micro and macro phenomena where macro-structures condition micro-dynamics and vice

versa new macro-structures are shaped by micro-processes."[99] In the case of national integration, as in the EU, these micro and macro processes interact in different ways. Where a standalone economy may interact with its own NIS, that of its trade partners, and that of the world economy as a whole, in the EU there is an added layer of cohesion that supersedes other external innovation systems. As Lundvall mentions, this creates incentive structures and behaviors that are unique to such a system. One of the biggest advantages that EU members enjoy are open borders, which allow human capital to flow between countries without immigration related problems. This greatly expands the pool of talent available to European firms. For example, engineering talent may flock to Germany while financial talent may move towards Switzerland. This constant flux of workers, researchers, and citizens means that knowledge transfers within the EU can happen much quicker than elsewhere. Innovations, and the productive efficiency they bring, will spillover far quicker in a consolidated innovation system of this sort.

Monetary integration is another characteristic of the EU that has generally positive effects on the innovation system. The advantage to individual nations within the EU is that they are relatively immune to currency speculation. As a result, there are no exchange rate imbalances within the EU itself; this allows ideas, businesses and human capital to move across borders far easier. It gives smaller economies the kind of monetary security that only established economies generally enjoy. Smaller economies, as well as small businesses, are more likely to be able to secure funding as the Euro affords a certain credibility to countries that use it. Foreign investors are more likely to invest in a

[99] Lundvall, Bengt-Åke. "National Innovation Systems—Analytical Concept and Development Tool." *Industry & Innovation* 14, no. 1 (2007): 95-119. doi:10.1080/13662710601130863.

country that has a stable currency backed by strong and legitimate institutions. In addition, MNCs in Europe can spread out across different countries without worrying about exchange rates and currency regulations affecting their ability to do business. These advantages share a common theme. In the EU, the movement of capital and knowledge across borders is lubricated, which allows for the creation of effective and specialized innovation clusters. An important caveat here is that, with currency integration comes a significant risk multiplier. If one country within the Euro were to fail, or if the European Central Bank were to falter, the stability of the entire region comes into question. This increases the risk of economic contamination.

The Innovative Capacity of the EU

In order to analyze the innovative capacity of the EU, it is crucial to first understand the makeup and distribution of innovative capabilities. The EU has quite a diverse group of member states. The scale extends from those whose innovative capabilities are globally competitive on their own, such as Germany and France, and those whose innovative capabilities are lacking and rely on EU knowledge transfers to boost efficiency. These countries are generally the ones that are struggling economically and do not have the surplus to spend on innovation policy. These countries, such as Greece and Portugal, show economic growth levels of 1-2% and as a result are not seeing improvements in their production frontiers. Many of these problems are systemic. For example, education systems in Portugal are rigid and poorly equipped to adapt to a knowledge economy. “David Vaughn, head of the OECD’s Portugal desk, agreed that education shortcomings … were one reason why Portugal has been unable to adapt

quickly when traditional industries such as textiles ran into stiff competition from Eastern Europe, China, and North Africa."[100] It is worrying for the future of the EU that Italy and Spain look to be falling into similar periods of economic stagnation. As a result, targeted innovation policy that looks to address these systemic issues is necessary in order to ensure the long term success of the EU.

Innovative Shortcomings

A result of this disparity in economic and innovative ability is an incongruous innovative landscape that prevents the EU from reaping the benefits of economies of scale. An important lubricant to innovative growth is venture capital and risk-loving credit markets. "While European venture has come on leaps and bounds, it remains a "smaller round, smaller exit" market."[101] This means that the exit strategies for startups are far more limited than in the US. In fact, between 2012 and 2016, Europe had 22 startups achieve exits of $250 million or more while the US had 166.[102] This is a significant disparity, and signals structural issues in the European venture market. Essentially, this means that after a startup has invested in R&D, achieved a technological breakthrough, and brought its product to market, the value it provides to the market is fundamentally less than for the same technology in the US. This may be the result of a

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[100] Wheatley, Alan, and Global Economics Correspondent. "Analysis: Euro zone strugglers lack innovative knack." Reuters. February 06, 2012. Accessed December 04, 2017. https://www.reuters.com/article/us-eurozone-economy-innovation/analysis-euro-zone-strugglers-lack-innovative-knack-idUSTRE8150KL20120206.

[101] Basta, Victor. "Venture investing in the US and Europe are totally different industries." TechCrunch. June 07, 2017. Accessed December 04, 2017. https://techcrunch.com/2017/06/07/venture-investing-in-the-us-and-europe-are-totally-different-industries/.

