Innovation and Firm Performance: A Comparative Study of Rapidly Developing Economies & the European Union

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ABSTRACT

This dissertation analyzes the innovation efforts of large, technology-intensive firms as they pertain to firm performance. The research examines two distinct groups of technology intensive firms deriving from countries with opposing stages of economic development and contrasting demographics of their populations: Rapidly Developing Economies (RDEs) and European Union (EU) countries. Technology enables firms to re-imagine their core competencies, improve existing processes, and model improved processes and routines. By understanding the return on investing in innovative pursuits, firms could adapt strategic business models to capture firm growth that has previously been under-developed and secure a competitive advantage. Likewise, local and national government agencies could offer specific incentives to help ensure longevity and sustainability to their position in world markets and identify previously untapped trading partners and strategic alliances. In addition, strategists would be better equipped to support and target R&D initiatives during declines in the market and/or industry. The results are reported according to manufacturing and service industries. The studies indicate that the most profitable firms derive from the service sector versus manufacturing. Custom Computer Programming firms represents the highest profit margins in EU countries and

Computer Programming Services represents the highest profit margins for RDE countries. Despite more firms being represented from RDE than the EU, these firms do not spend more than large, technology firms from the EU. Upon investigating which group acquired more patents, it was found that RDE countries have more patents granted than EU countries. In addition, RDEs currently have more high-tech exports as a percentage of manufactured goods per capita than EU countries. The impact of the global recession appeared to have an impact on large, technology-intensive firms in the EU in particular, while a majority of RDE firms have already returned to or have exceeded pre-recession levels. The incorporation date was also examined to determine both the age of firms included in the study, as well as the labor capital of both groups. It was determined that RDE firms included in the study hire significantly more employees than EU firms, and more manufacturing employees were hired than those in the service sector.

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CHAPTER 1: INTRODUCTION

"Innovation: A Comparative Study of Rapidly Developing Economies & the European Union" is a dissertation which comparatively analyzes determinants of innovation as they pertain to firm performance. The research examines two distinct groups of technology intensive firms deriving from countries with opposing stages of economic development. As firms become increasingly more innovative to secure and maintain a competitive advantage, the necessity to safeguard and protect such enhancements and advances to their products and services is crucial.

Innovative business models must extend below low cost advantages in order for today's multinationals to secure a foothold to compete in the global marketplace against established key players. Measures of innovative performance of technology intensive industries in previous studies have included R&D expenses, patents granted, and new product announcements. All these can ultimately redefine the competitive landscape in pursuit of excellence in their chosen fields, however, they do so at their own pace. Some firms prefer to make minor changes to existing products and services more often than frequent, significant changes to existing or new product lines.

Globalization has been driven by technology and software is at the center of many of the most disruptive business models introduced over the past two decades. Software has profoundly impacted every industry as it has the ability to fundamentally "alter, disrupt, and create industries, business models, and sources of competitive advantage" (BCG f, 2013).

Technology: The Conduit of Innovation

Technology enables firms to re-imagine their core competencies, improve existing processes, and model improved processes and routines. As developing economies grow their technology resources, they are granted global access to build upon and enhance existing dynamic capabilities as well as reach a market of approximately 6.8 billion mobile broadband users by 2018 (Dean et al, 2013). Today's multinationals would be hard-pressed to be successful without having utilized technology to increase efficiencies and overall effectiveness of virtually every business function. Hardware and software dependency is prevalent in a significant amount of industries, as it plays a crucial role in the designing of products, process, and routines, as well as analyzing data, running facilities and managing customers.

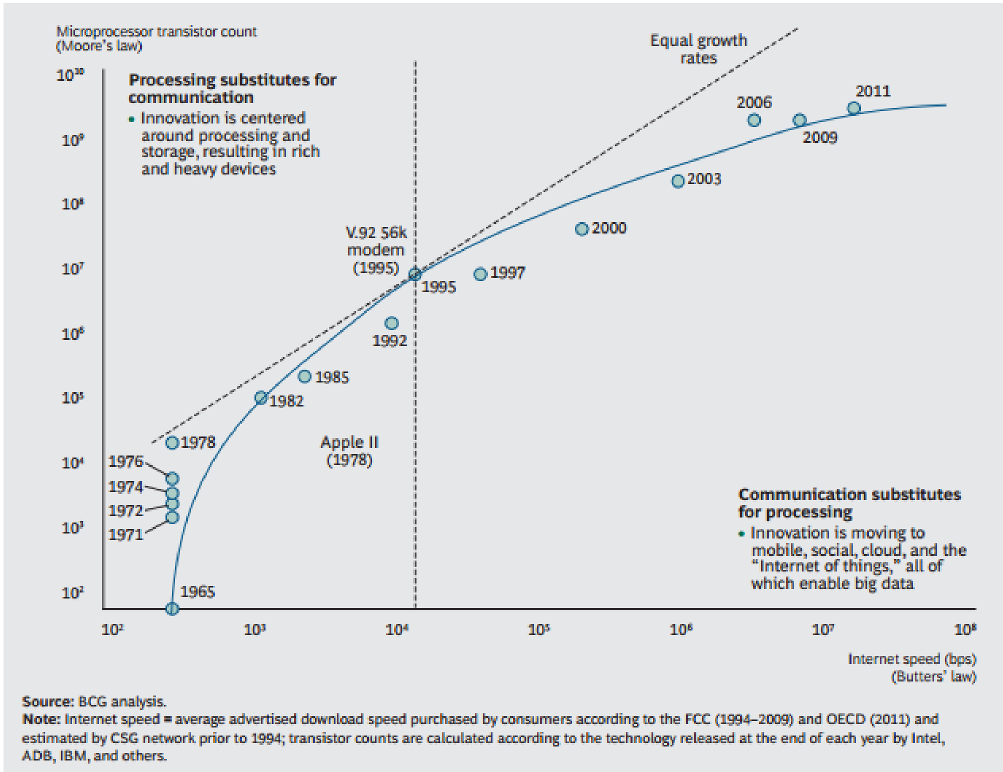
Cloud computing estimates are even more favorable, as technology intensive firms, such as Amazon, Google, and Microsoft invest billions of dollars in building and computing storage capacity that can be easily accessed and affordable. The cloud has abundant bandwidth and is a "disruptive force because it enables both a uniform user experience and smaller, lighter, more portable devices" (Dean & Gilliland, 2011). It also has "community to computing resources, and it will help spark the creation of new business models built around collaboration, networks, and information in nearly all industries. As the cloud democratizes information technology, it provides a growth lever for entrepreneurs and small businesses. By some estimates the cloud market could reach nearly $250 billion by 2017 as corporate clients grow more comfortable with pay-as-you-go computing" (Dean et al, 2013).

Innovation has also adapted to become more mobile to enable large transfers of data onto the "cloud" and the rise of smart devices for global connectivity and social media is leading to a data transfers of 27 terabytes per second. Such escalation has attracted heavy investment regardless of firm size, and has led to five types of commercial opportunities (Dean et al, 2013):

1. Generating new business insights
2. Improving core operating processes
3. Enabling faster, better decision making
4. Taking advantage of changing value chains
5. Creating new, data-centric businesses.

Communications actually surpasses processing as a structural driver to growth as depicted in Figure 1 on the following page. Seemingly omnipresent connectivity and affordable devices will drive global IP (Internet Protocol) traffic, which has quadrupled in the past five years, to triple by 2017 to 1.4 zettabytes annually. What is a zettabyte? According to Dean et al, it is the equivalent of all the movies ever made circling the global Internet once every three minutes (2013).

Figure 1 - Communications is Beating Processing as a Structural Driver of Growth



(BCG, 2013, p. 8)

Who will be the global challengers taking advantage of this market in which innovation is king?

Focus of Research

Abundant scholarly works and books examine the impact of innovative pursuits of technology intensive firms on performance, however, such studies and accounts do not compare the impact of innovation on economic growth of the two groups examined within this study: Rapidly Developing Economies and Developed Economies. Both opposing groups were chosen for their opposing characteristics, but primarily for their degree of development as well as their contrasting demographics of their populations.

The selected groups are Rapidly Developing Economies identified by the Boston Consulting Group and the European Union. In addition, this research is concentrated to high-tech hardware, software and service firms specifically operating within both specified groups.

Rapidly Developing Economies (henceforth RDEs) have resulted from fast-moving globalization forces such as the Internet, decreased trade barriers by the World Trade Organization, significant increase in low-cost communication technologies, and economic reforms. Characteristics of RDEs include but are not limited to (BCG d, 2006; BCG b, 2014):

1. Rapidly developing markets – Some markets are very large and fast-growing, such as China, India and Russia, which have a younger, growing middle class due to the aforementioned shaping forces as well as increased levels of consumption.
2. Low cost resources – This enables domestic firms to acquire advantages over foreign firms. Examples of low cost resources may be property, equipment, raw materials, and capital. These costs are considerable less than developed countries in the European Union, where the manufacturing site itself (grounds & utilities), labor, and architectural services.
3. Difficult operating environments – Navigating and managing the trials of operating under such conditions as low-income consumers, under-developed logistics and distribution channels, indefinite legal environments, talent acquisition, and shortages can generate highly capable firms after managing such challenging operating environments.

4. Training grounds for competing with global incumbents – Significant inward foreign direct investment flows into RDEs annually. These markets are ripe for multinationals to take advantage of the sheer growth of the middle class consumers and institutional voids that have become inviting business opportunities to eradicate bureaucratic and operational inefficiencies.

How do these differ from Emerging Markets? There are currently eight groups of Emerging Markets (EMs) that are defined more out of convenience by the author/creator than anything else, such as financial institutions naming investment groups. The characteristics are similar, however, the most important difference is the rate of growth. There is no agreed upon number and the classification of which is rarely clearly defined. However, the Boston Consulting Group (BCG) offers the distinct, detailed characteristics of their group of countries denoted as “Rapidly Developing Economies”. It is for this reason that the BCG, who generates the highly anticipated Top 100 Global RDE Challengers list, was selected for this research.

This study encompasses the past six installments of this coveted list of multinationals, which includes specific methodology on their selection. All firms must have had at least $1 billion in revenues in order to ensure that they have the means to operate on a global scale, as well as having an overseas revenue of either ten percent of total revenue or $500 million (BCG b, 2014). Newcomers that meet the criteria have been rapidly developing “innovative and advanced digital services”, which allow firms to strengthen and build dynamic capabilities as well as assist consumers by providing services to meet their demands. These newcomers also stress that their success is driven by innovation rather than low costs, and are depicted in Figure 2 below (BCG b, 2014).

Figure 2 - List of Rapidly Developing Economies (RDEs)

Argentina	Egypt	Mexico	Saudi Arabia
Brazil	Hungary	Philippines	South Africa
Chile	India	Poland	Thailand
China	Indonesia	Qatar	Turkey
Colombia	Malaysia	Russia	U.A.E.

The opposing group of countries for this comparative study is the European Union, henceforth EU. There are specific conditions that countries applying for membership must meet, which are referred to as the "Copenhagen criteria". Such criteria include the applicant demonstrating that they have a free-market economy, a stable democracy and the rule of law, and acceptance of all legislation set forth by the EU, including the euro as its form of currency.

The EU is characterized by a union of 28 member states (See Figure 3 on the following page) and has more clearly defined historical roots than the opposing group, RDEs. The EU has continued to grow in size and power over the years by the accession of new member states. The Maastricht Treaty of 1993 established the EU under its current name and the single market was aimed at ensuring the free movement of people, products, services, and capital. The shared monetary union was established in 1999, but euro wasn't fully legal and tender in all member states until 2002.

Figure 3 - European Union Member Countries

Austria	Estonia	Italy	Portugal
Belgium	Finland	Latvia	Romania
Bulgaria	France	Lithuania	Slovakia
Croatia	Germany	Luxembourg	Slovenia
Cyprus	Greece	Malta	Spain
Czech Republic	Hungary	Netherlands	Sweden
Denmark	Ireland	Poland	United Kingdom

This single market is a significant trading power with current investment pursuits in transport, energy and research. The EU recognizes science, technology and innovation as important drivers for "Europe 2020" growth strategy, which sets a 3% R&D intensity goal as one of the five headline targets to be realized by this date.

The EU is represented at the United Nations, G8, World Trade Organization and the G-20. If the EU were a single country, it would rank first in nominal GDP ($18 USD trillion) and second in GDP (PPP) in the world. The 2014 population is approximately 507 million people or 7.3% of the total world population, and member countries also have a very high Human Development Index (HDI).

Research Question

This research primarily focuses on the innovative efforts of technology intensive hardware and software firms of both groups: the developed economies represented by EU member countries and rapidly developing economies represented by the RDE group. The research questions is: Are large, technology firms in Rapidly Developing Economies more innovative than large, technology firms in the European Union?

Innovation factors will primarily be measured by R&D expenditures and patents granted. However, innovative efforts may include many other potential activities and factors, such as: the acquisition of talent (i.e. scientists and researchers), the firms' location type (headquarters, branch, single location) and incorporation date, as well as the number of high-tech exports. These factors may ultimately lead to corresponding positive profit margins, faster rates of firm growth, and economic growth.

The EU member countries are more developed than the opposing group of RDE countries, however, this does not necessarily mean that they are more innovative or the perceived gap between these countries is expanding. This study proposes that successful innovative efforts in RDEs may potentially drive and surpass those of developed countries. Therefore, overall this research ultimately suggests that RDE high-technology firms are actually more innovative than more developed high-technology firms deriving from the EU, as will be proposed in the hypotheses.

By understanding the return on investing on innovative pursuits, firms could adapt strategic business models to capture firm growth that has previously been under-developed. Likewise, local and national government agencies could offer specific incentives to help ensure longevity and sustainability to their position in world markets and identify previously untapped trading partners and strategic alliances.

Research Scope

This dissertation analyzes innovation factors as they pertain to firm performance. The research examines two distinct groups of technology intensive firms deriving from countries with opposing stages of economic development: developed & developing economies.

It measures firm-level data to ultimately determine which group is more innovative. Strategists would be better equipped to support and target R&D initiatives during declines in the market and/or industry. In addition, by understanding the return on investing in innovative pursuits, firms could adapt strategic business models to capture firm growth and secure a competitive advantage.

This research is limited to public firms that have at least $10 USD million in sales and are active in 8 High-tech Manufacturing Industries and 13 High-tech Service industries depicted in Figure 4 on the following page. SIC stands for Standard Industrial Classification code, which is assigned by the U.S. government to firms in order to identify and classify the primary business of the firm for statistical data. Firms may belong to one or more SIC codes as depicted by Figure 4 on the following page.

Figure 4 - SIC Codes

High-Tech Service SIC Codes	
73710000	Custom Computer Programming Services
73710300	Computer Software Development & Applications
73710301	Computer Software Development
73710302	Software Programming Applications
73730000	Computer Integrated Systems Design
73730100	Systems Software Development Services
73730200	Systems Integration Services
73730201	Local Area Network (LAN) Systems Integrator
73730300	Computer System Selling Services
73760000	Computer Facilities Management
73790000	Computer Related Services, nec
73790100	Computer Related Maintenance Services
73790200	Computer Related Consulting Services

High-Tech Manufacturing SIC Codes	
35710000	Electronic Computers
35720000	Computer Storage Devices
35750000	Computer Terminals
35770000	Computer Peripheral Equipment, nec
35780301	Automatic Teller Machines (ATM)
73720000	Prepackaged Software
73729901	Application Computer Software
73729902	Business Oriented Computer Software

A total of 568 firms meet the aforementioned criteria and are included in the study, however, both Hungary and Poland appear in both RDE and EU economic groups, therefore they have been dropped from the study.

Hypotheses

Hypothesis One (H_1):

Large technology firms in Rapidly Developing Economies (RDEs) spend more on R&D compared to large technology firms in EU countries.

Global challengers from RDEs are no longer relying on low costs and large domestic markets as their primary resources of competitive advantage. Senior strategists of these challengers must continue to present solutions to market constraints. They need to continue to create innovations and disruptions through their innovative pursuits with regard to R&D. Firms that are not investing in providing consumers with higher value added products and services will find themselves surpassed by other multinationals who are striving to get the biggest returns on their investments pertaining to R&D expenditures. This study focuses on larger firms who are perceived as having greater resources upon which to draw from to generate innovation and conduct explorative and exploitive activities.

Hypothesis Two (H_2):

Large technology firms in Rapidly Developing Economies (RDEs) are more profitable compared to large technology firms in EU countries

Many firms realize that one of the worst places to cut costs when already running on a lean budget is R&D. The BCG top global challengers have a competitive advantage from lower overhead since their inception, so these firms have more resources to funnel into activities that provide more lucrative profit margins. This growth has stimulated more inward foreign direct investment and increased employment rates. The global Information Technology services market in particular has grown considerably. Such growth fuels international contracts and strong after-tax profit margins.

Hypotheses Three (H_3):

Rapidly Developing Economies (RDEs) acquire more patents per capita compared to EU countries.

R&D Expenditures is the most widely used variable to measure innovative effort of firms, however, it is certainly not an indicator of innovative output. It is for this reason that the number of patents granted will be utilized. The number of patents granted continues to grow, especially in RDEs. This is a critical measurement of innovation efforts. This number is expected to continue to grow and narrow the overall gap between both groups.

Hypothesis Four (H_4):

RDEs have more high-tech exports as a percentage of manufactured goods per capita than EU countries.

It is important to point out that in regards to market share of technology intensive industries, multinationals from the EU are the challengers and the RDEs are the established firms. Trade Agreements between partners have facilitated the movement of products and services as a result of globalization and cause export revenues to rise between parties.

Terminals, shipping facilities and trade ports are at capacity and the demand for container also continues to grow. Such facilities are expected to accommodate a significant portion of global traffic and trade and investing in such infrastructure is a necessity as a result of this expected growth.

Motivation for the Research:

The motivation for embarking on this research is my genuine interest in innovation and rapidly developing economies. Throughout my doctoral studies, I have continually studied this group of countries and the many predictions surrounding their predicted surpassing of established developed economies in the future. Due to their persistent growth patterns, despite tumultuous economic declines, these countries are still the focus of prominent scholarly works and continued research. I found myself choosing these countries as topics for my own research, publications and my classroom. However, having the opportunity to provide multinationals operating in technology intensive industries with the ability to apply my findings to their vision and strategy is the most attractive and rewarding motivation for this research.