[102] Ibid.,

smaller market, increased regulatory issues or cultures of mediocrity in public markets. TechCrunch predicts that without specific policy shifts it could take 20-30 years for the venture market to mature to US levels. Another potential cause of this phenomenon is the fact that even though "Europe has deep engineering talent, many big startups focus on business model innovation in areas such as media, retail, and gaming rather than on breakthrough technology developments that can usher in new industries."[103] This is largely because regulations regarding high growth industries such as cryptocurrency, self-driving cars, and drones are varied across Europe. As a result, it is much more difficult for entrepreneurs to bring their products to market and guarantee growth to their capital providers. If the EU is to achieve economies of scale, a crucial aspect in competitive advantage, it is imperative that it brings these barriers down.

Proposed Solutions

Current EU economic and innovative goals signify that European leadership is aware of these shortcomings and are working towards solutions. The EU has targeted innovative integration, and an emphasis on high-growth industries in an innovation strategy directive established in 2010. This plan, called Europe 2020, is the European Commission's strategy for growth, job creation, and global competitiveness. In fact, it specifically mentions that this strategy "specifically arise[s] from the belief that Europe's

[103] Auchard, Eric. "Does Europe Have What It Takes to Create the Next Google?" US News. https://www.usnews.com/news/technology/articles/2017-11-30/does-europe-have-what-it-takes-to-create-the-next-google.

future is connected to its power to innovate."[104] The plan targets that 3% of Europe's GDP across the public and private sector will be invested into R&D by the year 2020.

The initiative, known as the Innovation Union (IU), plans to develop a framework for institutionalized knowledge transfer and innovative activity. This includes measures to complete the European Research Area, an early 2000s initiative to remove obstacles barring the movement of researchers and academics in Europe. The IU hopes to comprehensively cut all red tape surrounding the movement of knowledge and knowledge workers between European research institutions. The IU also hopes to use public procurement budgets to finance innovation, create a sophisticated innovation metric, and to institute a European knowledge market for patents.[105] The Innovation Union is also focused on removing regulatory bottlenecks that impede the flow of capital and knowledge between countries. Importantly, it is clear that the European Commission hopes that these directives will foster the growth of small businesses that play a large role as drivers of innovation. Complementary to this initiative is the implementation of Horizon 2020, the IUs financial framework. With a budget of €80 billion, Horizon 2020

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[104] De Oliveira, Teresa. "Fact Sheet: Europe and India Innovation Landscapes." Indigo Policy. https://indigoprojects.eu/object/document/234/attach/Fact_sheet_Europe_and_India_Innovation_landscapesPolicies_Framework_and_Programmes.pdf.

[105] "Key initiatives." Key initiatives - Innovation Union - European Commission. Accessed December 04, 2017. http://ec.europa.eu/research/innovation-union/index_en.cfm?pg=key.

is focused on providing the financial muscle to foster R&D, support small businesses, and create a pool of capital for European innovation markets. [106]

These initiatives are targeted and salient, signifying that the EU is prioritizing innovation and knowledge as key factors in its bid for global competitiveness. The initiatives listed above carefully target many of the most pressing structural flaws within the EU's innovation system. As a result, it is clear that with this solid goal, the EU is taking steps in the right direction. This level of targeted action is similar to that of China's 2015 document that outlined its desire to allow markets to influence innovation. Similar to that document, Europe 2020 is a clearheaded and salient plan that looks to pivot European economic policy into the 21st century. The difference, however, is that China has much more of a grip over its economy than the European Union has over its member states. Top down directives of this sort are useful, but if constituent actors do not latch on to them, then these policy changes might not be as effective as hoped. The question then arises as to whether or not these lofty goals are achievable, and whether or not progress so far lends itself to validate the legitimacy of Europe 2020.

Results of Europe 2020

With less than 3 years to go to reach its targets, the vision of Europe 2020 has quite a distance to go. As of 2016, according to research done by the European Investment Bank (EIB), Europe would need to "spend an additional €130 billion a year to

[106] Puslecki, Zdzislaw. "Innovations in the Strategy of the European Union's Economic Growth." http://pressto.amu.edu.pl/index.php/pp/article/viewFile/1701/4076.

meet the EU's target of spending 3% of GDP on R&D."[107] It will need an additional €90 billion to keep up with advanced technologies, €10 billion to close the education quality gap with the US and €65 billion to reach EU targets for broadband, data center capacity and cyber-security.[108] These are daunting numbers but lofty goals are crucial if Europe is to challenge itself to rise as a world leader.

The EU's Competitive Advantage

In order to achieve these goals Europe must focus on developing its own competitive advantage. As has been explored earlier, the development of a competitive advantage after a period of emulation is essential in the establishment of a successful innovation system. Europe's competitive advantage, with respect to its innovation system, is the diversity of skill and thought that it has within it. In addition, the EU is in the unique position that it has a group of functioning democracies held together by an able governing body. As a result, Europe already has the infrastructure of organically grown, bottom-up innovation clusters. Germany, with regards to engineering and automotive manufacturing, or France's institutes of higher learning, constitute world class innovation clusters that could grow even further if nurtured with targeted EU policy. As a result, the EU has a unique mix of the US and Chinas polar opposite innovation systems. Now, being able to institute top down directives when there are a host of constituent countries who have opinions and stakes in the matter is not easy. The extent

[107] Hoyer, Werner. "Europe is lagging the US in innovation, but that's about to change." Quartz. January 20, 2016. Accessed December 04, 2017. https://qz.com/597791/europe-is-lagging-the-us-in-innovation-but-thats-about-to-change/.
[108] Ibid.,

to which the EU can balance the desires and specificities of its constituents, with targeted and driven policy will ultimately determine the success of the EU on a global level.

Critics view Europe 2020 and Horizon 2020 as largely successful as they have lent a focus to economic development in Europe. Some of the successes that the EU has seen include, the EIB having successfully created a fund that specifically mitigates risk for investment in small businesses, thus creating a market for venture capitalists. European startups, such as Spotify, have begun to penetrate the world stage successfully. It seems that the EU is crawling out of the depths of the financial crisis with a focused vision of its future. Many are already looking past 2020 and forecasting how the EU should approach the next ten years. It seems that consensus is that while "Horizon 2020 is like a flashlight spreading an average light over a wide area. The successor of the programme should be mission-oriented even further with funding closely-linked to fewer but bigger goals."[109] The EU, it seems, is focused on slowly narrowing their focus until they can develop a functioning innovation system that can rival the US and China. In attempting to close this innovative gap, it is telling that there are no European companies in the tech space at the same level as Facebook, Google, Tencent, or Huawei. The success of Europe 2020, and the EU over the next 20 years, could well be indicated by whether it can foster an innovative environment that results in the creation of similar world leading MNCs.

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[109] Novakov, Andrey. "Beyond Horizon 2020: Europe's winning streak of innovation and research ambition." EURACTIV.com. November 29, 2017. Accessed December 04, 2017. https://www.euractiv.com/section/economy-jobs/opinion/beyond-horizon-2020-europes-winning-streak-of-innovation-and-research-ambition/.

Conclusions

These case studies illustrate that NIS strategies should be tailored to reflect the many institutional, developmental, and cultural characteristics of a nation. The scale, created by the US and China, lends a useful lens with which to analyze the management of national innovation systems. However, there is no inherent winner between the two. Identifying one strategy as better than the other is overly speculative. Instead, the adoption of aspects of either one of these frameworks of governance depends heavily on the specificities of the country in question. Taking a successful NIS strategy and applying it to a different country will not work. An NIS strategy is the culmination of deeply entrenched economic and cultural factors that form the basis of a modern day competitive advantage. The extent, to which a country is able to take advantage of that competitive advantage, is shaped by innovation policy.

It can be argued then, that all catching up economies have an inherent competitive advantage. The incredibly specific nature of a NIS means that those same conditions cannot be replicated elsewhere. As a result, each nation has its own specific set of competitive advantages. India's knowledge intensive labor force, English speaking population, and diversity of thought constitute its main advantage. The US boasts a risk taking entrepreneurial mindset buoyed by powerful private enterprise. China boasts a growing and receptive population as well as an incredibly focused leadership structure. Lastly, the EU has a unique consortium of economies that, with the proper policy, could create a massively productive innovative cluster. The extent to which a nation's

government understands these factors and molds national policy around them, is the extent to which a nation will succeed.

It becomes clear that timing and flexibility is crucial in the pursuit of a competitive advantage. A large part of Chinas success is down to well-timed decision making on the part of its government. First, Chinas strategic liberalization of its borders initiated a technology transfer. Then, China was able to settle into its strengths as a manufacturing powerhouse while it developed the ability and technological scale to begin innovating. China then proceeded by emulating foreign technology and eventually made the seamless transition into a world innovative power. In this way, strategic timing in relation to national factors is extremely important in the development of a competitive advantage. The landscape of technology is changing incredibly quickly. The extent to which a country can predict change and react accordingly is another source of competitive advantage.