CHAPTER 2: SURVEY OF LITERATURE

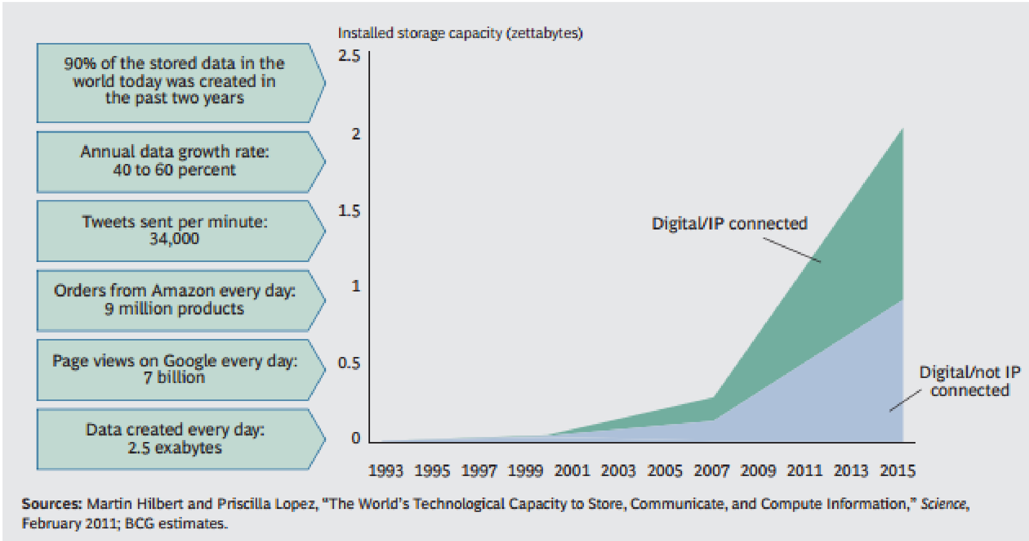
The Survey of Literature is focused on R&D efforts of firms and the resulting outputs as they pertain to firm performance. Several areas are provided to fully investigated, such as product innovation learning relating to knowledge capital, which is acquired as a result of innovatory pursuits, as well as ambidextrous orientation in the context of acquiring competitive advantage. In addition, the survey also investigates the impact of innovative efforts in the form of patents granted and international trade. The survey of literature concludes with opportunities and challenges to firms.

Multinational Enterprises (MNEs) play an integral role in the development and diffusion of innovative capabilities that can increase and sustain firm performance as well as positively impact economic growth. It is necessary for such firms to engage in research and development activities, as it serves as a long-term goal of contributing to firm success by "building advantageous competitiveness for the future" (Prahalad & Hamel, 1990).

Leaders of multinational firms need to reassess their current strategies and alter their business models in response to the rapidly changing competitive landscape. This will not be enough. Multinationals will also need to build dynamic capabilities that utilize the latest technological advances in their given industries, while simultaneously focusing on several key elements, such as: innovation rates, “overall strategy, alliances, customer-centricity, and productivity—essentially managing the transition from current business models to new ones” (Dean et al, 2013). Wipro is an example of a technology intensive multinational from India (RDE) who is a significant provider of R&D services with over 12,000 Product Engineering Services that build extensive engineering capabilities and market “innovative technology-based solutions that leverage their strengths in engineering and research” (BCG d, 2006).

As previously discussed, technology is the conduit of innovation. With the rise of social media and aforementioned “big data”, innovation is becoming increasingly more mobile, social, user-friendly, and convenient through the use of smart devices and global connectivity growing at a speed of 27 terabytes per second. According to the BCG, more than half of all data will have an IP (Internet Protocol) Address, as illustrated in Figure 5 on the following page. Perhaps some of the most significant points for multinationals operating in technology intensive industries are the amount and growth rate of online data with 90% of the stored data in the world today having been created in the past two years. There is also opportunity for investment in this regard for multinationals to not only store and communicate this data, but also protect it. This need to protect and secure data in an online environment will become increasingly crucial as our dependence on technology continues to escalate with an annual data growth rate of 40 to 60 percent.

Figure 5 - In 2015, More Than Half of All Data Will Have an IP Address



Source: https://www.bcgperspectives.com/Images/BCG_The_Great_Software_Transformation_Dec_2013_tcm80-151638.pdf

RDEs in particular are "on the hinge of history, balanced between a remarkable past decade of growth and innovation and a promising but unproven future. Their future success will depend on whether they can maintain their momentum over the new decade and continue to narrow the gap with global multinationals" (BCG e, 2011). The Top Global Challengers are taking advantages of opportunities to buy attractive assets in order to remain financially fit and compete against more established companies (BCG e, 2011).

Global R&D Systems

According to Cantwell's findings in 1998, the largest European companies performed about seven percent of their total R&D outside of their national borders as early as the 1930s. Multinationals were appealing to local preferences to gain market share back then, however, "the nature, scope and magnitude were limited…Now, multinational enterprises develop R&D units who are tasked with encompassing innovation activities to develop products for global markets or even perform basic research to develop technology" (Mott, 2004).

The growth of global R&D systems has been influenced in recent decades by a number of far-reaching changes that have occurred in the macro techno-economic environment. “One such driving force has been the emergence of new pervasive technologies…” (2004). Technologies such as microelectronics, information and communication technologies (ICT), biotechnology and advanced materials are diffusing rapidly as new products, services, and processes are developed leading to improvements in routines and productivity (Mott, 2004).”

“Despite the growing trend of R&D internationalization, a major portion of corporate R&D is still conducted in the home countries of the multinational firms” (Blomkvist, Kappen & Zander, 2011; Di Minin & Bianchi, 2011; Dunning & Lundan, 2008; OECD, 2007; Patel & Pavitt, 1991; Zanfei, 2000). Belberbos et al. suggest that a motivation “for international R&D is to develop new technologies overseas by accessing foreign R&D resources and local technological and scientific strengths” (2013). This is commonly referred to home-base-augmenting or innovative R&D, with the latter gaining a lot of attention through scholarly research (Ambos, 2005; Cantwell & Mudambi, 2005; Chung & Alcacer, 2002: Chung & Yeaple, 2008; Florida, 1197, Kuemmerle, 1997; OECD, 2007; Song, Asakawa & Chu, 2011; Song & Shin, 2008; Todo & Shimizutani, 2008; von Zedtwitz & Gassmann, 2002), and can “lead to knowledge sourcing with a positive impact on the performance of home-country or overall R&D operations” (Criscuolo, 2009; Griffith, Harrison, & Van Reenen, 2006; Iwasa & Gdagiri, 2004; Lahiri, 2010; Neito & Rodriguez, 2011; Penner-Hann & Shaver, 2005; Bedlerbos, 2013).

Today, multinationals find themselves faced by RDE firms that are not just newcomers but becoming established key players in their chosen industries. These top performers are gaining strength and momentum post-economic crisis, as they benefit from their home market growth, low-cost advantage, and opportunistic acquisitions abroad. RDEs are an important growth engine for technology intensive industries as they grow and develop their dynamic capabilities in an increasingly complex global marketplace.

The Price of Innovation

A firm has two reasons to conduct R&D efforts, according to Cohen and Levinthal (1989, 1990): to generate new knowledge for the purpose of creating new products and processes and also to build absorptive capacity to assimilate external information. It is for this reason that the amount of R&D expenditures "represents the observable measure of a firm's absorptive capacity. The more driven a firm is to learn, the greater the R&D expenditures will be…positive incentives include high technological opportunity, a difficult learning environment, and large R&D spillovers from competitors. Empirical tests using data at the business unit level generally supported these propositions" (1995).

Several scholarly works list a number of organizational variables related to innovation, however, many are dated and may not be applicable in today's global, technology-intensive marketplace. Some of these variables include firm size, market power, firm age, organizational structure, and the extent of vertical integration. Firm size, for instance, may be a variable, but may not sufficiently explain causality or significance, rather than it representing a way to classify firms. This variable also used to be utilized as it was perceived to possess greater resources to generate innovation and conduct explorative and exploitive activities. "R&D as a proportion of sales can be categorized as a strategic variable. This variable reflects the allocation of resources towards such activity and directly measures a firm's absorptive capacity. Whether this variable is used to depict the allocation of resources or absorptive capacity, it will relate in some way to the technological performance of the firm in some way" (Stock, 1995).

The Boston Consulting Group (BCG) has published the Top Global Challengers from RDEs six times: 2006, 2008, 2009, 2011, 2013, and 2014. Initially, these challengers relied on low cost resources and large captive markets such as China and India, which were their primary sources of competitive advantage. This advantage is eroding as lower costs may be found elsewhere and multinationals originating in RDEs must develop new capabilities in order to provide more high value-added products and continue investing in R&D. RDEs spent "$9 billion on R&D in 2004, equivalent to 1.3% of sales, to support the work of their 250,000 to 300,000 scientists" (BCG d, 2006). As their investment in innovative pursuits increased, their annual R&D expenditures more than tripled from 2007 through 2011 and from 2008 through 2013, their R&D expenditures increased by an average of sixteen percent (BCG c, 2014).

Among the top global challengers in rapidly developing economies, one would discover those that represent innovative leaders with high performance products that out-perform their counterparts within the same industry**.** Thoughtful pursuit and emulation of such successful firms would require thoughtful consideration of what high technological performance represents and how to quantify it for measurement purposes as the digital divide diminishes with 45 percent of the world's population utilizing the Internet by 2016, with nearly 800 million users being Chinese (BCG, 2013, p. 21).

According the BCG, the global challengers from the 2013 list are at a turning point in both their individual history as well as in the history of the economic development of RDEs, as their cost advantage over competitors is eroding. In response to this fact, these challengers have been building new capabilities such as manufacturing higher-quality products, harnessing their cash resources, and investing in R&D (Bhattacharya et al, p. 18). Many innovations are aimed at creating new business models rather than tangible products.

China and India do attract considerable foreign direct investment (henceforth FDI) from this group of rapidly developing economies. The market potential and new demand drive original innovation, which may change the whole landscape of multinational R&D network (Wang et al, 2012 p. 12). "Overseas R&D in developing countries is viewed as primarily cost-reduction driven and amidst to take advantage of local human resources to serve the home country.

Often, overseas R&D may be perceived as a cost-reduction measure to take advantage of local talent and resources unavailable elsewhere to serve headquarters and subsidiaries (Chen, 2004; Kumar & Argarwal, 2005; Lewen et al., 2009). "In addition, this type of R&D is relatively routinized and peripheral" (Wang et al, 2012).

"Large developing countries, such as Brazil, China and India, have dual technology environments. On the one hand, there are high-tech science and technology talents, which show complementarities with Western economies. On the other, a larger portion of the economy displays low science and technology development. TNCs are attempting to exploit the former" (Mott, CH 7, 2004).

"In general, it is observed that technology-intensive industries, such as electronics, biotechnology, chemicals and pharmaceuticals tend to internationalize their strategic R&D to a greater degree than other industries" (Mott, p. 2, 2004). Senior strategists of these challengers must continue to present "solutions to the constraints of emerging markets. They need to continue to create innovations and disruptions…but they also need to spend more money on R&D" (BCG b, 2014).

The Bottom Line – Profit Margins

The best performing large technology intensive industries have leaders at the helm that are able to navigate and provide direction to their teams in the most competitive environments, while demonstrating the ability to alter their course at any point of their journey. Effective leaders use "the adaptive processes to drive faster, more insightful approaches to innovation and to manage the shifting skills profiles required for their workforce" (Dean et al, 2013). They do all this effectively despite possible lack of experience and/or imperfect information. If leaders managed for cash instead of future growth and sustainability, the pace of innovation could slow and "the balance of power may shift to fewer, larger companies, potentially slowing innovation and discouraging growth" (Dean et al, 2013).

As previously mentioned this research focuses on technology intensive computer and software industries, which consist of several sub-industries with varying degrees of performance and innovation activities. Each sub-industry is dedicated to either manufacturing or services. For example, according to Dean et al, there are seven consumer device companies and 22 software and IT services companies generated "an average annual TSR of 7 percent over the five years...Computer hardware companies in the sample, victims of slow sales and contracting multiples, generated – 7 percent annual TSR…as rising R&D costs and price pressures took their toll", thereby faring less well than the first example which benefited from sales growth and improving margins (2013).

"IBISWorld forecasts industry revenue to grow at an annualized rate of 4.0% to $714 billion in the five years to 2019. During that time, the industry will benefit from continued economic recovery and growth in digital information and content" (p. 4, 2013). The revenue growth in these technology intensive industries will be spurred by innovations in products and service offerings as well as the continued growing demand for information technology. The high-velocity pace with which changes and technology take pace is unrelenting and omnipresent. This holds true in both manufacturing and service sectors of the technology intensive computer and software industries.

According to the BCG, the top global challengers have been able to resolve the three classic strategic tradeoffs regarding returns confronting companies: volume versus margin, rapid expansion versus low leverage, and growth versus dividends depicted below (2011, p. 9) (See Figure 6 on the following page).

Figure 6 - Top Global Challengers Resolve Three Classic Tradeoffs

Resolving Tradeoffs
Volume vs. Margins
Conventional logic assumes that firms make tradeoffs between volume and margin. The global challengers outperformed global peers by aggressively pursuing growth and taking advantage of their lower cost base to achieve higher margins.
Rapid Expansion vs. Low Leverage
To expand rapidly, companies often need to increase leverage to fund growth. The global challengers, however, achieved more than three times the sales growth of their global peers, while maintaining comparable leverage. Since the start of the economic downturn, they have reduced their leverage below that of their global peers. In 2009, the average debt-to-equity ratio among the global challengers was 65 percent, 3 percentage points lower than it was in 2005. By contrast, the same ratio for global peers rose from 52 percent to 66 percent over the same period.
Growth vs. Dividends
Investors expect growth companies to pay much lower dividends—if they pay them at all. Yet the global challengers have managed to achieve higher levels of growth than their global peers while delivering greater dividend yields in all years since 2004 except one.

Source:
https://www.bcgperspectives.com/Images/BCG_Companies_on_the_Move_Jan_2011_tcm80-70055.pdf

Prominent firms aggressively pursue growth while taking advantage of lower cost base advantages in order to achieve higher profit margins. However, firms must strategize carefully, as in order for them to expand their operations they increase leverage to fund this growth, which comes at a price. The BCG top global challengers, however, deriving from rapidly developing firms "achieved more than three times the sales growth of their global peers, while maintaining comparable leverage" (2011, 9). This is not to say that the economic downturn had no effect on these firms over this time period, however since then, they have "reduced their leverage below that of their global peers" (2011, p. 9).

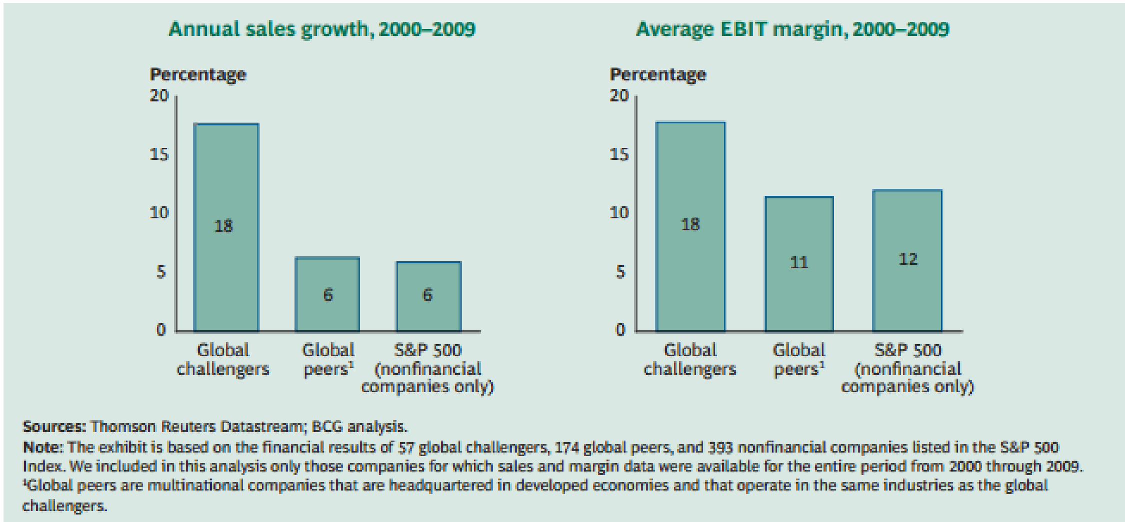
> "In 2009, the average debt-to-equity ratio among the global challengers was 65 percentage, 3 percentage points lower than it was in 2005. By contrast, the same ratio for global peers rose from 52 percent to 66 percent

> over the same period. Investors expect growth companies to pay much lower dividends – if they pay them at all. Yet the global challengers have managed to achieve higher levels of growth than their global peers while delivering greater dividend yields in all years since 2004 except one" (BCG, 2011, p. 9).

Mature, developed markets are characterized by slow-growth (i.e. EU), while quite the opposite is the case with RDEs, which may experience high-growth and volatility. The timeline from the past twelve years has depicted growth. "From 2008 through 2011, the revenues of global challengers grew by an annual average of 16 percent. Their average revenues now exceed those of the nonfinancial S&P 500 companies" (BCG c, 2013). Meanwhile, RDEs are fueling almost two-thirds of global GDP growth (BCG e, 2011).

Global challengers are indeed making a lasting impression with revenues increasing annually by 18 percent from 2000 to 2009, which is triple the average annual growth rate of their global peers in the same industry and the nonfinancial firms among the S&P 500 (BCG e, 2011). This growth rate was achieved without sacrificing margins. "The average operating margin (earnings before interest and taxes , or EBIT) of global challengers that were publicly listed during those years was 18 percent—6 percentage points higher than the average of the nonfinancial constituents of the S&P 500" (BCG e, 2011) (See Figure 7 on the following page). The global challengers have actually outperformed the S&P 500, the MSCI Emerging Markets Index, and their global peers for the past 12 years (BCG c, 2013).