Similarly, a strategic understanding of innovative shortcomings is crucial in the development of competitiveness. The EU, for example, is entirely cognizant of the innovative potential at its disposal. It understands that regulatory discrepancies, poor credit markets, and obstacles to knowledge flow are impeding its progress. Europe 2020, as a result, identified these issues and established proposed solutions. Whether these solutions have lived up to expectations is up for debate but less important in this discussion. The key point being that, the EU is steering its innovation system in the right direction, thus ensuring sustainable competitiveness.

It becomes clear then, that direction is crucial in the administration of a national system of innovation. However, directing the economy does not have to imply heavy-handed planning. It is the role of the government to assemble the pieces of a NIS in a way that fosters progress. In order to organize the many factors involved, a government must have a clear picture of where it is going. China and the EU have a clear idea of what they are trying to achieve. Their methods are worlds apart, but their innovation plans allow them to move in the direction of a goal. In a globalized economy, in which competitive advantages are fleeting, a clear strategy becomes crucial. This is where the India and the US' innovation systems are lacking. The US remains globally competitive, and even hegemonic, in global technology, but this is largely down to the power of its MNCs. The US' NIS has very little legitimate strategy. The majority of the prerogative is provided by private enterprise. A unified strategy would not contradict the US' capitalist, free market ideology. Instead, it would establish a framework within which US private enterprise can improve on itself and work to achieve national goals. Without a concrete strategy, Americas perch at the apex of global innovation could prove to be precarious.

Chapter 6: Emerging Technology as a Determinant of Competitive Advantage

First Mover Advantage

In an analysis of innovative competitive advantage, it is useful to analyze the state of current emerging technology. An analysis of industry changing new technology is crucial in gauging the scale of advantage that a country stands to gain from innovation. This analysis also creates a loose end goal to the otherwise very open-ended concept of 'innovation'. A large part of the US' current innovative power is that it was the first country to harness and commercialize the power of the internet and personal computing. As a result, the world's leaders in internet technology and hardware were formed in the US. This "first mover advantage" is generally accepted as being universally advantageous. "Although no advantage lasts forever, firms that succeed in building durable first-mover advantages, tend to dominate their product categories for many years."[110] There are a few concrete competitive advantages from being the first to market. "By starting earliest, first movers have more time than later entrants to accumulate and master technical knowledge."[111] Secondly, firms are able to preempt competitors to key resources and as a result, extend their head start. These concepts can be applied to nations as well. Nations that achieve scale in the use of promising emerging technology can

[110] Lanzolla, Fernando SuarezGianvito. "The Half-Truth of First-Mover Advantage." Harvard Business Review. July 31, 2014. Accessed December 04, 2017. https://hbr.org/2005/04/the-half-truth-of-first-mover-advantage.
[111] Ibid.,

establish themselves as the world leaders. They can then attract the best human capital, researchers and academics, management, and financial capital.

Emerging Technology

There are a few emerging technologies that seem poised to greatly affect society. The Internet of Things (IoT), is expected to have a significant impact on global consumers. The IoT is the idea that everything from clothing, to appliances, to construction materials will eventually be connected to the internet. This will allow users to integrate connectivity closely into their personal lives. This technology is poised to have a large impact on medicine as well. Nanotechnology, which goes hand in hand with the IoT, promises to revolutionize the way in which doctors interact with patients. The idea is that much more of the human body can be tracked and studied using nanosensors that can be inserted into the body. Battery technology is another high growth market since machines are getting increasingly small, while lithium is getting increasingly scarce. Blockchain technology is promising as it could potentially change the way in which we interact with money and transactions. Blockchains allow for a secure transaction infrastructure that, in its most narrow application, eliminates the need for banks and other financial institutions. Autonomous vehicles promise to change society's transportation systems, while creating efficiency on a massive scale. These are all potential industries that could challenge societal assumptions about the nature of computing, connectivity, and transportation.[112] One common theme ties these emerging

[112] "These are the top 10 emerging technologies of 2016." World Economic Forum. Accessed December 04, 2017. https://www.weforum.org/agenda/2016/06/top-10-emerging-technologies-2016/.

markets together. All of them heavily rely on the manipulation and application of data. Data is increasingly become a fundamental pillar of our information based society. Therefore, the most important and potentially world changing technology is Artificial Intelligence (AI). AI is the use of data to extrapolate and simulate intelligent behavior in computers.[113] Some have referred to AI as the next frontier of technological progress, after the information revolution. While there have been large-scale accomplishments in AI to date, they have barely scratched the surface of its potential.

The Potential of Artificial Intelligence

The country that can best harness and apply AI will lead the world into a new generation of computing. "AI will realign power, influence, relationships and most of all change the competitive landscape."[114] Russian President Vladimir Putin once said, of AI, that "whoever becomes the leader in this sphere will become the ruler of the world."[115] In fact, the implications of AI are so far reaching that they are not even fully known to us at the moment. It is clear that AI will be the core technology behind drones, self-driving cars, weapons, and robotics. Going further, AI equipped supercomputers "have the capacity to learn, mine, connect and predict the future of anything—from stock trades, to

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[113] "Artificial Intelligence." Merriam-Webster. Accessed December 04, 2017. https://www.merriam-webster.com/dictionary/artificial%20intelligence.

[114] Canton, James. "More Human Then Human: AI as a Competitive Advantage." The Huffington Post. May 29, 2016. Accessed December 04, 2017. https://www.huffingtonpost.com/james-canton/more-human-then-human-ai_b_10199716.html.

[115] Allen, John R., and Amir Husain. "The Next Space Race Is Artificial Intelligence." Foreign Policy. November 03, 2017. Accessed December 04, 2017. http://foreignpolicy.com/2017/11/03/the-next-space-race-is-artificial-intelligence-and-america-is-losing-to-china/.

energy prices, to become virtual docs or androids that go to space."[116] The nature of military capabilities will also change drastically. "Some researchers believe it will be as transformative as the advent of aircraft, nuclear weapons, and computers.[117] Governments will need to fundamentally rethink their defense strategies. AI will allow robots to perform productive functions within economies, in fact, it will even allow computers to learn and adapt as humans do. There will be mass automation of jobs, which may have a short-term negative impact on nation's constituents, but will provide a long-term positive reallocation of resources. These almost unlimited benefits to AI are the next frontier of human creation and must be a national priority in any NIS. Importantly, the complex and data dependent nature of AI means that it is not a technology that is easily emulated. AI requires massive amounts of data to interact with and incredibly powerful computers in order to predict and learn. In addition, AI is such a vast and specialized field that the tacit knowledge required is immense. As a result, the first mover advantage is especially strong in the pursuit of AI.

The Race for Artificial Intelligence

The US and China are leading the pack regarding the development of AI, while other developed economies lag behind. The pursuit of AI was born in the US, and as a

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[116] Canton, James. "More Human Then Human: AI as a Competitive Advantage." The Huffington Post. May 29, 2016. Accessed December 04, 2017. https://www.huffingtonpost.com/james-canton/more-human-then-human-ai_b_10199716.html.

[117] Kinnucan, Emma , and William Carter. "Machine Intelligence: We Need a National Strategy." The Atlantic. Accessed December 04, 2017. http://www.theatlantic.com/sponsored/booz-allen-hamilton-2017/machine-intelligence-we-need-a-national-strategy/1497/.

result, the US enjoys a slight edge in its current development. Google, Microsoft, Tesla, and Facebook are all fiercely competing to build world-changing applications of artificial intelligence. However, as is the trend, China is hot on the trail and looks set to close the gap soon. Other developed economies, such as Canada, Russia, and the European Union, have AI programs but they pale in comparison to those of the US and China. In 2017, China's State Council released their New Generation of Artificial Intelligence Development Plan. It promises large-scale investment into "cultivating the governmental, economic, and academic ecosystems to drive breakthroughs in machine intelligence."[118] Crucially, since AI is a technology that is dependent on massive quantities of data, China has a significant advantage. The grand size of Chinas internet industry as well as the lack of data privacy means that China has a significant quantity of data. Transactions through WeChat payments, purchases made on Alibaba, and interactions on Chinese made mobile phones are not subject to the same data privacy regulations that US firms are. This constitutes a major competitive advantage for China. This approach is in stark contrast to recent US policy. President Trump's recently proposed budget looks to slash funding for the National Science Foundation and other organizations backing AI research.[119] According to James Lewis, senior fellow at the Center for Strategic and International Studies, "it's a race in the new generation of computing, the difference is that China seems to think it's a race and America doesn't."[120]

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[118] Ibid.,
[119] Mozur, Paul, and John Markoff. "Is China Outsmarting America in A.I.?" The New York Times. May 27, 2017. Accessed December 04, 2017. https://www.nytimes.com/2017/05/27/technology/china-us-ai-artificial-intelligence.html.
[120] Ibid.,