Figure 7 - Global Challengers Exhibited Strong Sales Growth and Margins



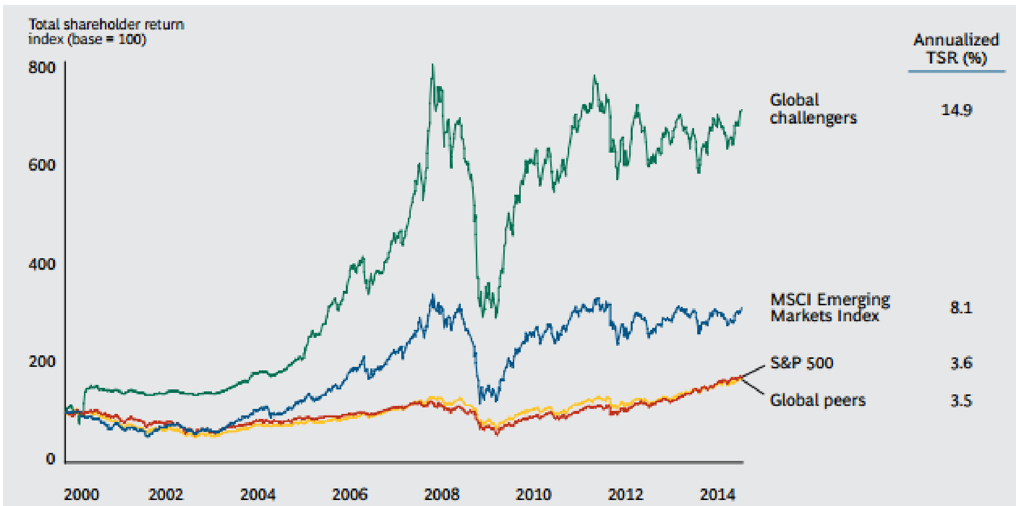
Source: https://www.bcgperspectives.com/Images/BCG_Companies_on_the_Move_Jan_2011_tcm80-70055.pdf

"Global challengers are growing more quickly than are comparable companies. From 2000 through 2013, the revenues of global challengers grew by an annual rate of 18% on average, compared with 7% for global peers and 6 percent for the nonfinancial S&P 500 (BCG b, 2014)." Such growth requires support from a skilled and talented workforce as new markets are tapped and running a global organization and acquiring and maintaining high cost talent becomes a crucial part of operations. Job growth in RDEs has been equally impressive as from 2008 through 2013, challengers increased their employment by 32%, compared with 11% for the nonfinancial S&P 500" (BCG b, 2014). Examples of significant employment growth in RDEs include average annual employment rates in India, which have risen to 40% by IBM Global Services, Accenture, and HP Enterprise Services (BCG e, 2011).

The economic downturn took a toll on the total shareholder return (TSR) of nearly all companies. But the performance of the global challengers has bounced back much more quickly and strongly than that of other companies. "From 2000 to 2009, the annualized

TSR was 17 percent for the global challengers while it practically stood still for the S&P 500 and global peers and rose much more modestly for the MSCI Emerging Markets Index" (BCG e, 2011). "From 2005-2009, global challengers delivered an annual return of 22 percent, on average, while global peers delivered just 5 percent" (BCG e, 2011). (See Figure 8 below).

Figure 8 - Global Challengers Outperform Over the Long Term



Sources: S&P Capital IQ; BCG analysis.
Note: The index base of 100 was set using data from January 1, 2000, and the data was analyzed through May 19, 2014. All indexes were weighted by the market capitalization of their constituent stocks. The index is based on data from 82 publicly listed global challengers and from 266 global peers. Global peers are multinational companies that operate in the same industries as the global challengers.

Source:
https://www.bcgperspectives.com/Images/Redefining_Global_Competitive_Dynamics_Sep_2014.pdf

Capturing and sustaining such dynamic growth requires a highly-skilled and talented workforce that shares the same level of commitment to develop products and provide services in these large high tech firms. They must learn how to conduct exploratory and exploitive innovative pursuits.

Product Innovation Learning

Considering learning in innovation involves redesigning existing products attributes, which is referred to as "re-innovation" by Rothwell and Gardiner (1989). Organizational learning can also be referred to as "product innovation learning", which is "the increasing effectiveness of product development efforts as a result of practice and refinement of innovation-related skills" (McKee, 1992). Argyris and Schon provide a similar definition. Organizational learning is "experienced-based improvement in organizational task performance" (1978). Although both definitions are dated, it remains clear that such learning plays a crucial role in regards to innovation as it holds strategic implications.

The assets acquired as a result of innovatory pursuits, commonly referred to as "knowledge capital", determine "ownership advantage" in regards to international market power (Athukorala & Kohpaiboon, p. 1336, 2010). R&D creates tacit knowledge, which requires a "high level of communication between the involved parties in order to transfer it" (De Meyer, 1991; Fisch, 2003; Gupta & Govindarajan, 2000; Nobel & Birkinshaw, 1998; Belderbos, 2013). Earlier models of knowledge being generated back in headquarters at home and subsequently shared with and applied by overseas subsidiaries has been replaced by newer models of knowledge capital being created by all functions of a firm (Wang, et al, 2012) and its competitiveness relies on the firm's ability to integrate knowledge from all over the world (Almeida & Phene, 2004; Bartlett & Ghoshal, 1989; Gupta & Govindarajan, 2000; Hedlund, 1994; Nobel & Birkinshaw, 1988).

Abernathy and Clark classify innovations into two categories: ranging from conservative to radical (1985). Conservative innovations enhance existing firm competences, while radical innovations disrupts existing firm or even industry competences. Abernathy and Clark map four types of innovations: architectural, niche, regular, and revolutionary with two axes: one indicating the effect of an innovation on the firm's market/customer linkages and the other axis indicating the effect of the innovation on the firm's technology/production competence. Stock (1995) interprets their work as implying "that revolutionary innovations are changes to process technology that produce new product technologies, where changes to the process applied to existing products most likely fall into the regular category. The implication is that architectural and revolutionary innovations result in technological discontinuities".

The ability to continually engage in activities that explore and exploit new opportunities is essential to all organizations across the globe. Such an ability for a firm is referred to as ambidextrous orientation, henceforth "AO", as both activities are performed simultaneously (Jansen, George, Van den Bosch, & Volberda, 2008).

"While exploitation consists of learning activities that are based on the refinement, efficiency, selection, and implementation of existing knowledge, exploration refers to the search, variation, experimentation, and discovery of new knowledge" (Heavey, p.5 2009). Thusly, one could consider exploitation relating to existing knowledge and exploration relating to newly discovered knowledge. Knowledge in both forms are essential, however, innovators rely more on explorative pursuits. Technical activities should always be consistent with market needs (Mitchell, 1985; Brownlie, 1987; Brownlie, 1992; Burgelman and Maidique, 1988). Abernathy and Clark classify innovations into two categories: ranging from conservative to radical (1985).

“Now an emerging evolutionary framework considers the ‘organizational learning’ by TNCs as the core explanation for globalization of R&D” (Mott, p. 2, 2004). These transnational corporations locate their R&D operations in close proximity to science and technology centers. “Learning takes place through closer interaction with major customers, suppliers and knowledge producers, such as universities” (Niosi, 1999). Locating R&D units near Science & Technology (S&T) Centers was once desirable, and now is a necessity. According to Mott, “the general trend has been that: (1) basic scientific knowledge is playing an increasingly crucial role in major technological advance, (2) many recent major innovations have occurred through cross-fertilization of different scientific disciplines, and (3) technology has acquired stronger systemic features” (Mott, 2004).

“The key driving force for globalization of R&D in recent years has been the increasing demand and competition for skilled scientists” (Motts, p. 32 2004). “…the RDE talent pool is deep and growing quickly, and RDE players are at an advantage when it comes to monetizing that pool relative MNCs that are setting up RDE-based R&D centers” (BCG d, 2006). With R&D resources roughly 1/5 the cost of development costs of western competitors, which may be the cause of multinationals setting up R&D centers (BCG d, 2006). Developments of such technologies requires a broad and diverse range of scientific disciplines and technological inputs, crossing the traditional boundaries between scientific and technological disciplines and categorization” (Howells, 1990).

Time-Based Innovation

Is time on their side? RDEs may have acquired certain advantages by learning from others' experiences within their given industry, as well as having a clearer sense of the capabilities that will be required. However, being first to market does have its privileges. The assumption in time-based innovation with regards to innovation has been that being the first to market is generally positive (Stalk, 1988; Vessey, 1991; Blackburn, 1990).

Taking advantage of learning curve effects in production and the perceived benefits of acquired patents are both general arguments for technology-based first-mover advantages. The predicament lies in keeping the technology propriety, which may prove difficult in many unregulated markets. According to Lieberman's empirical evidence, rivals can duplicate patented innovations rather quickly and at a lower cost (1988). Empirical research also includes studies in the diffusion rate of product and process innovation (Mansfield, 1985), the benefits to pioneer firms of patents and trade secrets (Robinson, 1988), and the rate and cost of imitating patented innovations (Mansfield, Schwartz, and Wagner, 1981).

"Existing literature has shown that entry timing matters for firm success in terms of financial performance (Lieberman and Montgomery, 1988), technology success (Schilling, 2002), and survival (Agarwal and Bayus, 2004, Bayus and Agarwal, 2007, Chen, Williams and Agarwal, 2011; Dowell and Swaminathan, 2006)." (Qian, 2011).

Entry timing also matters for a firm's inventive performance (Ahuja and Lampert, 2001; Fleming and Sorenson, 2001; Jiang, Tan and Thursby, 2011). Mechanisms leading to these beneficial outcomes are considered motivating factors for a firm to enter early or late; the motivating factors for choosing entry timing for each of these two strategic maneuvers may differ (Conner, 1988). (Qian p. 91, 2011).

The learning or experience curve depicts operations that are performed routinely. The cumulative production doubles as the time and cost required to produce one unit declines by a constant rate. Competitive cost advantages can be obtained by firms being the first to develop and introduce a product to the market. As firms gain such advantages, by moving down the learning/experience curve earlier and faster than their competitors (Stalk, 1988; Blackburn, 1990; Lieberman, 1988). The assumption in time-based innovation with regards to innovation has been that being the first to market is generally positive (Stalk, 1988; Vessey, 1988; Blackburn, 1990).

Many consumer goods and services need to be tailored to the local market, especially higher value-added products from technology intensive industries. This requires both strong capabilities and several functions working together with R&D, such as marketing, supply chain management, talent acquisition, and sales. Marketers must define what customer needs and requirements are for the product and translate these needs into technical specifications that will meet them. This translation is designed through Quality Function Deployment (Hauser and Clausing, 1988). Gehani promoted cross-functional integrating of R&D, Marketing, and production through utilizing computer hardware and software programs for efficiency (1992).

“The innovatory process essentially involves communication and cooperation with personnel involved in production design, marketing and other related key functions. There is also the need for better motivation of R&D efforts towards objectives set by the top management (Athukorala and Kohpaiboon, 2010). This also needs to be communicated across a network of teams for a shared vision.”…dispersion for executing parallel R&D projects at plant level could be wasteful and reduce productivity of the overall R&D effort (Daft and Lengel, 1986).

Top management often has the unenviable task of considering leveraging or stretching current resources in order to make decisions pertaining to R&D (Coombs, 1996, Prahalad & Hamel, 1990, 1993; Roussel, Saad, & Erickson, 1991). According to Kim (2013), such R&D decisions are difficult as they are “made with high uncertainty and risk, since market reaction, market value, and financial benefits do not linearly respond to R&D expenditures” (Lach & Schankerman, 1989; Koku, 2010).

Easy growth opportunities overseas are usually pursued and tapped out quite early, however, then comes the more daunting task of taking on new initiatives aimed at expanding international revenue. BCG Global Challengers have “substantially outperformed” S&P500 firms, MSCI Emerging Markets Index firms, as well as their global peers realizing total shareholder returns of 3.6%, 8.1%, and 3.5% respectively (BCG b, 2014). The Global Challengers had annualized total shareholder returns of 14.9%, nearly double that of their nearest competitor MSCI Emerging Market Index firms which scored 8.1%.

For high-tech firms to become true global leaders, they need to “develop even deeper benches of talent and strengthen current people practices. Therefore, as the cost edge of global challengers shrinks, they need to become increasingly innovative—not just pouring money into R&D but also developing a strategic view of the technological landscape and their place within it” (BCG b, 2014).

The changing pattern of global competition, coupled with rapid technological changes leading to the shortening of product life cycles, placed innovation as a key source of competitive strength” (Motts, Ch. 3. P. 9 2004). “When an emerging radical technology will potentially displace the current technology, a shift from the existing technology regime to a new one is likely to occur. Such a regime shift impacts not only the core technology of incumbents, but also the operation of and coordination across upstream and downstream activities” (Qian, 2011). As incumbents are all utilizing the same design, one may assume that the “impact on core technology is similar across incumbents, as they are currently using the same dominant design. While industry entry represents a complete shift from the old to the new regime, engagement in R&D prior to commercialization can happen in the interim of this shift” (Qian, 2011).

Measuring Innovation Output – Patents Granted

The most widely used variable to measure innovative effort or innovative activity is R&D expenditures, however, it is not an indicator of innovative output. Therefore, patent counts will be the variable utilized in this study to measure innovative output. According to Scherer (1990), the number of patented inventions is “the most comprehensive quantitative indicator of industrial technology outputs”. “International patents are the most useful innovation efforts, and may even represent direct indications of innovative output…Patents are acknowledged to provide a reliable and unbiased indication of national innovative effort" (Nam & Barnett, 2011; Huang, Shih, & Wu, 2011; Ma, Lee & Chen, 2011).

"Intellectual property performance can be used as a measure of the output of inventive activities, innovative activities technological changes, technological strengths, and accumulated capabilities of the globalization of technology because IPR performances, such as patents, publications in scientific journals, copyrights, and trademarks, are regarded as products of innovation efforts, and may even represent direct indicators of innovative output" (Nam & Barnett, 2011; Huang, Shih, & Wu, 2011; Ma, Lee & Chen, 2009). In order to be patented, it must be packaged. This process of commercialization represents the "process of the production, manufacturing, packaging, marketing and distribution that embodies an innovation" (Rogers, 2003).

Technology-based first-mover advantages include taking advantage of learning curve effects in production and the perceived benefits of acquired patents. The predicament lies in keeping the technology propriety, which may prove difficult in many unregulated markets. Pharmaceutical patents, for example, offer weak protection from competitors. (Stock, 1995) "However, other factors are beginning to offset this apparent weakness…RDEs are fast developing R&D talent" (BCG d, 2006). According to Lieberman's empirical evidence, rivals can duplicate patented innovations rather quickly and at a lower cost (1988).

Learning curve effects involving first-mover effects theoretical models have been the focus of some studies (Spence, 1981; Lieberman, 1987) as have patent races (Reinganum, 1983; Conner, 1988). According to Stock (1995), empirical research also includes studies in the diffusion rate of product and process innovation (Mansfield, 1985), the benefits to pioneer firms of patents and trade secrets (Robinson, 1988), and the rate and cost of imitating patented innovations (Mansfield, Schwartz, and Wagner, 1981).

Intellectual Property Rights (IPR) protect creative works, trade secrets, and newly developed technology to promote innovations that add to a country's knowledge base and prevent others from taking action that infringe upon or damage the property of the owner (Nam & Barnett, 2011). Although the trade of innovative goods is a main route for the international exploitation of locally produced innovations, technological processes and routines may also be exploited to acquire technological advantages which introduce the latest technology. "This strategy of exploitation in foreign markets innovations is both: *embodied* in products (a product is patented to prevent others from producing similar goods, thus covering the existing market); and *disembodied* (an innovation is patented in order to license it)" (Nam & Barnett, 2011). Such exploits help diminish transportation costs, barrier to imports, and high wage differentials in the importing country.

"Other studies also proposed that stronger IPR protection not only encourages FDI, R&D, and employment in developing countries, and the rate of technology transfer, but also decreases wage gaps in the developed and developing countries, and temporarily increases innovation rates in the developed countries" (Nam & Barnett, 2011; Helpman, 1993; Lai, 1998; Dinopoulos & Segerstrom, 2010, Bosworth & Yang, 2000)

The U.S. Patent Trademark Office (USPTO) provide indices of patents granted, which are in turn utilized by the World Economic Forum (WEF), United Nations Industrial Development Organization (UNIDO), as they are generally accepted by each entity as representing the most valuable innovations (Archibugo & Cocoa, 2005). Patent applications require the name of the inventor, their country of residence, and location of inventive activity for the patent (Ma, Lee, & Chen, 2011).

"The recent avalanche of high-profile patent cases and patent sales, mainly in the technology and telecommunications sectors but also in others, has made it clear that innovation depends, in part, on owning an idea" (Gilliland, Varadarajan Raj, 2014). Clearly, the strategic consideration of which innovations to pursue and develop should be weighted against the degree of protection. Gilliland et al, suggest strong innovators are "more than twice as likely as their weaker counterparts to use IP as a source of competitive advantage" (2014).

The growth in the number of patents acquired by RDEs was severely lacking when compared with the EU from the BCG 2006 Report. Their general weakness is reflected in the small number of patents they held. "From 1999 through 2003, all companies based in the 5 largest RDEs obtained only 3,900 U.S. patents, whereas companies based in Japan and Germany obtained 166,000 and 54,000, respectively (BCG, 2006, p. 22). Clearly, the RDEs are at a disadvantage during this time period, however, this research proposes that the number of patents granted is growing faster than EU member countries. From 2008 through 2013, the challengers increased their R&D spending by an average of 16 percent, four times faster than the top 100 US patent issuers—but they still have a long way to go to catch up" (BCG b, 2014).

Despite this relative weakness, the BCG also reported RDEs were developing talent (i.e. graduates in engineering, mathematicians, and scientists) for which the pool of graduates would be 12 times the output that of the university system (BCG, 2006, p. 22). In addition, RDEs were also utilizing resources which are far less expensive at one-fifth the development cost of Western competitors (BCG, 2006, p. 22).