However, America still enjoys many competitive advantages due to the sheer power of its private sector. President Trump's budget, while it slashes funding to research centers, affords tax breaks to the private sector. This essentially puts the R&D burden on private companies. An emphasis on the private sector is the trademark of the American NIS and so far, US firms have led in the field. In 2016, Google developed an AI system named AlphaGo designed to play the complicated strategy game Go. At a tournament in 2017, AlphaGo successfully "beat the best player in the world, a Chinese national."[121] Professor of machine learning at Peking University, Zha Hongbin, said that "after AlphaGo came out and had such a big impact on the industry, the content of government discussions got much wider and more concrete."[122] This illustrates that Chinas approach is targeted and ambitious but US firms are the leaders in the field.

The pursuit of AI is a seminal moment in human technological progress with strong parallels to the space race. The pursuit of dominant national innovation systems, as analyzed in this paper, leads up to breakthroughs like this. The US and China have entered a technology arms race that pits their opposing national innovation systems against each other. The nation that comes out on top could possibly dominate global technology and trade for years to come. The result of the race for AI then, could be a leading indicator of the efficacy of the US and Chinas respective national innovation systems. If China were to overtake the US in the development of AI, it would be difficult to argue that Chinas top down economy is not an effective way to organize a NIS. In 1958, Lyndon B. Johnson issued the stark, if hyperbolic, warning that the winner of the

[121] Ibid.,
[122] Ibid.,

space race would gain "control, total control, over the Earth for purposes of tyranny or for the service of freedom."[123] The space race was different, in that US policy was sharply focused on making it to the moon. The result was that the US succeeded, not just "by reaching the moon, but by inspiring the next generation of scientists, technologists, and optimists."[124] In this way, the race for artificial intelligence has the potential to create and instill lasting cultures of innovation in the country that can get there first. The Chinese government is echoing much of the targeted and nationalistic rhetoric that defined the space race in the US. US private enterprise is powerful, but as mentioned above, could be all the more powerful with a targeted government directive.

[123] Allen, John R., and Amir Husain. "The Next Space Race Is Artificial Intelligence." Foreign Policy. November 03, 2017. Accessed December 04, 2017. http://foreignpolicy.com/2017/11/03/the-next-space-race-is-artificial-intelligence-and-america-is-losing-to-china/.
[124] Ibid.,

Chapter 7: Areas for Further Research: Global Innovation Systems and the Role of the MNC

A Framework for Global Innovation Systems

It can be argued that in an increasingly globalized knowledge economy, national boundaries could become far less relevant. Binz and Truffer argue that where innovation systems are a set of interactions between actors and institutions, national and regional innovation systems ignore interactions on a supranational level that may affect how organizations influence territorially embedded innovation dynamics.[125] The globalization of capital flows and knowledge means that innovation occurring in one nation could have simultaneous positive externalities in another, if institutions permit. Venture capital is an example of such a phenomenon. Venture firms have no specific loyalty to their home country; their goal is to sniff out innovation where it may be. As a result, flows of venture capital bring risk-loving credit markets to countries that may not have similar institutions. They also bring ideas, expertise, and knowledge across borders. This is just one example of innovation systems overflowing beyond national boundaries. Another useful example might be the foreign development of easily replicable scientific breakthroughs. Global knowledge networks allow for other countries to emulate that breakthrough and avoid R&D costs. Binz and Truffer go on to argue that an analysis of innovation systems should "be able to explain the processes that lead to the creation (and decline) of new

[125] Binz, Christian, and Bernhard Truffer. "Global Innovation Systems—A conceptual framework for innovation dynamics in transnational contexts." *Research Policy* 46, no. 7 (2017): 1284-298. doi:10.1016/j.respol.2017.05.012.

technologies and industries."[126] In addition, they emphasizes that the level in which actors interact with these international systems depends heavily on the industry. They argue that specific industries and types of innovation are more closely intertwined with foreign actors than others are. Examples given are open source software developments and the positive externalities they provide for economies and research centers all around the world. Another example is a US MNCs supply chain and research process being spread across Chinese manufacturers and Indian IT engineers. The result is that innovation clusters are created that extend beyond national boundaries. This dissemination of knowledge and creation of networks is part of a larger Global Innovation System (GIS).