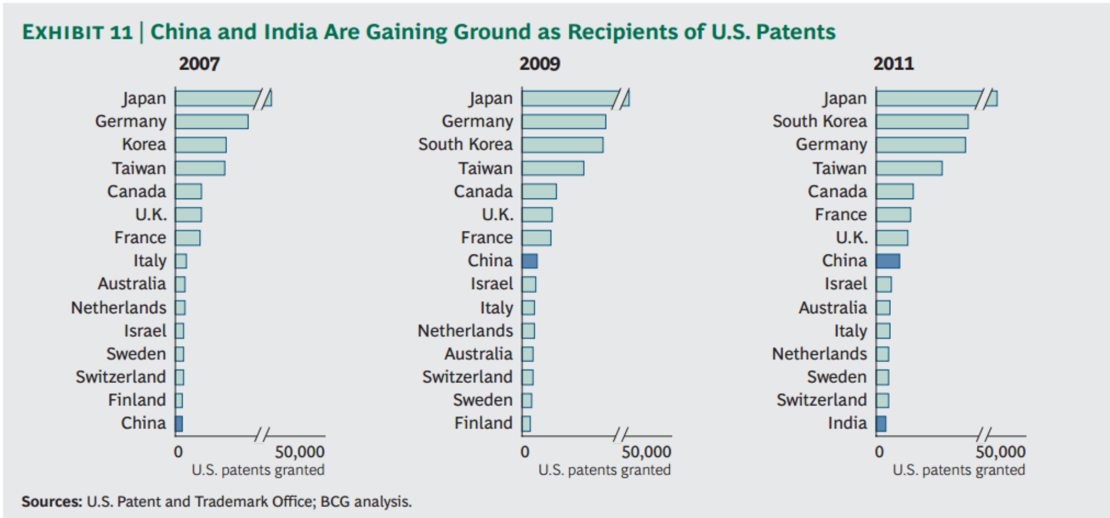
Companies need to ensure they are getting the most out of their talent pool, train and re-train them to keep up with existing and new technologies, and retain them through providing attractive career paths. Training should focus on "languages, frameworks, platforms, and applications where supply is short", as talent acquisition is a top priority in technology intensive industries (Gilliland, Varajaradan, & Raj, 2014). Interactions with universities and science centers may lead to a "co-evolution of technological capabilities" (Freeman, 1987; Leydesdorff & Etzkowitz, 1996; Lundvall, 1992; Murmann, 2003; Nelson, 1993; Beldebos, 2013).

According to the 2013 BCG top global challengers, "the number of patents granted by the U.S. Patent and Trademark Office to companies based in RDEs increased at a rate more than three times faster than that of companies in other countries. If this growth continues, up to 25 percent of the patents issued in 2018 may originate in RDEs—up from just 1 percent in 2006" (Bhattacharya, p. 19). The patent growth in China and India alone has increased in excess of 30 percent annually, and these challengers account for approximately 22 percent of the growth in patents in RDEs despite representing less than 11 percent of the firms from RDS that received U.S. patents two years prior in 2011 (BCG, 2013).

RDEs are certainly focusing their efforts on innovation. In the past five years (2009-2013), "the number of U.S. Patent and Trademark Office to companies based in RDEs increased at a rate more than three times faster than that of companies in other countries. If this growth continues, up to 25 percent of the patents issued in 2018 may originate in RDEs—up from just 1 percent in 2006" (BCG c, 2013).

The number of patents originating from China and India is increasing by 30 percent annually (BCG c, 2013). "Overall, challengers are responsible for about 22 percent of the growth in patents issued to investors in RDEs—even though they represent less than 11 percent of the companies from RDEs that received U.S. patents in 2011" (BCG c, 2013). In 2011, companies from China were granted more U.S. patents than companies in Israel, Australia, Italy, Netherlands, Sweden and Switzerland (BCG c, 2013). India joined China in the top 15 for the first time in 2011. China debuted on the list in 2007 (See Figure 9 on the following page).

Figure 9 - China & India Are Gaining Ground as Recipients of U.S. Patents



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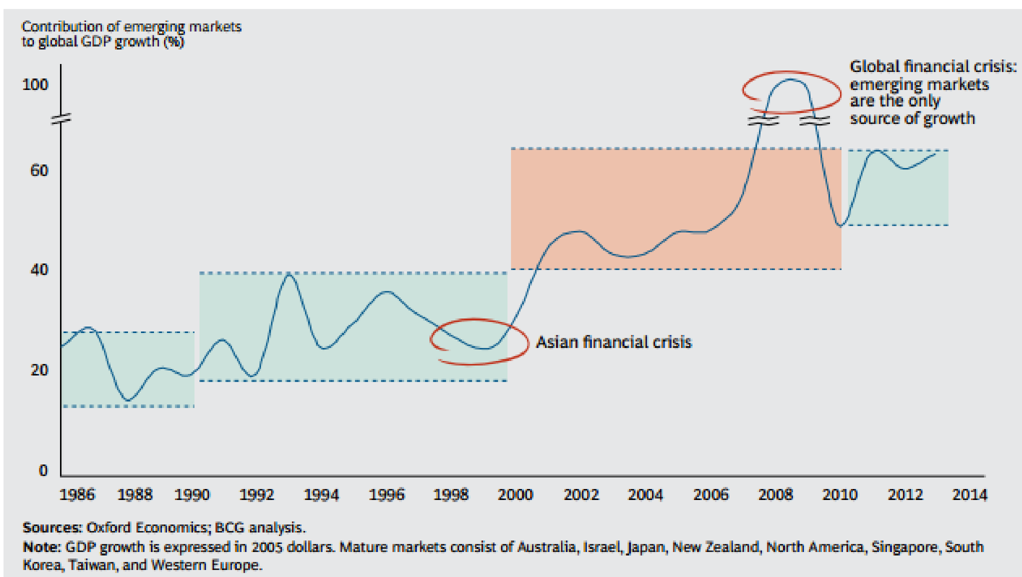
Economic Growth - Impact of Global Recession

The world economy has not fully escaped the unrelenting grip of the global recession. There has been only a modest improvement in the economy in 2014, which is only expected to increase between 2.5% and 3.0% (WTO, 2014). Developing countries as a whole (not just RDEs), are expected to grow between 4.5% and 5.0%, repeating their previous year's performance, while transition economies are expected to further decelerate to around 1.0% (WTO, 2014). Developed economies are predicted to grow from 1.3% to 1.8%, which may be assisted by the "more accommodating monetary policy stance" by the European Central Bank, which has helped "pull demand growth back into positive territory" (WTO, 2014).

RDEs are fueling a significant portion of GDP growth, despite the recent global recession. This stability allows for sustainability and growth to continue as opposed to developed countries who were certainly not left unscathed by the economic downturn. While others are trying to recover, technology intensive industries in RDEs continue to grow and generate high value-added products.

According to Oxford Economics and BCG Analysts, emerging markets were the only source of growth during the global financial crisis as shown in Figure 10 below. The rapid success of many of these firms has been attributed to "relying on innovation, talent, and other strengths to win" (BCG b, 2014).

Figure 10 - Emerging Markets Are Powering Global Growth



Source:
https://www.bcgperspectives.com/Images/Redefining_Global_Competitive_Dynamics_Sep_2014.pdf

RDEs are fueling "two-thirds of global GDP growth" (BCG b, 2014). According to the Boston Consulting Group, if RDEs maintain their current growth rates, fifty of the global challengers could qualify for inclusion into the Fortune Global 500 within the next five years and by 2020, “the challengers could collectively generate $8 trillion in revenues, an amount roughly equivalent to the collective revenues of the S&P 500 today” (BCG e, 2011).

China and India now represent less than 50% of the total number of firms on the Top Global Challenger list for the first time in 2014. The inaugural 2006 list only had 10 countries represented and 2014 has nearly double the number of countries represented with 18. “Over the past decade, the share of global GDP generated by RDEs rose from 18 percent to 31 percent; their share of world trade jumped almost as much, from 18 percent to 28 percent. As of 2011, RDEs accounted for “half of the influential G-20” and 75/100 are in the Fortune 500 (BCG e, 2011).

It is further estimated that RDEs will grow at approximately a 5.5% annual average growth rate over the next ten years, as opposed to developed economies, such as the EU, that will only grow at a mere 2.6% annual average growth rate (BCG e, 2011). This is how each group of countries will grow relative to each other, but how do they measure up to an economic growth indicator such as GDP?

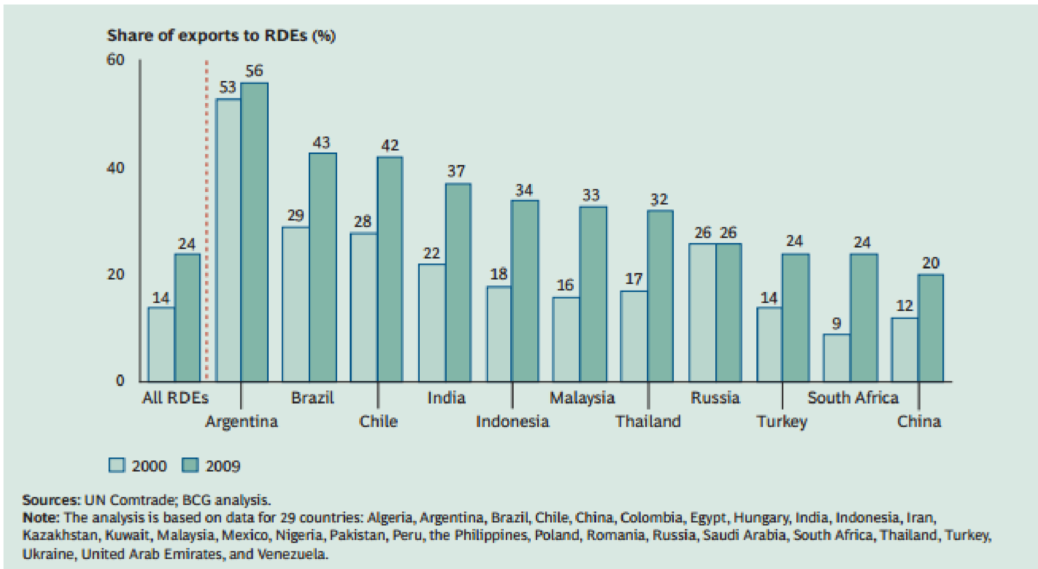
As of 2011, RDEs captured 31% of global GDP, however, this will increase to 45% by 2020 (BCG e). All this growth is not going to originate from the presumed BRIC nations of Brazil, Russia, India and China, however. If these countries are excluded, along with Mexico, the “40 countries projected to have the highest growth in real GDP over the new decade include 18 countries in Africa, Eastern Europe, and Latin America” (BCG e, 2011). This certainly paints a different picture for strategists and economists alike to ponder over the next ten years.

Straining to Meet Demand – Trade Outlook

Rapidly developing economies are increasing their participation in international trade as they grow their customer base through not just expanding their marketing and production efforts, but also their R&D activities. Such activities help multinationals stay on the cutting edge of technological innovation and increase their competitive strength in the global marketplace, which in turn can develop the economies in which they operate.

"The main factors providing economic justifications for enhanced R&D in developing economies today are: (1) the recognition that emerging economies are themselves growing markets for advanced products; and (2) the ability of emerging economies to produce advanced manufactured products for exports in global markets" (Motts, 2004). RDEs have already started producing higher value-added products and exporting them to global markets, however, they also do a significant portion of trade with each other. The expansion of emerging markets is swelling trade volumes in the region as depicted in Figure 11 on the following page.

Figure 11 - Many RDEs Derive Significant Export Revenues from Other RDEs

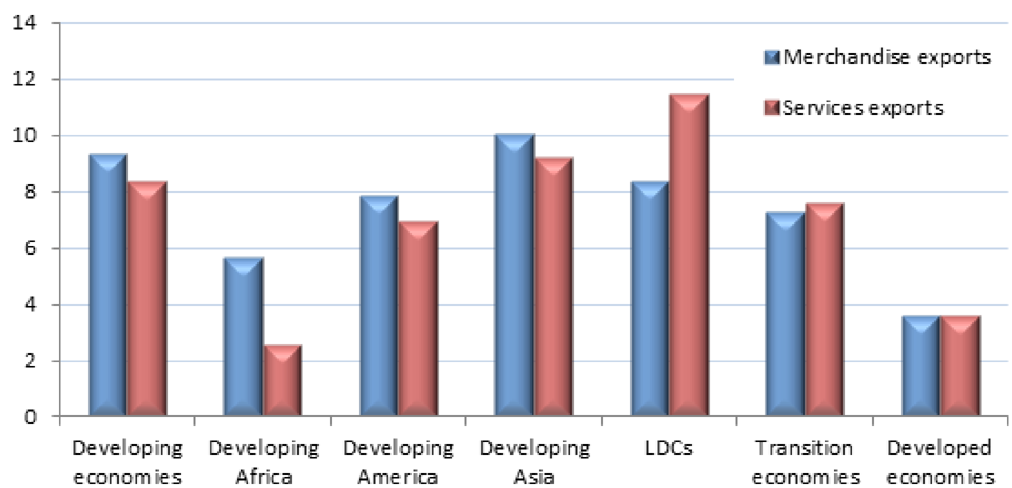


Source:
https://www.bcgperspectives.com/Images/BCG_Companies_on_the_Move_Jan_2011_tcm80-70055.pdf

Such countries as Brazil, Chile, India, Indonesia, Malaysia, Thailand, and Russia now receive more than 25 percent of their export revenues from other RDEs" (BCG e, 2011). In addition, the fastest growing top 20 trading partners of 2020 are predicted to be India and the United Arab Emirates, followed by other RDE countries such as: China and India, and then China and Brazil as partners (BCG b, 2014). (See Appendix 1). Asia, Africa and South America have higher market share than their multinational competitors as they "understand the constraints of these markets and have business models that apply to them. In many markets, multinationals are the challengers—not the other way around" (BCG b, 2014).

According to UNCTAD and WTO estimates, "World merchandise exports grew by 2.1% in 2013 (current prices)" (2014). Overall, both entities reported that the fourth quarter of 2013, when compared with the same quarter the previous year, that "world merchandise exports and imports volume increased by 3.6% and 2.8%, respectively" (2014). See Figure 12 below. In addition, "Developing economies registered the fastest exports growth among the major groups (4.2%), followed by developed region (3.2%)" (UNCTAD & WTO, 2014). Developed countries maintained the same level of total exports during the final quarter of 2013 as they had in the previous year (UNCTAD & WTO, 2014).

Figure 12 - Annual Avg Growth Rates of Mdse & Svc Exports, 2008-2013 (%)



Source: http://unctad.org/en/pages/Statistics.aspx

The highest annual average growth service sector from 2008 through 2013 has been computer and information services at an average of 9.1% annual average growth (UNCTAD & WTO, 2014). It is also in the "computer and information services sector that developing economies record highest growth rates: 13 % on average annually since 2008, compared with 7.5 % for developed countries" (UNCTAD & WTO, 2014).

This increase in trade in general is straining the capacity at ports and terminals around the world. However, this less prevalent in the European Union, and significant investment in infrastructure elsewhere will be necessary to meet demand. For instance, “in Latin America, port capacity will need to double every five years in order to accommodate increasing cargo traffic. Container demand in Asia grew by an average of 12 percent annually from 2005 through 2009, compared with growth of 5 percent in other parts of the world. By 2015, the Asia-Pacific region is expected to handle 68 percent of global traffic, and trans-Pacific trade combined. In order to accommodate this growth, $51 billion in port-related infrastructure investments are required, according to the United Nations” (BCG e, 2011).

To illustrate response for this demand, global challenger, DP World of the United Arab Emirates, has a core strategy of focusing on rapidly developing economies and is growing fifty percent larger than the industry average. They are simply targeting where their competitors are not and/or do not have the capacity to meet their consumer needs. Of DP World’s 50 terminals and 11 new developments and major expansions, 37 are in Africa, Asia, and Latin America. DP World plans to double capacity in line with market demand during the new decade to around 92 million TEU (can industry measure of container unites), mostly in such emerging markets as Brazil, Egypt, India, Pakistan, and Turkey” (BCG e, 2011).

Opportunities & Challenges to Firms

Half of the top global challengers from the BCG 2006 list did not make the cut and were replaced by new challengers for the 2013 list. New opportunities for these challengers to reach the next level of global expansion would be for them to build capabilities beyond cost advantages, greater engagement with both private and public entities, and greater access to new growth opportunities as they develop localized approaches in emerging markets (BCG, 2013, p. 29).

"The success of global challengers will increasingly rest on innovation, operational excellence, quality, branding, and customer service. These capabilities need to be backed by organizational capabilities such as talent management and brand-building (BCG, 2013, p.28). In addition, these firms have been entering into partnerships and alliances with other global challengers versus other established multinationals to share mutual knowledge and expertise, gain access to new markets, achieving scale to compete globally, and share high-risk investments (BCG, 2011, p. 19). Lastly, these partnerships are born from positions of strength versus past ventures that were formed based on transfers of technology from the MNE to the challenger or to satisfy regulatory requirements present in the RDE (BCG, 2011, p. 19).

BCG top global challengers are financially fit firms which utilize innovate business models that have allowed them to succeed in new markets and acquire attractive assets in order to compete with more established companies that may still be in recovery mode. "If they maintain their growth trajectories, they will acquire significant status over the new decade. Within the next five years, 50 of the global challengers could qualify for inclusion in the *Fortune* Global 500. Within ten years 15 to 20 challengers may join the *Fortune* 100. By 2020, the challengers could collectively generate $8 trillion in revenues, an amount roughly equivalent to the collective revenues of the S&P 500 today" (BCG, 2011, p. 22). It is important to note that external economic conditions can influence such predictions.

Firms in developed and developing economies alike face multiple challenges in the high-tech industry as they feel "increased pressures on several fronts—including significantly more volatile costs, changes in government priorities, and the need for international brand recognition and world-class R&D capabilities—have not deterred the challengers from their growth ambitions" (BCG 2009, p. 22).

Excessive rates of innovation may prove detrimental to firm performance as evidenced by Yoffie & Cusumano's (1999) work describing how increasing resistance of corporate clients to rapid product developments by Netscape in the 1990s (Kim, 2013). Strategic R&D decisions involve high levels of uncertainty and financial risk. While studies illustrate the importance of tacit knowledge (R&D managers' knowledge or experience), R&D managers' openness, decision-making, and R&D strategies, "there is a lack in examining R&D management capabilities toward new technology, knowledge, and tacit knowledge in achieving innovation and executing strategies" (Kim, 2013).

CHAPTER 3: METHODOLOGY

This dissertation is a comparative study that evaluates innovation factors of two groups depicting opposing levels of economic development: Rapidly Developing Economies and the European Union. Large, technology-intensive firms originating in both groups had to be public firms acquiring at least $5 million in sales. This requirement caused several RDE countries to be dropped from the study: Argentina, Brazil, Chile, Colombia, Egypt, Mexico, and Russia. Several EU countries were also dropped, because they didn't meet this requirement either: Bulgaria, Croatia, Czech Republic, Estonia, Latvia, Lithuania, Luxembourg, Malta, Portugal, Romania, and Slovakia. As Hungary and Poland appeared in both groups, they were dropped from the study.

A total of 568 large high-tech firms; 271 from RDEs and 297 from the EU. The complete datasets associated with each hypothesis may be found in the Appendix: "Complete Dataset for Statistical Analysis" beginning on page 100. These firms were originally queried by 5-6 digit NAICS industry codes. This resulted in the following breakdown as shown in Figure 13 below:

Figure 13 – Eligible Firms by Group & NAICS Industry Codes

RDEs	EU	Code	Description
13	7	334111	Electronic Computer Manufacturing
3	0	334112	Computer Storage Device Manufacturing
13	16	334118	Computer Terminal & Other Computer Peripheral Equipment Manufacturing
216	247	54151	Computer Systems Design & Related Services
55	50	511210	Software Publishers
271	**297**	**Total Technology Firms in the Study**	

Estimation and Hypothesis Testing for Two Population Parameters

Each group was compared to the other through estimating the difference between the two means when σ_1 and σ_2 are unknown, using independent samples. "When estimating a two population means for unknown standard deviation, the critical value is a *t*-value from the *t*-distribution. It was assumed that the populations are normally distributed and the samples are independent of each other. The samples are considered independent, as both datasets have no influence on any specific amount will be found in the other sample. The confidence interval estimate for the difference between two population means is calculated as follows:

$$(\overline{X_1} - \overline{X_2}) \pm t s_p \sqrt{\frac{1}{n_1} + \frac{1}{n_2}}$$

Where:

$$s_p = \sqrt{\frac{(n_1 - 1)s_1^2 + (n_2 - 1)s_2^2}{n_1 + n_2 - 2}}$$

Equals pooled standard deviation

t = Critical *t*-value from the *t*-distribution, with degrees of freedom equal to $n_1 + n_2 - 2$

In the above equation s_1^2 and s_2^2 are estimators of the same population variance, σ^2.

A weighted average, denoted as s_p^2 to estimate σ^2, where the weights are the degrees of freedom associated with each sample. The pooled standard deviation was utilized:

$$s_p = \sqrt{\frac{(n_1 - 1)s_1^2 + (n_2 - 1)s_2^2}{n_1 + n_2 - 2}}$$

Variables and Data Sources

NAME	SOURCE
H_1: *Large technology firms in Rapidly Developing Economies (RDEs) spend more on R&D compared to large technology firms in EU countries*	
Sales, 2013	Hoovers
R&D Expenditures, 2013	OneSource Income Statement
H_2: *Large technology firms in Rapidly Developing Economies (RDEs) are more profitable compared to large technology firms in EU countries*	
Net Profit Margin, 2013	One Source GlobalData
H_3: *Rapidly Developing Economies (RDEs) acquire more patents per capita compared to EU countries*	
# Patents Granted, 2012	World Trade Organization Statistics Database
Adult Population, 2012	CIA World Factbook
H_4: *RDEs have more high-tech exports as a percent of manufactured goods than EU countries*	
High-Tech Exports (% of manufactured goods), 2012	World Databank
GDP per capita, 2012	World Databank

CHAPTER 4: RESEARCH FINDINGS AND DESCRIPTIVE STATISTICS

Manufacturing vs. Service Firms

Each firm included in the study were separated into two possible groups by eight digit Standard Industrial Classification (SIC) codes: high-tech service or high-tech manufacturing according to their primary industry. The result for each hypothesis is categorized accordingly with the total number of firms broken out by either region; RDE or EU. A total of 13 high-tech service SIC codes are represented in this study and 9 high-tech manufacturing SIC codes (See Figure 14 below).

Figure 14 High-Tech Standard Industrial Classification (SIC) Codes

Service		***Manufacturing***	
73710000	Custom Computer Programming Services	35710000	Electronic Computers
73710300	Computer Software Development & Apps	35720000	Computer Storage Devices
73710301	Computer Software Dev	35750000	Computer Terminals
73710302	Software Programing Applications	35770000	Computer Peripheral Equipment, nec
73730000	Computer Integrated Systems Design	35780300	Banking Machines
73730100	Systems Software Development Services	35780301	Automatic Teller Machines (ATM)
73730200	Systems Integration Services	73720000	Prepackaged Software
73730201	Local Area Network (LAN) Systems Integrator	73729901	Application Computer Software
73730300	Computer System Selling Services	73729902	Business Oriented Computer Software
73760000	Computer Facilities Mgmt		
73790000	Computer Related Services		
73790100	Computer Related Maintenance Services		
73790200	Computer Related Consulting Services		

Hypothesis One (H_1)

The first hypothesis in the study postulated that large technology firms in Rapidly Developing Economies (RDEs) spend more on Research and Development (R&D) compared to firms in European Union (EU) member countries.

There were 100 RDE technology intensive firms with three-quarters from the service sector of the industry and one-quarter from the manufacturing sector (See Figure 15 below). Of these 75 service firms the largest number of firms belonged to those primarily participating in Computer Software Development, followed by Computer Integrated Systems Design and Computer Software Development & Application who are tied for second and third. Prepackaged Software represented almost half of all the RDE manufacturing firms.

Figure 15 - Overall RDE Results

Manufacturing SIC Codes		
35710000	Electronic Computers	5
35720000	Computer Storage Devices	2
35750000	Computer Terminals	1
35770000	Computer Peripheral Equipment, nec	2
35780300	Banking Machines	2
35780301	Automatic Teller Machines (ATM)	1
73720000	Prepackaged Software	11
73729901	Application Computer Software	1
73729902	Business Oriented Computer Software	2
	TOTAL RDE FIRMS	**27**
High-Tech Service SIC Codes		
73710000	Custom Computer Programming Services	7
73710300	Computer Software Development & Applications	11
73710301	Computer Software Development	23
73710302	Software Programming Applications	1
73730000	Computer Integrated Systems Design	11
73730100	Systems Software Development Services	8
73730200	Systems Integration Services	5
73790000	Computer Related Services, nec	5
73790100	Computer Related Maintenance Services	1
73790200	Computer Related Consulting Services	1
	TOTAL RDE FIRMS	**73**

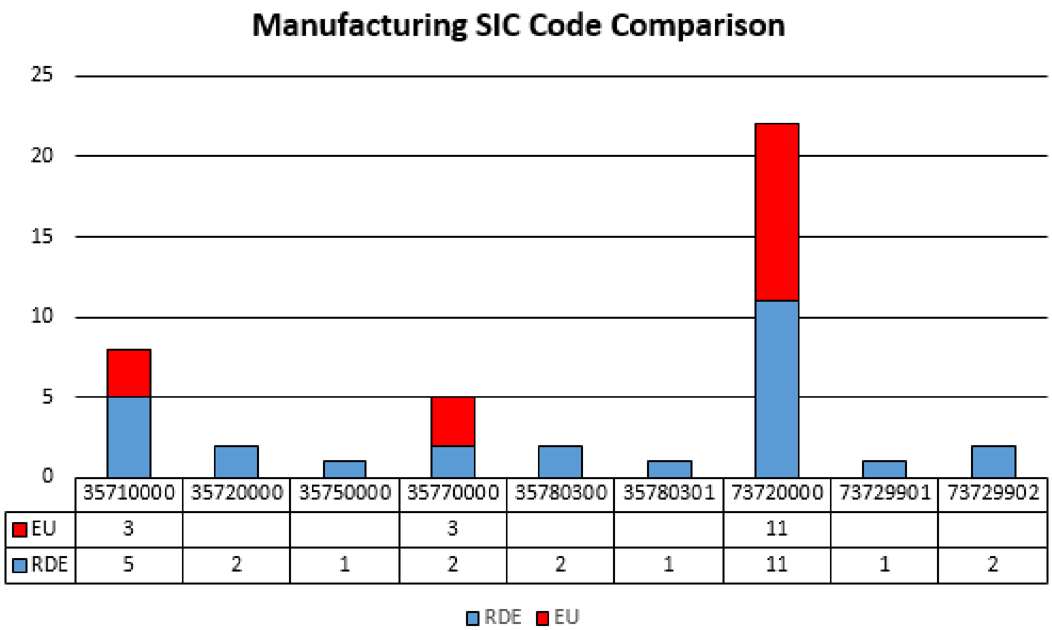
The EU had very similar representation. There were a total of 74 technology-intensive firms (See Figure 16 below), with three-quarters from the service sector and one-quarter from manufacturing. Computer Related Services represented nearly half of the service firms, followed by Custom Computer Programming Services.

Figure 16 - Overall EU Results

Manufacturing SIC Codes	
35710000 Electronic Computers	3
35770000 Computer Peripheral Equipment, nec	3
73720000 Prepackaged Software	11
TOTAL EU FIRMS	**17**
High-Tech Service SIC Codes	
73710000 Custom Computer Programming Services	19
73710300 Computer Software Development & Applications	1
73710301 Computer Software Development	9
73790000 Computer Related Services, nec	25
73790200 Computer Related Consulting Services	3
TOTAL EU FIRMS	**57**

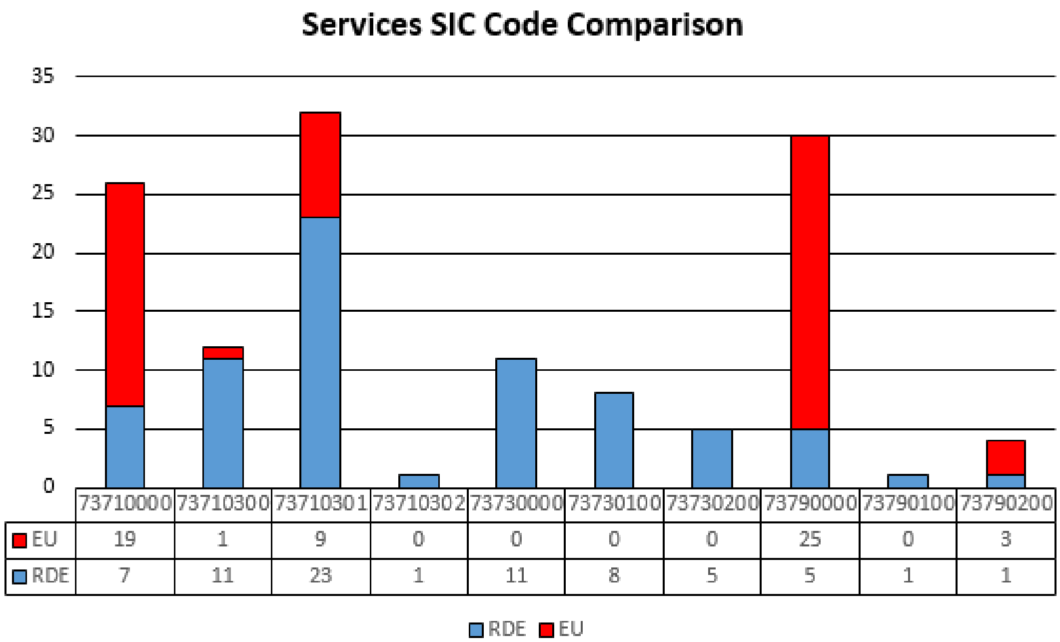
When comparing both groups of countries, a distinct, leading manufacturing SIC code emerges: 73720000 Prepackaged Software (See Figure 17 on the following page). Both groups actually tie with 11 firms representing this particular sector for all firms included in this dataset. The other two distinctions are represented by 35710000 Electronic Computers and 35770000 Computer Peripheral Equipment. The rest of the SIC codes are widespread and limited if any representation from both groups.

Figure 17 - Manufacturing SIC Code Comparison



Evaluation of the Service SICs, surmises that the highest represented Service SIC for RDE countries is 73710301 Computer Software Development followed by a tie for the next most prominent SICs: 73730000 Computer Integrated Systems Design and 73710300 Computer Software Development & Applications. The EU countries, however, do not follow suit. The most prominent SIC code representing services is 73790000 Computer Related Services, followed by 73710000, Custom Computer Programming Services, and 73710301 Computer Software Development as depicted in Figure 18 on the following page.

Figure 18 - Service SIC Code Comparison



The data collected from these firms measured the proportion of R&D Expenditures to Sales for each firm. The null hypothesis suggested that the proportion of RDE R&D Expenditures would be less than or equal to EU R&D Expenditures. This null hypothesis was accepted as the t-stat was less than t-crit and the p-value of 0.16604 is not less than 0.05 (See Figure 19 on the following page).

Figure 19 - H_1 Data Analysis

t-Test: Two-Sample Assuming Unequal Variances

	Proportion RDE	*Proportion EU*
Mean	125.7374477	12.43208946
Variance	1325898.852	361.356465
Observations	100	88
Hypothesized Mean Difference	0	
df	99	
t Stat	0.983848008	
P(T<=t) one-tail	0.163794297	
t Critical one-tail	1.660391156	
P(T<=t) two-tail	0.327588594	
t Critical two-tail	1.984216952	

Both groups were also compared by their manufacturing and service sectors to see if there was a difference between the two groups and whether RDE firms spent more on R&D expenses than EU firms. It was ultimately determined that there was not a distinction between groups (See Appendix 1). In addition, both groups were further examined to see if there was a significant difference between manufacturing and services within the same economy (i.e. Comparison of RDE manufacturing and RDE service). The results indicated that neither group is significantly outspending the other in R&D (See Appendix 2). However, there was a distinct concentration of SIC codes for the EU firms where only three manufacturing and five service SIC codes were represented (See Appendix 3).

Lastly, the data depicting top spending firms was gathered to represent those technology intensive firms who spent at least $5 million US. This decreased the number of observations to 56 RDE and 39 eligible EU firms, which in itself demonstrates that more RDE firms met this criteria than EU firms. The data analysis proves that top spending

R&D firms from RDEs do not spend more than EU firms (See Appendix 4). Consequently, more RDE firms may have met the criteria, however, they are not spending more than their EU counterparts.

Hypothesis Two (H_2)

The second hypothesis in the study postulated that large technology firms in Rapidly Developing Economies (RDEs) are more profitable compared to firms in European Union (EU) member countries.

There were 81 RDE and 118 EU technology intensive firms, which were primarily represented by service SICs with 72 out of 81 for the RDE group and 92 out of 118 or 89% and 80% respectively. The largest RDE SIC code representing one-third of all industrial codes was Computer Software and Development, followed by Computer Software Development & Applications and a tie for third between Custom Computer Programming Services and Computer integrated Systems Design (See Figure 20 on the following page).

Figure 20 - Overall RDE Results

High-Tech Service SIC Codes		
73710000	Custom Computer Programming Services	10
73710300	Computer Software Development & Applications	14
73710301	Computer Software Development	23
73710302	Software Programming Applications	1
73730000	Computer Integrated Systems Design	10
73730100	Systems Software Development Services	4
73730200	Systems Integration Services	5
73730201	Local Area Network (LAN) Systems Integrator	1
73730300	Computer System Selling Services	1
73790000	Computer Related Services, nec	3
	TOTAL RDE FIRMS	**72**
High-Tech Manufacturing SIC Codes		
35710000	Electronic Computers	5
35750000	Computer Terminals	1
73720000	Prepackaged Software	2
73729902	Business Oriented Computer Software	1
	TOTAL RDE FIRMS	**9**

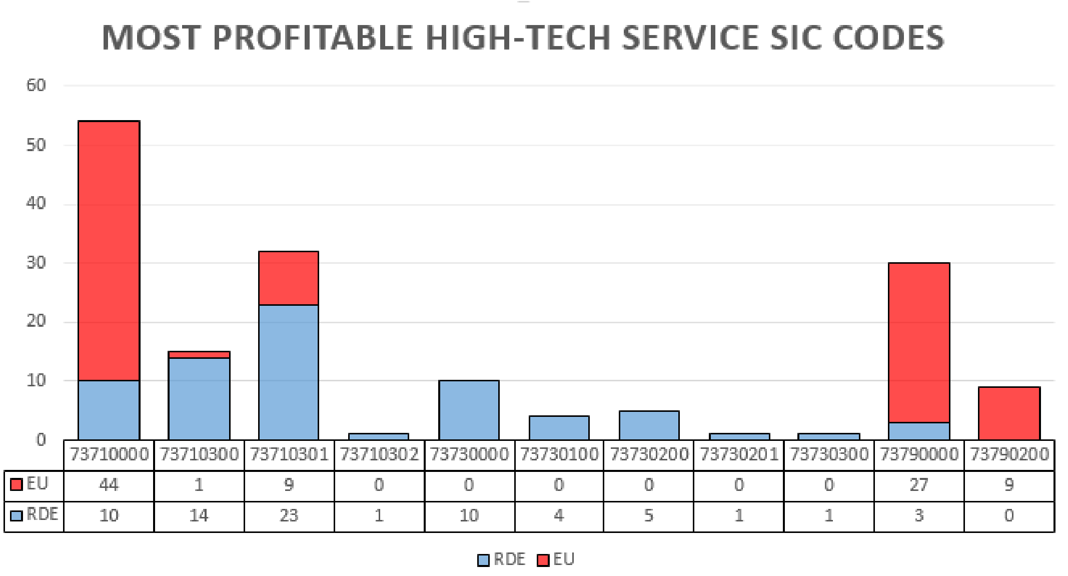
The EU large technology intensive firms included in the study were also predominantly from the service sector at 78% of those eligible. The Custom Computer Programming Services represented almost half of these firms, followed by Computer Related Services, nec at a distant second (See Figure 21 on the following page).

Figure 21 - Overall EU Results

High-Tech Service SIC Codes		
73710000	Custom Computer Programming Services	44
73710300	Computer Software Development & Applications	1
73710301	Computer Software Development	9
73760000	Computer Facilities Management	2
73790000	Computer Related Services, nec	27
73790200	Computer Related Consulting Services	9
	TOTAL EU FIRMS	**92**
High-Tech Manufacturing SIC Codes		
35710000	Electronic Computers	3
35770000	Computer Peripheral Equipment, nec	2
73720000	Prepackaged Software	21
	TOTAL EU FIRMS	**26**

The representation of each SIC is presented in Figure 22 on the following page. One can readily determine that the most profitable SIC code overall is 73710000 Custom Computer Programming Services. This code also represents the highest sector for EU countries, while 73710300 Computer Software Development represents the most profitable SIC code overall for RDE countries.