The global innovation system is largely a product of the expanding role and increased internationalization of private enterprise. Positive externalities that arise from globalization are generally the result of the expansion of MNCs. Since these companies are driven by a profit motive, they have incentive to spread ideas, capital and knowledge wherever there is potential for economic growth. The creation of global innovation systems is advantageous as labor and services can be sourced from nations who have comparative advantages in the area. The result is a reduction of costs, a diversity of thought in value chain innovation, and global market penetration.

The Growing Power of MNCs

As a result, as MNCs grow increasingly powerful and global, their expansive activities result in innovative and knowledge flows out of the home country. Of the

[126] Ibid.,

world's top 100 global entities, sixty-nine are corporations, while 31 are countries. Walmart generates more revenue than Australia, South Korea, and India.[127] It is clear then, that the power of MNCs is growing hand in hand with globalization. Uzunidis and Boutillier argue that the internationalization of MNCs is inherently exploitative of the home state. They go on to explain that, as new technologies are developed in an MNCs home market, the biggest opportunity for profit is to move these innovations abroad in order to be the first to market. In this way, a home country's innovation system, that fosters productive inter-MNC competition, is useful for MNCs to "strengthen their technological advantages globally."[128] As a result, it is possible that increased globalization means that the economic and knowledge related benefits of powerful MNCs begins to flow out of the home state and towards new markets abroad. A paradox then arises since the power of a nations NIS is largely driven by the extent to which it can create powerful and innovative private enterprises. Yet, as MNCs gain power, the economic benefits of their innovation spreads abroad, counteracting the competitive advantages enjoyed by the home state.

MNCs as a Challenge to the State

The growth of MNCs then, challenges the role of the state in the development and maintenance of national competitive advantage. A large pillar of the analysis of national

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[127] Myers, Joe. "How do the world's biggest companies compare to the biggest economies?" World Economic Forum. Accessed December 04, 2017. https://www.weforum.org/agenda/2016/10/corporations-not-countries-dominate-the-list-of-the-world-s-biggest-economic-entities/.

[128] Uzunidis, Dimitri, and Sophie Boutillier. "Globalization of R&D and network innovation: what do we learn from the evolutionist theory?" Journal of Innovation Economics & Management. October 23, 2012. Accessed December 04, 2017. https://www.cairn.info/revue-journal-of-innovation-economics-2012-2-page-23.htm.

systems of innovation revolves around the importance of private enterprise. In both Lundvall and Porter's frameworks, the crux of national innovative power is achieved through private enterprise. The consensus is, that government innovation policy should work to best foster conditions for the growth of MNCs, which in turn will benefit the domestic economy and create positive social and innovative externalities. The issue arises when MNCs have no direct obligation to foster the competitive advantage of the home state. The very actors that create a national competitive advantage, in this model, do so as a side effect of their operations. A counter argument arises that the nature and extent of globalization is a result of national policies that regulate or deregulate trade relations and international mobility. However, in states in which there are strong delineations between the private and public sectors, the private sector wields considerable power. Protectionism limits firms' access to global markets, capital and knowledge, which are increasingly becoming vital to the success of private enterprise.[129] Limiting a firm's access to these crucial networks runs the risk of incentivizing firms to move their bases of operations abroad. As a result, states lose the ability to control the level of global integration of their constituents. In addition, firms wield considerable economic power in domestic politics and as a result angle for policies that benefit their success. This analysis shows that this success is not necessarily in line with that of the nation.

[129] Hardy, John. "Is Global Capitalism Eroding the State?" E-International Relations. Accessed December 04, 2017. http://www.e-ir.info/2008/09/22/is-global-capitalism-eroding-the-state/#_edn16.

The Power of MNCs in Relation to China

This phenomenon has been observed as US firms attempt to penetrate the Chinese market. China has specific rules that "require foreign firms who want to enter certain industries – such as energy, telecommunications and autos – to form joint ventures with local partners."[130] These ventures result in the transfer of crucial innovative secrets to local Chinese companies, who then adapt it to their own innovative processes. In fact, Apple has announced that it plans to open four large R&D centers in four Chinese Cities. Amazon and Microsoft as well, already operate with local partners in the Chinese market. These companies are the cream of the crop when it comes to American innovation. Their willingness to cooperate with Chinese regulations, that no doubt negatively affect the US' competitiveness, is telling. In fact, "some experts say that handing over technology has effectively become a cost of doing business in China -- a market too big for most companies to ignore."[131] Crucially, these companies have the opportunity to refuse to do business in China when faced with such demands; however the profit motive is too big of a factor it seems. This highlights the paradox of globalization in the development of a competitive advantage. The more globalized the world economy gets, the more difficult it is to foster a competitive advantage. This speaks to a potential benefit of the Chinese planning economy in the long run.