Figure 22 - Overall Representation of SIC Codes



	73710000	73710300	73710301	73710302	73730000	73730100	73730200	73730201	73730300	73790000	73790200
EU	44	1	9	0	0	0	0	0	0	27	9
RDE	10	14	23	1	10	4	5	1	1	3	0

The data collected from these firms measured the proportion of Net Income to Sales Revenue to acquire the Net Profit Margin for each firm. The null hypothesis suggested that the proportion of RDE Net Profit Margin would be less than or equal to EU Net Profit Margin. This null hypothesis was accepted, as the t-stat was less than t-crit and the p-value of 0.1560 is not less than 0.05 (See Figure 23 below).

Figure 23 - H2 Data Analysis

t-Test: Two-Sample Assuming Unequal Variances

	RDE	*EU*
Mean	5.5485	2.586016949
Variance	508.9183091	254.9577336
Observations	80	118
Hypothesized Mean Difference	0	
df	132	
t Stat	1.014802673	
P(T<=t) one-tail	0.15602819	
t Critical one-tail	1.65647927	
P(T<=t) two-tail	0.31205638	
t Critical two-tail	1.978098842	

Both groups were also compared by their manufacturing and service sectors to see if there was a difference between the two groups and whether large, technology RDE firms were more profitable than their EU counterparts. It was ultimately determined that there was not a distinction between both groups (See Appendix 4). In addition, both groups were further examined to see if there was a significant difference between manufacturing and services within the same economy (i.e. Comparison of RDE manufacturing and RDE service). The results indicated that neither group is significantly out-performing the other in terms of Net Profit Margin (See Appendix 5 for RDE results and Appendix 6 for EU results). However, when all Net Losses were removed and only Net Profits were reported, there was a significant difference within both groups. The RDE firms were more profitable than EU firms with a p-value of 0.0050 as depicted in Figure 24 below. The EU firms did not represent a significant difference between Manufacturing versus Service large, technology firms (See Appendix 7).

Figure 24 - H2 RDE Net Profit Margins (Mfg vs. Svc)

t-Test: Two-Sample Assuming Unequal Variances

	RDE Mfg	*RDE Svc*
Mean	12.58655172	5.51
Variance	252.3630756	22.887775
Observations	58	9
Hypothesized Mean Difference	0	
df	42	
t Stat	2.69513533	
P(T<=t) one-tail	0.005037527	
t Critical one-tail	1.681952357	
P(T<=t) two-tail	0.010075054	
t Critical two-tail	2.018081703	

The countries representing the most data points from RDEs are China and India, while Germany, England and France from the EU. China was compared with India, as well as the rest of the RDEs, however, there was no evidence that high-tech Chinese firms are more profitable in either test (See Appendix 8). When these countries were compared against each other, firms from China were more profitable than France with the data output denoting a p-value of 0.0244 (See Figure 25 below).

Figure 25 – China vs. France Net Profit Margin

t-Test: Two-Sample Assuming Unequal Variances

	China	*France*
Mean	8.101304348	2.916190476
Variance	134.9062209	8.504384762
Observations	23	21
Hypothesized Mean Difference	0	
df	25	
t Stat	2.070659299	
P(T<=t) one-tail	0.02443315	
t Critical one-tail	1.708140761	
P(T<=t) two-tail	0.0488663	
t Critical two-tail	2.059538553	

Countries with the largest number of data points were compared against each other, specifically, China and India representing the RDE and Germany, England, Finland, and Sweden as depicted in Figure 26 on the following page.

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Figure 26 - Country Comparison

	China	India	England	Germany	Sweden	France
China	-	0.3150	0.4309	0.0602	0.1401	0.0244
India	0.3150	-	0.3757	0.2186	0.3313	0.1742
England	0.4309	0.3757	-	0.0997	0.1951	0.0558
Germany	0.0602	0.2186	0.0997	-	0.3513	0.4752
Sweden	0.1401	0.3313	0.1951	0.3513	-	-
France	0.0244	0.1742	0.0558	0.4752	-	-
Rest of RDEs	0.1970	0.3846	-	-	-	-
Rest of EU	-	-	0.0337	0.4065	-	-

In addition these countries were When all three largest groups with the EU dataset were compared individually with the rest of the EU, it was found that only England is significantly more profitable than the rest of the EU with a p-value of 0.0337 (See Figure 27 below).

Figure 27 - England vs. Rest of EU

t-Test: Two-Sample Assuming Unequal Variances

	England	*Rest of EU*
Mean	7.46952381	1.528762887
Variance	149.9361848	273.146713
Observations	21	97
Hypothesized Mean Difference	0	
df	38	
t Stat	1.882802571	
P(T<=t) one-tail	0.033699775	
t Critical one-tail	1.68595446	
P(T<=t) two-tail	0.067399549	
t Critical two-tail	2.024394164	

Lastly, the top performing firms in both groups were identified. For inclusion, the Net Profit Margin had to be greater than 5.0%. The data output suggests that the top performing large, high-tech firms from RDEs were not as profitable as firms from the EU due to a p-value of 0.0623 (See Appendix 9).

Hypothesis Three (H_3)

The third hypothesis in the study suggested that large technology firms in Rapidly Developing Economies (RDEs) acquire more patents per capita compared to firms in European Union (EU) member countries.

The patent counts only reflected the number of patents that were granted. The proportion of the number of patents granted to the adult population was utilized with both variables representing the same time frame: 2012. The adult population represented all those between ages 15-64. The average of total patents granted for both groups was RDE countries with 285,292 and EU countries with 48,361 for 2012.

Analysis of the data output determined that the null hypothesis was accepted, as the *t*-stat was less than the *t*-crit and the *p*-value was 0.2464 as depicted in Figure 28 on the following page.

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Figure 28 – RDE vs. EU Patents Granted per Capita

t-Test: Two-Sample Assuming Unequal Variances

	RDE	*EU*
Mean	88.93803557	110.8446987
Variance	9396.166968	7672.741463
Observations	14	24
Hypothesized Mean Difference	0	
df	25	
t Stat	-0.695939936	
P(T<=t) one-tail	0.24644306	
t Critical one-tail	1.708140761	
P(T<=t) two-tail	0.492886119	
t Critical two-tail	2.059538553	

Hypothesis Four (H_4)

The fourth hypothesis in the study proposed that RDE countries export more high-tech exports as compared to firms in European Union (EU) member countries.

The data collected for this hypothesis was the proportion of high-technology exports as a percentage of manufactured exports for 2012 to the GDP per capita for the same year. The resulting output validated rejecting the null hypothesis with a p-value of 0.0438 as depicted in Figure 29 on the following page. RDEs have more high-tech exports than the EU countries.

Figure 29 – Proportion of High-Tech Exports (% of Manufactured Goods) to GDP per capita

t-Test: Two-Sample Assuming Unequal Variances

	RDE	*EU*
Mean	0.002942646	0.000525247
Variance	2.38607E-05	1.79676E-07
Observations	14	25
Hypothesized Mean Difference	0	
Df	13	
t Stat	1.847808133	
P(T<=t) one-tail	0.043752151	
t Critical one-tail	1.770933396	
P(T<=t) two-tail	0.087504301	
t Critical two-tail	2.160368656	

The following RDE countries had the highest average number of high-tech exports from 2005-2012: 1) Philippines at 61.21%, 2) Malaysia at 47.36%, and 3) China at 27.59%. The top EU high-tech exports average for the same time period originated from 1) Malta at 50.10%, 2) Ireland at 26.50%, and 3) United Kingdom at 23.25% and Netherlands at 23.06%.

The global recession from 2008-2012 did not appear to have a very significant decrease in imports for RDE countries when analyzed, as almost every country had returned to pre-crisis level of high-tech exports as a percentage of manufactured goods. Philippines is an exception to the statement, however, it persists in representing the top exporter in this group.

The EU countries, however, have not fared as well as the RDE countries. They still have greater imports, but some countries have not returned to their pre-recession levels in

2005/2006. For instance, the following countries have lower high-tech exports as a percentage of manufactured goods: Belgium, Denmark, Estonia, Finland, Ireland, Luxembourg, Malta, Netherlands, Portugal, Sweden, and the United Kingdom. Of these countries, the highest negative percent difference was evident in: Finland -14%, Malta -13%, Ireland -12%, United Kingdom -11%, Netherlands -8%, and Denmark -6%.

Labor Capital

An investigation was conducted as to the support by laborers to the firms involved in this research. As a result, the number of employees were compared between both groups, RDE & EU countries, and each firm included in the study had to have greater than 500 employees. It was determined that RDEs have significantly more employees in large, technology-intensive firms when counted. However, a *t*-test generated a *p*-value of 0.0804. These results would indicate that RDEs do not hire significantly more employees than EU countries in the same technology-intensive industries.

The final comparison of employees working in manufacturing and service sectors yielded a significant difference between RDEs and EU countries when they were compared against one another (i.e. RDE Mfg vs. RDE Svc and EU Mfg vs. EU Svc). The *p*-value for RDEs was 0.0276 and 0.1234 for the EU countries as depicted below in Figures 30 and 31 respectively on the following page. These results would indicate that there are more employees in the manufacturing sector than the services sector.

Figure 30 - RDE Labor Capital

RDE Mfg. vs. RDE Service

t-Test: Two-Sample Assuming Unequal Variances

	RDE Mfg	*RDE Svc*
Mean	3.454545	10
Variance	14.87273	91.2
Observations	11	11
Hypothesized Mean Difference	0	
df	13	
t Stat	-2.10782	
P(T<=t) one-tail	0.027513	
t Critical one-tail	1.770933	
P(T<=t) two-tail	0.055025	
t Critical two-tail	2.160369	

Figure 31 - EU Labor Capital

EU Mfg vs. EU Service

t-Test: Two-Sample Assuming Unequal Variances

	EU Mfg	*EU Svc*
Mean	4.8	11
Variance	27.2	89.5
Observations	5	5
Hypothesized Mean Difference	0	
df	6	
t Stat	-1.28334	
P(T<=t) one-tail	0.123355	
t Critical one-tail	1.94318	
P(T<=t) two-tail	0.246709	
t Critical two-tail	2.446912	

Incorporation Date

The year of founding for firms utilized in this research was also analyzed to determine when the firms went public, in an attempt to gauge the median time frames of firms' absorptive capacity. While analyzing specific time frames and relating it to possible event studies is beyond the scope of this research, it would be helpful to relate firm performance measures to realized gains/losses which pertain to the ability of a firm to: a) recognize potential value in new technology-intensive manufacturing and service processes, routines, and information, b) the time it took the firm to assimilate it, and c) apply it to commercial ends for potential gain and possible improved competitiveness and sustainability.

The average incorporation date for RDE firms was 1990, while the average for EU firms was 1995. China and India represented the largest number of RDE firms with an average date of 2000 and 1992 respectively. Four EU countries represent a majority of incorporation dates with averages of: Germany (1995), England (1994), France (1994), and Finland (1984).

RDEs and EU incorporation dates were also analyzed with *t*-tests to determine whether the groups were significantly different from one another, which yielded a *p*-value of 0.0525 as depicted in Figure 32 on the following page.

Figure 32 - Incorporation Dates

t-Test: Two-Sample Assuming Unequal Variances

	RDE	*EU*
Mean	1997.389474	1995.357143
Variance	42.45307951	92.76247849
Observations	95	84
Hypothesized Mean Difference	0	
df	143	
t Stat	1.631781266	
P(T<=t) one-tail	0.052462928	
t Critical one-tail	1.655579143	
P(T<=t) two-tail	0.104925857	
t Critical two-tail	1.976692198	

CHAPTER 5: CONCLUSION

This dissertation comparatively analyzed two diverse groups of technology intensive firms deriving from countries with opposing stages of economic development. The following key findings may be concluded as a result of this research and data analysis:

<u>RDEs are not spending more on R&D than EU members</u>. In addition, there was no significant difference when manufacturing and services of the same group were compared (i.e. Comparison of RDE manufacturing and RDE service), and the same holds true for EU large, high-tech firms.

<u>More RDE firms are spending at least $5 million USD</u>. Despite more firms being represented from RDE than the EU, these firms do not spend more than large, technology firms from the EU.

<u>The most profitable firms derive from the service sector for both groups</u>. The most profitable large, technology firms from RDEs and EU countries derive from the service sector versus manufacturing.

<u>Custom Computer Programming Services represents the highest profit margins overall</u>. Computer Software Development represents the sector with the most gains for RDE countries, while Custom Computer Programming Services represents the highest profit margins in EU countries.

RDEs were more profitable than EU firms when only Net Profits were reported. When data representing net losses were removed from the data set, RDEs were significantly more profitable than EU firms.

Firms from England are more profitable than the rest of the EU. England is more profitable than its European Union counterparts.

RDEs had more patents granted than EU countries. The average of total patents granted for both groups was RDE countries with 285,292 and EU countries with 48,361 for 2012.

RDEs have more high-tech exports than EU countries. RDEs have more high-tech exports as a percentage of manufactured goods than EU countries.

The top 3 RDE exporting countries. The top 3 RDE exporting countries that had the highest average number of high-tech exports from 2005-2012: 1) Philippines at 61.21%, 2) Malaysia at 47.36%, and 3) China at 27.59%.

The top 3 EU exporting countries. The top EU high-tech exporting countries from 2005-2012 originated from 1) Malta at 50.10%, 2) Ireland at 26.50%, and 3) United Kingdom at 23.25% and Netherlands at 23.06%.

The global recession from 2008-2012 did not appear to have a very significant decrease in exports for RDEs. When analyzed, almost every country had returned to pre-crisis level of high-tech exports as a percentage of manufactured goods.

The global recession from 2008-2012 did have an impact on EU countries. Some countries have not returned to their pre-recession levels in 2005/2006. For instance, the following countries have lower high-tech exports as a percentage of manufactured goods: Belgium, Denmark, Estonia, Finland, Ireland, Luxembourg, Malta, Netherlands, Portugal, Sweden, and the United Kingdom. Of these countries, the highest negative percent difference was evident in: Finland -14%, Malta -13%, Ireland -12%, United Kingdom -11%, Netherlands -8%, and Denmark -6%.

RDEs do not hire significantly more employees than EU countries in the same technology-intensive industries. An investigation was conducted as to the support by laborers to the firms involved in this research. As a result, the number of employees were compared between both groups, RDE & EU countries, and each firm included in the study had to have greater than 500 employees. It was determined that RDEs have significantly more employees in large, technology-intensive firms when counted.

RDEs hire more employees in the manufacturing sector than the service sector. Both groups indicate that more employees are hired for manufacturing versus service industries in RDEs.

Returning to the original hypotheses yields the following final conclusions:

Hypothesis 1: Large technology firms in Rapidly Developing Economies (RDEs) spend more on R&D compared to large technology firms in EU countries. ACCEPT

Hypothesis 2: Large technology firms in Rapidly Developing Economies (RDEs) are more profitable compared to large technology firms in EU countries. ACCEPT

Hypothesis 3: Rapidly Developing Economies (RDEs) acquire more patents per capita compared to EU countries. ACCEPT

Hypothesis 4: RDEs have more high-tech exports, as a percentage of manufactured goods per capita, than EU countries. CAN NOT ACCEPT

BIBLIOGRAPHY

Abernathy, W., & Clark, K. (1985). Innovation: Mapping the winds of creative destruction. *Research Policy,* 102-102.

Agarwal, R. & B. Bayus. (2004). Creating and surviving in new industries. *Advances in Strategic Management*, 21: 107-130.

Ahuja, G. & C.M. Lampert. (2001). Entrepreneurship in the large corporation: A longitudinal study of how established firms create breakthrough discoveries. *Strategy Management Journal*, 22: 521-543.

Almeida, P. & Phene, A. (2004). Subsidiaries and Knowledge Creation: The Influence of the MNC and Host Country on Innovation. *Strategic Management Journal*, 25(8-9), 847-864.

Ambos, B. (2005). Foreign Direct Investment in Industrial Research and Development: A Study of German MNCs. *Research Policy*, 34(4): 395-410.

Archibugi, D. & Cocoa, A. (2005). Measuring Technological Capabilities at the Country Level; A Survey and a Menu for Choice. *Research Policy,* 34 (2005) 175-194.

Argyris, C. & Schon, D.A., (1978). Organizational Learning: A Theory of Action Perspective. Reading, MA: Addison-Wesley.

Athreye, S., & Cantwell, J. (2007). Creating Competition? Globalisation and the Emergence of New Technology Producers. *Research Policy*, 36(2), 209-226.

Athukorala, P. & Kohpaiboon, A. (2010). Globalization of R&D by US-Based Multinational Enterprises. *Research Policy*, 39: 1135-1347.

Bartlett, C.A., & Ghoshal, S. (1989), Managing Across Borders: The Transnational Solution. Boston, MA; Harvard Business School Press.

Bayus, B. L. & R. Agarwal. (2007). The role of pre-entry experience, entry timing, and product technology strategies in explaining firm survival, *Management Science*, 53(12): 1887-1902.

Bhattacharya, A. et al. (2013, August 13). Allies and Adversaries: 2013 BCG Global Challengers. Retrieved August 1, 2014, from https://www.bcgperspectives.com/content/articles/globalization_growth_allies_and_adversaries_2013_bcg_global_challengers/

Verma, S. et al. (2011). Companies on the Move: Rising Stars From Rapidly Developing Economies Are Reshaping Global Industries. Retrieved August 1, 2014, from http://www.bcg.com/documents/file70055.pdf

Aguiar, M. et al. (2009, January 1). The 2009 BCG 100 New Global Challengers. Retrieved August 1, 2014, from http://www.bcg.com.cn/export/sites/default/en/files/publications/reports_pdf/The_2009_BCG_100_New_Global_Challengers_Jan_2009.pdf

Aguiar, M. et al. (2006, May 1). The New Global Challengers: How 100 Top Companies from Rapidly Developing Economies Are Changing the World. Retrieved November 12, 2014, from http://www.bcg.com/documents/file14801.pdf

Aguiar, M. et al. (2014, February 1). 2014 BCG Global Challengers: Redefining Global Competitive Dynamics. Retrieved September 1, 2014, from https://www.bcgperspectives.com/content/articles/globalization_growth_redefining_global_competitive_dynamics/

Boston Consulting Group (a). (2013, January 1). Our Globalization Competencies. Retrieved November 12, 2014, from http://www.bcg.com/expertise_impact/capabilities/globalization/competencies.aspx

Aguiar, M. (2014, February 1). 2014 BCG Global Challengers: Redefining Global Competitive Dynamics. Retrieved September 1, 2014, from https://www.bcgperspectives.com/content/articles/globalization_growth_meet_2014_global_challengers/

Blackburn, J.D. (2011). Time based competition, in Moody, P., ed., Strategic Manufacturing,
1990.2011. "Quo Vadis? The Entry into New Technologies in Advanced Foreign Subsidiaries of the Multinational Enterprises". Journal of International Business Studies, 41(9): 1525-1549.

Blomkvist, K., Kappen, P., & Zander, I. (2010). Quo vadis? The entry into new technologies in advanced foreign subsidiaries of the multinational enterprise. *Journal of International Business Studies,* 1525-1549.*Journal of International Business Studies* 41, 1525-1549 (December 2010) | doi:10.1057/jibs.2010.22

Bosworth, D., & Yang, D. (2000). Intellectual Property Law, Technology Flow and Licensing Opportunities in the People's Republic of China. *International Business Review, 9*, 453-477.

Brownlie, D. (n.d.). The Strategic Management of Technology: A New Wave of Market-led Pragmatism or a Return to Product Orientation? *European Journal of Marketing, 21*(9), 45-65.

Brownlie, D. (n.d.). The Role of Technology Forecasting and Planning: Formulating Business Strategy. *Industrial Management & Data Systems, 92*(2), 3-16.

Burgelman, R., & Maidique, M. (1988). *Strategic management of technology and innovation*. Homewood, Ill.: Irwin.

Cantwell, J., & Mudambi, R. (2005). MNE Competence-creating Subsidiary Mandates. *Strategic Management Journal,* 1109-1128.

Chen, P., Williams, C., & Agarwal, R. (n.d.). Growing pains: Pre-entry experience and the challenge of transition to incumbency. *Strategic Management Journal,* 252-276.

Chen, S. (n.d.). Taiwanese IT firms' offshore R&D in China and the connection with the global innovation network. *Research Policy,* 337-349.

Chung, W., & Alcacer, J. (n.d.). Knowledge Seeking and Location Choice of Foreign Direct Investment in the United States. *Management Science,* 1534-1554.

Chung, W., & Yeaple, S. 2008. International Knowledge Sourcing: Evidence from US Firms Expanding Abroad. *Strategic Management Journal*, 29(11): 1207-1224.

Cohen, W.M. and Levinthal, D.A., Innovation and learning: the two faces of R&D, *Economic Journal*, 1989, 99, 569-596.

Cohen, W.M. and Levinthal, D.A., Absorptive capacity: a new perspective on learning and innovation, *Administrative Science Quarterly*, 1990, 35 (1), 128-152.

Coombs, R. (1996). Core Competencies and the Strategic Management of R&D. *R&D Management*. 26, 345-355.

Conner, K .R. Strategies for Product Cannibalism, *Strategic Management Journal*, 1988, 9 (Special Summer Issue), 9-26.

Daft, R.L. and Lengel. R.H., Organizational Information Requirements Media Richness and Structural Design, *Management Science*, 32 (5), 554-571.

Dean, D. (2013, December 1). 2013 TMT Value Creations Report: The Great Software Transformation. Retrieved from https://www.bcgperspectives.com/content/articles/technology_software_telecommunications_great_software_transformation_2013_tmt_value_creators_report/

Dean, D., & Gilliland, G. (2011, January 1). The Post-PC Era: A Disruptive Dawn. Retrieved from https://www.bcgperspectives.com/content/articles/technology_telecommunications_post_pc_era_disruptive_dawn/

De Meyer, A. (1991). Tech Talk. How Managers are Stimulating Global R&D Communication. *Sloan Management Review*, 32(3): 49-58.

Di Minin, A., & Bianchi, M. (2011). Safe Nests in Global Nets: Internationalization and Appropriability of R&D in wireless Telecom. *Journal of International Business Studies*, 42(7): 910-934.

Dinopoulos, E, Segerstrom, P. (2010) Intellectual Property Rights, Multinational Firms and Economic Growth. *Journal of Development Economics*. 92: 13-27.

Dowell, G. and A. Swaminathan. (2006), Entry timing, exploration, and firm survival in the early U.S. bicycle industry, *Strategic Management Journal*, 27(12): 1159-1182.

Dunning, J., & Lundan, S. (2008). "Multinational Enterprises and the Global Economy, 2nd ed. Cheltenham: Edward Elgar.

Fisch, J.H. (2003). "Optimal Dispersion of R&"D Activities in Multinational Corporations with a Genetic Algorithm". *Research Policy*, 32(8): 1381-1396.

Fleming, L. and O. Soronso. (2001). Technology as a complex adaptive system: evidence from patent data, *Research Policy*, 30(7): 1019-1084.

Florida, R. (1997). The Globalization of R&D: Results of a Survey of Foreign-Affiliated R&D Laboratories in the USA. *Research Policy*, 26(1): 85-103.

Freeman, C. (1987). "Technology Policy and Economic Performance". London: Pinter.

Gehani, R.R. (1992). Concurrent product development of fast-track corporations, *Long Range Planning*, 25 (6), 40-47.

Gilliland, G., Varadarajan, R., & Raj, D. (2014). Code Wars: The All-Industry Competition for Software Talent". Boston Consulting Group. May 2014. 1-12.

Gupta, A.K. and Govindarajan, V. (2000), Knowledge Flows Within Multinational Corporations. *Strategic Management Journal*, 21(4), 473-496.

J.R. and Clausing, D. (1988). The House of Quality, *Harvard Business Review*, 66 (3) 63-73.188.

Heavey, C. (2009). "A Dynamic Managerial Capabilities Model of Organizational Ambidexterity". p. 1-90.

Hedlund, G. (1994). A Model of Knowledge Management and the N-Form Corporation. *Strategic Management Journal*, 15, 73-90.

Helpman, E. (1993). Innovation, Imitation, and Intellectual Property Rights. *Econometrica* 61, 1247-1280.

Huang, H., Shih, H., and Wu, Y. (2011). Contagion Effects of National Innovative Capacity: Comparing Structural Equivalence and Cohesion Models". *Technological Forecasting and Social Change*. 76, 244-255.

Jansen, J., George, G., Van den Bosch, F.A.J, and Volberda, H.W. (2008). Senior team attributes and organizational ambidexterity: The moderating role of transformational leadership. *Journal of Management Studies*, 45, 982-1007.

Jiang, L., J. Tan and M. Thursby. (2011). Incumbent firm invention in emerging fields: evidence from the semiconductor industry, *Strategic Management Journal*, 32(1): 55-75.

Koku, P.S. (2010). R&D Expenditure and Profitability in the Pharmaceutical Industry in the United States. *JAMAR*, 8(1), 35-42.

Kumar, N., and Aggarwal, A. (2005). Liberalization, Outward Orientation and In-House R&D Activity of Multinational and Local Firms: A quantitative Exploration for Indian Manufacturing. *Research Policy*. 34(4), 441-460.

Kummerle, W. (1997). "Building Effective R&D Capabilities Abroad". *Harvard Business Review*, 75(2): 61-70.

Lach, S., & Schankerman, M. (1989). Dynamics of R&D and Investment in the Scientific Sector. *Journal of Political Economy*. 97(4), 880-904.

Lai, E. (1998). International Intellectual Property Rights Protection and the Rate of Product Innovation. Journal of Development Economics. 55: 133-153.

Lewin, A.Y., Massini, S., and Peters, C. (2009). Why are Companies Offshoring Innovation? The Emerging Global Race for Talent. *Journal of international Business Studies*, 10(6), 901-925.

Leydesdorff, L., & Etzkowitz, H. (1996). Emergence of a Triple Helix of University-Industry-Government Relations". *Science and Public Policy*, 23(5): 279-286.

Lieberman, M.B., (1987). The learning curve, diffusion, and competitive strategy, *Strategic Management Journal*, 8, 441-452.

Lieberman, M.B. and D. Montgomery. (1988). First-mover advantages, *Strategic Management Journal*, 9: 41-58.

Lihong, Q. (2011). Organizational Capabilities, Organizational Structure, and Their Dynamics: Three Essays on Boundary Choice and Capability Development in Entry Decisions. Dissertation.

Lundvall, B. A. (1992). "National Systems of Innovation: Towards a Theory of Innovation and Interactive Learning". London: Pinter Publishers.

Ma, Z., Lee, Y., and Chen, C. (2009). Booming or Emerging? China's Technological Capability and International Collaboration in Patent Activities. *Technological Forecasting & Social Change,* 76, 787-796.

Maidique, M.A. and Zirger, B.J. (1985). The new product learning cycle, *Research Policy*. 14, 299-313.

Mansfield, E., (1985). How rapidly does new industrial technology leak out? *Journal of Industrial Economics*, 34, 217-223.

Mansfield, E., Schwartz, M., and Wagner, S. (1981). Imitation costs and patents: an empirical study, *Economic Journal*, 91, 907-918.

McKee, D. (1992). An organizational learning approach to product innovation, Journal of *Product Innovation Management*, 9 (3), 232-245.

Mitchell, G.R. (1985). New approaches for the strategic management of technology, *MurTechnology in Society*, 7, 227-239.

Mott, W.H. (2004). Globalization: People, Perspectives, and Progress. Westport, CT: Praeger.

Murmann, J.P. (2003). Knowledge and Competitive Advantage: The Co-evolution of Firms, Technology and National Institutions". Cambridge: Cambridge University Press.

Nam, Y and Barnett, G. (2011). Globalization of Technology: Network Analysis of Global Patents". *Technological Forecasting & Social Change*, 78, 1471-1485.

Nelson, R. R. (1993). National Innovation Systems: A comparative Analysis. New York: Oxford University Press.

Nobel, R. and Birkinshaw, J. (1998). Innovation in Multinational Corporations: Control and Communication Patterns in International R&D Operations. *Strategic Management Journal*, 19(5), 479-496.

OECD. (2007). Intellectual Assets and International Investment: A Stocktaking of the Evidence". Report to the OECD Investment Committee DAF/INV/WD. Paris: OECD.

Patel, P., & Pavitt, K. (1991). Large Firms in the Production of the World's Technology: An Important Case of 'Non-Globalisation'. *Journal of International Business Studies*. 22(1): 1-21.

Prahalad, C.K. & Hamel, G. (1990). The Core Competence of the Organization. Harvard Business Review. 68(3), 79-91.

Prahalad, C.K. & Hamel, G. (1993). Strategy as Stretch and Leverage. Harvard Business Review. 71(2), 75-84.

Qian, L. (2011). *Organizational Capabilities, Organizational Structure, and Their Dynamics: Three Essays on Boundary Choice and Capability Development in Entry Decisions.* Dissertation. 5/25/2011

Reinganum, J.F. (1984). Uncertain innovation and the presence of monopoly, *American Economic Review*, 73, 741-748 1983.

Robinson, W.T. (1985). Sources of Market Pioneer Advantages: The Case of Industrial Goods Industries", Journal of Marketing Research, 22, pp. 297-304.

Rogers, E. (2003). The Diffusion of Innovation. 5th ed. The Free Press. New York.

Rothwell, R. and Gardiner, P. (1989). The Strategic Management of Re-innovation, *R&D Management*, 19 (2), 147-160.

Roussel, P.A., Saad, K.N., & Erickson, T.J. (1991), Third-Generation R&D: Managing the Link to Corporate Strategy. Boston, MA: Arthur D. Little.

Scherer, F.M. (1990). Industrial Market Structure and Economic Performance, Chicago: Rand McNally.

Schilling, M.A. (2002). Technology success and failure in winner-take-all markets: Testing a model of technological lock out, *Academy of Management Journal*, 45: 387-398.

Song, J., Asakawa, K., & Chu, Y. (2011). What Determines Knowledge Sourcing from Host Locations of Overseas R&D Operations?: A study of Global R&D Activities of Japanese Multinationals. *Research Policy*, 40(3): 380-390.

Spence, M. (1981). The learning curve and competition, Bell Journal of Economics, 12, 49-70.

Stalk, G. (1988). Time — The Next Source of Competitive Advantage, *Harvard Business Review*, 66 (4), 41-51.

Stock, G.N. (1995). *A Dynamic Model of Technological Performance.* Dissertation.

Taylor, A and Wagner, K. (2014). *Rethinking your Innovation System*. Boston Consulting Group.

Todo, Y. & Shimizutani, S. (2008). Overseas R&D Activities and Home Productivity Growth: Evidence from Japanese Firm-Level Data. *Journal of Industrial Economics*, 56(4): 752-777.

UNCTAD. (2014). 2014 Trade and Development Report, Retrieved November 14, 2014, from http://unctad.org/en/PublicationsLibrary/tdr2014_en.pdf

Von Zedtwitz, M., & Gassmann, O. (2002). Market versus Technology Drive in R&D Internationalization: Four Different Patterns of Managing Research & Development". *Research Policy*, 31(4): 569-588.

Vessey, J. (1991). The New Competitors: They Think in Terms of "Speed-to-Market," *Academy of Management Executive*, 5 (2)23-33.

Wang, J., Xue, L., and Liang, Z. (2012). Multinational R&D in China: From Home-Country-Based to Host-Country-Based. *Innovation: Management, Policy & Practice*. 14 (2); 192-202.

World Trade Organization. (2014). Retrieved November 16, 2014, from http://stat.wto.org/COUNTRYPROFILE/WSDBCOUNTRYPFVIEW.ASPX?LANGUAGE=E&COUNTRY=E28

Yoffie, D.B. & Cusumano, M.A. (1999). What Netscape Learned from Cross-Platform Software Development. Communications of the ACM, 42(10), 72-78.

Zanfei, A. (2000). Transnational Firms and the Changing Organisation of innovative Activities. *Cambridge Journal of Economics*, 24(5): 515-542.

APPENDIX

Table 1 – H_1 Comparison of Mfg/Svc between Groups

Manufacturing

t-Test: Two-Sample Assuming Unequal Variances

	Proportion RDE High-Tech Mfg	*Proportion EU High-Tech Mfg*
Mean	7.8142673	11.48910114
Variance	91.18367074	225.1532329
Observations	27	17
Hypothesized Mean Difference	0	
df	24	
t Stat	-0.901369485	
P(T<=t) one-tail	0.188174433	
t Critical one-tail	1.71088208	
P(T<=t) two-tail	0.376348866	
t Critical two-tail	2.063898562	

Service

t-Test: Two-Sample Assuming Unequal Variances

	Proportion RDE High-Tech Svc	*Proportion EU High-Tech Svc*
Mean	169.3528706	13.00886113
Variance	1815934.564	471.3122044
Observations	73	57
Hypothesized Mean Difference	0	
df	72	
t Stat	0.991106697	
P(T<=t) one-tail	0.162476323	
t Critical one-tail	1.666293696	
P(T<=t) two-tail	0.324952645	
t Critical two-tail	1.993463567	

Table 2 – H_1 Comparison of Mfg/Svc within Same Group

Manufacturing

t-Test: Two-Sample Assuming Unequal Variances

	*Proportion **RDE** High-Tech Mfg*	*Proportion **RDE** High-Tech Svc*
Mean	7.8142673	169.3528706
Variance	91.18367074	1815934.564
Observations	27	73
Hypothesized Mean Difference	0	
df	72	
t Stat	-1.024137286	
P(T<=t) one-tail	0.154599545	
t Critical one-tail	1.666293696	
P(T<=t) two-tail	0.309199091	
t Critical two-tail	1.993463567	

Service

t-Test: Two-Sample Assuming Unequal Variances

	Proportion EU High-Tech Mfg	*Proportion EU High-Tech Svc*
Mean	11.48910114	13.00886113
Variance	225.1532329	471.3122044
Observations	17	57
Hypothesized Mean Difference	0	
df	38	
t Stat	-0.327661256	
P(T<=t) one-tail	0.372483125	
t Critical one-tail	1.68595446	
P(T<=t) two-tail	0.744966249	
t Critical two-tail	2.024394164	

Table 3 – H_1 Comparison of Mfg/Svc within Same Group – SIC Codes

EU

Manufacturing SIC Codes		
35710000	Electronic Computers	3
35770000	Computer Peripheral Equipment, nec	3
73720000	Prepackaged Software	11
	TOTAL EU FIRMS	**17**

High-Tech Service SIC Codes		
73710000	Custom Computer Programming Services	19
73710300	Computer Software Development & Applications	1
73710301	Computer Software Development	9
73790000	Computer Related Services, nec	25
73790200	Computer Related Consulting Services	3
	TOTAL EU FIRMS	**57**

RDE

Manufacturing SIC Codes		
35710000	Electronic Computers	5
35720000	Computer Storage Devices	2
35750000	Computer Terminals	1
35770000	Computer Peripheral Equipment, nec	2
35780300	Banking Machines	2
35780301	Automatic Teller Machines (ATM)	1
73720000	Prepackaged Software	11
73729901	Application Computer Software	1
73729902	Business Oriented Computer Software	2
	TOTAL RDE FIRMS	**27**

High-Tech Service SIC Codes		
73710000	Custom Computer Programming Services	7
73710300	Computer Software Development & Applications	11
73710301	Computer Software Development	23
73710302	Software Programming Applications	1
73730000	Computer Integrated Systems Design	11
73730100	Systems Software Development Services	8
73730200	Systems Integration Services	5
73790000	Computer Related Services, nec	5
73790100	Computer Related Maintenance Services	1
73790200	Computer Related Consulting Services	1
	TOTAL RDE FIRMS	**73**

Table 4 – H_1 Comparison of Top R&D Spending Firms

t-Test: Two-Sample Assuming Unequal Variances

	RDE SIC	*EU SIC*
Mean	30736.24386	136.0846154
Variance	53719230856	259235.4308
Observations	57	39
Hypothesized Mean Difference	0	
df	56	
t Stat	0.996769384	
P(T<=t) one-tail	0.161582072	
t Critical one-tail	1.672522303	
P(T<=t) two-tail	0.323164143	
t Critical two-tail	2.003240719	