As globalization intensifies and national borders become increasingly less prohibitive, China has the ability to protect its technological secrets in a way that the US,

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[130] "How China squeezes tech secrets from U.S. companies." CNNMoney. Accessed December 04, 2017. http://money.cnn.com/2017/08/14/news/economy/trump-china-trade-intellectual-property/index.html.
[131] Ibid.,

or any democracy, cannot. Chinese companies have a strong top down obligation to align their goals with the long-term plan of the Chinese economy. If globalization becomes a danger to the technological competitive advantage of nations in the future, China is well placed to succeed. Further research would benefit from understanding how the future globalization of innovation systems will affect the relative power of the private and public sectors. In addition, understanding how this balance of power between private and public actors influences a nation's competitiveness on a global scale will be crucial in shaping long-term innovation policy.

Another area of interest might be the role that developing countries play in this evolving world system. The economic development of developing countries has often been heavily reliant on larger economies and FDI. With the advent of a GIS, it is possible that cheap conditions within developing countries will leave them vulnerable to further economic exploitation. A counter argument is that, since intangible goods are greatly valued in a knowledge economy, developing countries may be afforded more mobility. Further research could be useful in determining the role that developing countries play, in relation to innovative powerhouses, and in relation to the GIS itself.

Concluding Remarks

The coming of the information revolution set up a fundamental reshaping of productive processes that have shaped the global competitive landscape. The instantaneous nature of information and the potential productive power it brings is the crux of the emerging 'knowledge economy'. Under this paradigm, theoretical knowledge is the driving force behind the creation of value. The use of knowledge, in this case, is the extent to which actors can combine tacit and codified knowledge in the development of processes, products and innovations that create incremental increases in productivity or efficiency. Innovations are most beneficial when applied to pushing the frontier of technology. However, innovation can be as simple as minimizing costs or integrating consumers in a novel way.

Innovation and entrepreneurship create incremental advancements that push national progress. Innovating beyond the capabilities of other nations is tremendously valuable as it allows a country to reap large productive, social and economic benefits in relation to other countries. As a result, the development of knowledge, and as an extension, innovation, is a key determinant in global competitiveness going forward. The development of the personal computer in the US is an example of innovation leading the world technology frontier and creating positive externalities for consumers, entrepreneurs and the US government.

The extent to which a nation is able innovate is determined by the cultural, governmental and economic factors that make up its national innovation system. A nations NIS is the result of complex interactions between institutions, MNCs, private

actors and citizens. Fostering and developing an effective NIS is the root determinant of national competitive advantage.

In this analysis, we see the clash of two conflicting NIS strategies as innovative superpowers. A heavy handed and meticulously planned Chinese economy sits in stark contrast to the free market capitalism employed by the US. As a result, an analysis of national innovation also compares these two schools of thought.

In fact, this conflict of mentalities draws strong historical parallels. The US and the Soviet Union championed two polar opposite philosophies. The animosity between the two countries was not just the result of conflicting political systems. It was a battle for resources, for worldwide hegemony and for soft power. This animosity, and mutual fear, manifested itself in the space race. The rhetoric surrounding the race was not just a scientific rivalry. It equated scientific dominance with political superiority, cultural victory etc… It was not NASA against the Soviet Space Program; it was the US against the USSR. In this climate, scientific achievement was glorified as a culmination of national values and collaboration.

Changing dynamics of innovation are not dissimilar to the competitive dynamics introduced by the space race. In a knowledge economy, the productivity of a country is measured by its innovation. That innovation is a culmination of the deep intricacies that characterize that country. As a result, no two innovative processes or systems can be the same. There is something wholly nationalistic about that concept. With a world beating innovation, a nation can claim legitimacy for its political institutions, point to the hard work of its constituents, and to the brilliance of its enterprise. Competitive innovation

therefore, provides a global sphere for competition that fosters nationalism, yet simultaneously encourages the development of the *global* innovative frontier.

While the US and China lead the charge, many countries are close behind waiting for the chance to gain competitive ground. The advantages that innovation systems like India and the EU face are deeply specific to their own system. The complex interactions of firms and citizens mean that each nation has a completely unique competitive advantage. The extent to which governmental policies can identify and move towards that advantage is the extent to which countries will be able to catch up with world leaders. Along the same lines, the extent to which world leaders can continue pushing the frontier of technology is the extent to which they will maintain powerful, entrenched competitive advantages.

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