Table 5 – H_2 Comparison of Mfg/Svc between Groups

Manufacturing

t-Test: Two-Sample Assuming Unequal Variances

	RDE Mfg	*EU Mfg*
Mean	5.553380282	3.431521739
Variance	571.7347027	108.8382394
Observations	71	92
Hypothesized Mean Difference	0	
df	91	
t Stat	0.698205497	
P(T<=t) one-tail	0.243414529	
t Critical one-tail	1.661771155	
P(T<=t) two-tail	0.486829058	
t Critical two-tail	1.986377154	

Services

t-Test: Two-Sample Assuming Unequal Variances

	RDE Svc	*EU Svc*
Mean	5.51	-0.405769231
Variance	22.887775	785.0914334
Observations	9	26
Hypothesized Mean Difference	0	
df	29	
t Stat	1.033901375	
P(T<=t) one-tail	0.154863832	
t Critical one-tail	1.699127027	
P(T<=t) two-tail	0.309727665	
t Critical two-tail	2.045229642	

Table 6 – H_2 Comparison of Mfg/Svc within Groups

Manufacturing

t-Test: Two-Sample Assuming Unequal Variances

	RDE Mfg	*RDE Svc*
Mean	5.553380282	5.51
Variance	571.7347027	22.887775
Observations	71	9
Hypothesized Mean Difference	0	
df	65	
t Stat	0.013326859	
P(T<=t) one-tail	0.49470392	
t Critical one-tail	1.668635976	
P(T<=t) two-tail	0.989407841	
t Critical two-tail	1.997137908	

Services

t-Test: Two-Sample Assuming Unequal Variances

	EU Mfg	*EU Svc*
Mean	3.431521739	-0.405769231
Variance	108.8382394	785.0914334
Observations	92	26
Hypothesized Mean Difference	0	
df	27	
t Stat	0.685024697	
P(T<=t) one-tail	0.249583762	
t Critical one-tail	1.703288446	
P(T<=t) two-tail	0.499167524	
t Critical two-tail	2.051830516	

Table 7 – H_2 Comparison of Mfg/Svc within EU

t-Test: Two-Sample Assuming Unequal Variances

	EU Mfg	*EU Svc*
Mean	7.114657534	9.655
Variance	47.40351134	101.6881324
Observations	73	18
Hypothesized Mean Difference	0	
df	21	
t Stat	-1.012200793	
P(T<=t) one-tail	0.161481605	
t Critical one-tail	1.720742903	
P(T<=t) two-tail	0.322963211	
t Critical two-tail	2.079613845	

Table 8 – H_2 Comparison of China to India and Other RDEs

<u>China versus India</u>

t-Test: Two-Sample Assuming Unequal Variances

	China	*India*
Mean	8.101304348	6.1138
Variance	134.9062209	550.8636077
Observations	23	50
Hypothesized Mean Difference	0	
df	71	
t Stat	0.483711446	
P(T<=t) one-tail	0.315039609	
t Critical one-tail	1.666599658	
P(T<=t) two-tail	0.630079218	
t Critical two-tail	1.993943368	

<u>China versus Rest of RDEs</u>

t-Test: Two-Sample Assuming Unequal Variances

	China	*Rest of RDEs*
Mean	8.101304348	4.518421053
Variance	134.9062209	661.1828992
Observations	23	57
Hypothesized Mean Difference	0	
df	77	
t Stat	0.857326073	
P(T<=t) one-tail	0.196962622	
t Critical one-tail	1.664884537	
P(T<=t) two-tail	0.393925245	
t Critical two-tail	1.991254395	

Table 9 – H_2 Comparison of Top Performing Firms

t-Test: Two-Sample Assuming Unequal Variances

	RDE Net Profit Margin	*EU Net Profit Margin*
Mean	17.01487805	12.56765957
Variance	280.7680756	60.55496179
Observations	41	47
Hypothesized Mean Difference	0	
df	55	
t Stat	1.559093563	
P(T<=t) one-tail	0.062355192	
t Critical one-tail	1.673033965	
P(T<=t) two-tail	0.124710384	
t Critical two-tail	2.004044783	

Table 10: Top 20 Bilateral Trading Partners in 2020

EXHIBIT 10 | Emerging Markets Will Dominate the Top 20 Trading Partners in 2020

Top 20 bilateral trading partners in 2020

Rank		Market	Market	Bilateral trade value in 2020 ($billions)	Share of global trade (%)	CAGR, 2010-2020 (%)
⬆	1	China	United States	1,056	3	11
➡	2	China	Hong Kong	1,017	3	9
⬇	3	United States	Canada	894	3	5
⬇	4	United States	Mexico	869	3	8
⬆	5	China	South Korea	672	2	14
⬆	6	China	Germany	406	1	11
➡	7	Germany	Netherlands	388	1	7
⬇	8	China	Japan	382	1	4
⬇	9	Germany	France	339	1	5
⬆	10	China	India	318	1	18
⬆	11	China	Australia	294	1	14
⬇	12	Saudi Arabia	Taiwan	270	1	5
➡	13	Germany	Belgium	252	1	6
⬆	14	China	Singapore	251	1	14
⬆	15	China	Brazil	226	1	15
⬆	16	India	United Arab Emirates	223	1	23
➡	17	Germany	Austria	220	1	7
⬆	18	China	Netherlands	201	1	13
⬇	19	Germany	United Kingdom	199	1	5
⬆	20	Germany	Poland	197	1	8

⬆ Rise ➡ Steady ⬇ Decrease

Sources: International Trade Commission; Economist Intelligence Unit; BCG analysis.
Note: The arrows denote the change in ranking from 2010.

Source: https://www.bcgperspectives.com/Images/Redefining_Global_Competitive_Dynamics_Sep_2014.pdf

Complete Data for Statistical Analysis

Hypothesis 1:

RDE Sales ($ Million)	RDE R&D Exp 2013	Proportion RDE
$15,184.73	$1,749,893	11524.0310
$12,737.67	$278.4	2.1856
$2,712.89	$26.2	0.9658
$856.25	$1.7	0.1985
$851.58	$13.4	1.5735
$787.90	$3.0	0.3808
$723.59	$31.4	4.3395
$678.11	$70.8	10.4408
$671.09	$218.7	32.5888
$585.90	$43.5	7.4245
$550.74	$4.4	0.7989
$535.98	$72.9	13.6013
$487.63	$94.9	19.4615
$411.60	$22.8	5.5394
$386.30	$10.9	2.8216
$352.75	$20.4	5.7831
$346.08	$5.9	1.7048
$334.19	$1.3	0.3890
$311.90	$6.9	2.2122
$304.27	$7.7	2.5306
$296.90	$8.5	2.8629
$233.04	$17.7	7.5953
$227.91	$2.7	1.1847
$219.29	$14.2	6.4754
$217.40	$14.0	6.4397
$205.11	$31.2	15.2114
$198.05	$4.5	2.2722
$182.45	$2.1	1.1510
$179.07	$13.4	7.4831
$167.37	$12.5	7.4685
$152.88	$18.5	12.1010
$152.02	$26.7	17.5635

EU Sales ($ Million)	EU R&D Exp 2013	Proportion EU
$23,147.53	3029.4	13.0874
$3,332.69	129.5	3.8857
$1,339.01	143.3	10.7019
$844.95	0.7	0.0828
$663.17	46.3	6.9816
$612.94	43.1	7.0317
$363.81	2.7	0.7421
$310.88	4.3	1.3832
$242.74	26.3	10.8346
$180.77	16.5	9.1276
$173.21	16.4	9.4683
$120.76	3.7	3.0639
$111.63	14.5	12.9893
$100.85	6	5.9494
$78.48	6.6	8.4098
$76.69	2.7	3.5207
$73.72	4.5	6.1042
$70.56	0.2	0.2834
$63.67	1.1	1.7277
$58.45	0.1	0.1711
$53.88	6.5	12.0638
$51.27	5.8	11.3127
$50.94	9.5	18.6494
$48.88	7.9	16.1620
$41.00	4.8	11.7073
$23.98	0.2	0.8340
$20.12	5.4	26.8390
$19.81	4.6	23.2206
$18.66	6	32.1543
$16.67	2.8	16.7966
$1,178.23	231.9	19.6821
$814.32	80	9.8241

$151.23	$40.3	26.6482
$146.30	$35.6	24.3336
$144.71	$26.5	18.3125
$141.40	$10.4	7.3550
$138.84	$7.0	5.0418
$138.56	$10.8	7.7945
$135.67	$3.4	2.5061
$132.19	$4.1	3.1016
$130.04	$3.2	2.4608
$126.94	$3.5	2.7572
$123.49	$0.8	0.6478
$122.62	$4.8	3.9145
$109.59	$9.9	9.0337
$98.57	$1.0	1.0145
$95.43	$2.8	2.9341
$91.53	$6.7	7.3200
$87.83	$6.7	7.6284
$82.34	$9.1	11.0517
$79.34	$3.1	3.9072
$78.00	$7.2	9.2308
$76.15	$5.0	6.5660
$66.48	$3.8	5.7160
$62.45	$2.4	3.8431
$61.62	$7.7	12.4959
$57.45	$9.8	17.0583
$57.14	$6.6	11.5506
$57.07	$4.7	8.2355
$56.43	$4.8	8.5061
$55.78	$0.8	1.4342
$52.74	$9.0	17.0648
$49.23	$6.7	13.6096
$48.35	$13.5	27.9214
$47.51	$3.2	6.7354
$47.37	$17.1	36.0988
$45.60	$2.0	4.3860
$41.98	$0.3	0.7146
$38.75	$2.6	6.7097
$38.20	$1.1	2.8796
$37.85	$1.5	3.9630
$37.33	$6.2	16.6086
$36.18	$0.1	0.2764

$438.75	38.8	8.8433
$433.06	29.6	6.8351
$247.21	23.8	9.6274
$70.24	0.5	0.7118
$68.15	13.4	19.6625
$53.56	6.9	12.8827
$48.40	7.9	16.3223
$33.93	2.9	8.5470
$31.99	0.5	1.5630
$31.68	4.5	14.2045
$29.84	3.9	13.0697
$27.47	3.7	13.4692
$27.16	4.3	15.8321
$23.09	0.7	3.0316
$22.31	8.3	37.2030
$21.89	4.8	21.9278
$19.55	3.7	18.9258
$18.73	2.2	11.7459
$16.57	0.6	3.6210
$16.28	4.6	28.2555
$16.11	0.3	1.8622
$10.36	0.2	1.9305
$1,022.46	19.8	1.9365
$1,017.90	16.6	1.6308
$197.92	0.5	0.2526
$154.62	34	21.9894
$112.90	0.2	0.1771
$65.08	9	13.8291
$20.24	1.5	7.4111
$16.15	0.7	4.3344
$31.55	5.7	18.0666
$9.46	0.4	4.2283
$9.40	0.4	4.2553
$213.51	48.9	22.9029
$169.80	24.1	14.1932
$135.66	0.3	0.2211
$113.80	16.3	14.3234
$52.48	1.2	2.2866
$18.37	3.1	16.8753
$9.79	15.8	161.3892
$2,119.18	2	0.0944

$32.38	$1.2	3.7060
$31.76	$4.3	13.5390
$31.10	$2.9	9.3248
$30.08	$13.1	43.5505
$29.07	$5.8	19.9518
$20.53	$0.4	1.9484
$12.28	$2.3	18.7296
$11.56	$0.2	1.7301
13,662.16	32.60	0.2386
8,249.00	148.10	1.7954
947.69	15.70	1.6567
372.56	2.10	0.5637
342.77	6.00	1.7504
278.75	0.60	0.2152
178.49	227.90	127.6822
156.75	154.90	98.8198
137.60	5.10	3.7064
63.13	0.10	0.1584
57.82	2.20	3.8049
45.13	3.20	7.0906
43.93	10.20	23.2188
40.53	21.20	52.3069
17.04	1.90	11.1502
14.69	0.80	5.4459
682.11	99.00	14.5138
21.67	1.40	6.4605
33.05	1.50	4.5386

$56.47	0.6	1.0625
$28.62	0.6	2.0964
$12.82	0.8	6.2402
$10.39	1.6	15.3994
$5.01	0.7	13.9721
$43.78	4.2	9.5934
$59.97	3.5	5.8363
$12.93	8.1	62.6450
$13,724.00	1133	8.2556
$177.35	1.4	0.7894
$22.07	1.4	6.3435
$92.53	6.9	7.4570
$45.62	9.5	20.8242
$116.48	2.4	2.0604
$6.08	2.2	36.1842

RDE Mfg	Sales ($ Million)	R&D Expenses 2013	Proportion RDE High-Tech Mfg	SIC
China	$12,737.67	$278.4	2.1856	35710000
China	$856.25	$1.7	0.1985	35710000
China	$678.11	$70.8	10.4408	35720000
China	$535.98	$72.9	13.6013	35770000
China	$411.60	$22.8	5.5394	35780301
China	$346.08	$5.9	1.7048	35750000
China	$334.19	$1.3	0.3890	35710000
China	$311.90	$6.9	2.2122	73729902
China	$304.27	$7.7	2.5306	35770000
China	$296.90	$8.5	2.8629	35710000
China	$167.37	$12.5	7.4685	73720000
China	$151.23	$40.3	26.6482	73720000
China	$141.40	$10.4	7.3550	35780300
China	$138.84	$7.0	5.0418	35780300
China	$122.62	$4.8	3.9145	35710000
China	$98.57	$1.0	1.0145	73720000
China	$95.43	$2.8	2.9341	73720000
China	$91.53	$6.7	7.3200	73720000
China	$82.34	$9.1	11.0517	73729901
China	$57.45	$9.8	17.0583	73729902
China	$55.78	$0.8	1.4342	73720000
China	$47.51	$3.2	6.7354	73720000
China	$45.60	$2.0	4.3860	73720000
China	$41.98	$0.3	0.7146	73720000
China	$37.85	$1.5	3.9630	35720000
China	$30.08	$13.1	43.5505	73720000
China	$12.28	$2.3	18.7296	73720000
Services	Sales ($ Million)	R&D Expenses 2013	Proportion RDE High-Tech Svc	SIC
China	$15,184.73	$1,749,893	11,524.0310	73710000
China	$2,712.89	$26.2	0.9658	73730100
China	$851.58	$13.4	1.5735	73730000
China	$787.90	$3.0	0.3808	73710000
China	$723.59	$31.4	4.3395	73710300
China	$671.09	$218.7	32.5888	73710301
China	$585.90	$43.5	7.4245	73710301

China	$550.74	$4.4	0.7989	73730000
China	$487.63	$94.9	19.4615	73710301
China	$386.30	$10.9	2.8216	73710300
China	$352.75	$20.4	5.7831	73730100
China	$233.04	$17.7	7.5953	73790000
China	$227.91	$2.7	1.1847	73710301
China	$219.29	$14.2	6.4754	73730200
China	$217.40	$14.0	6.4397	73710301
China	$205.11	$31.2	15.2114	73730200
China	$198.05	$4.5	2.2722	73710300
China	$182.45	$2.1	1.1510	73710301
China	$179.07	$13.4	7.4831	73730000
China	$152.88	$18.5	12.1010	73710301
China	$152.02	$26.7	17.5635	73710000
China	$146.30	$35.6	24.3336	73710000
China	$144.71	$26.5	18.3125	73710000
China	$138.56	$10.8	7.7945	73710300
China	$135.67	$3.4	2.5061	73710301
China	$132.19	$4.1	3.1016	73730100
China	$130.04	$3.2	2.4608	73730100
China	$126.94	$3.5	2.7572	73730000
China	$123.49	$0.8	0.6478	73730000
China	$109.59	$9.9	9.0337	73710301
China	$87.83	$6.7	7.6284	73730000
China	$79.34	$3.1	3.9072	73710301
China	$78.00	$7.2	9.2308	73710301
China	$76.15	$5.0	6.5660	73710301
China	$66.48	$3.8	5.7160	73710301
China	$62.45	$2.4	3.8431	73730200
China	$61.62	$7.7	12.4959	73730200
China	$57.14	$6.6	11.5506	73730200
China	$57.07	$4.7	8.2355	73710301
China	$56.43	$4.8	8.5061	73790100
China	$52.74	$9.0	17.0648	73790000
China	$49.23	$6.7	13.6096	73730000
China	$48.35	$13.5	27.9214	73730000
China	$47.37	$17.1	36.0988	73710300
China	$38.75	$2.6	6.7097	73730100
China	$38.20	$1.1	2.8796	73730100
China	$37.33	$6.2	16.6086	73790000
China	$36.18	$0.1	0.2764	73730000

China	$32.38	$1.2	3.7060	73730100
China	$31.76	$4.3	13.5390	73710301
China	$31.10	$2.9	9.3248	73730100
China	$29.07	$5.8	19.9518	73730000
China	$20.53	$0.4	1.9484	73710301
China	$11.56	$0.2	1.7301	73710301
India	13,662.16	32.60	0.2386	73710300
India	8,249.00	148.10	1.7954	73710301
India	947.69	15.70	1.6567	73710300
India	372.56	2.10	0.5637	73710300
India	342.77	6.00	1.7504	73710300
India	278.75	0.60	0.2152	73710301
India	178.49	227.90	127.6822	73710301
India	156.75	154.90	98.8198	73710301
India	137.60	5.10	3.7064	73710301
India	63.13	0.10	0.1584	73790200
India	57.82	2.20	3.8049	73710302
India	45.13	3.20	7.0906	73790000
India	43.93	10.20	23.2188	73710300
India	40.53	21.20	52.3069	73710000
India	17.04	1.90	11.1502	73710301
Malaysia	14.69	0.80	5.4459	73710300
Brazil	682.11	99.00	14.5138	73790000
Brazil	21.67	1.40	6.4605	73730000
Turkey	33.05	1.50	4.5386	73710000

EU Mfg	Sales ($ Million)	R&D Expenses 2013	Proportion EU High-Tech Mfg	SIC
Germany	$3,332.69	129.5	$3.89	35710000
Germany	$663.17	46.3	$6.98	73720000
Germany	$612.94	43.1	$7.03	35710000
Germany	$180.77	16.5	$9.13	73720000
Germany	$173.21	16.4	$9.47	73720000
Germany	$111.63	14.5	$12.99	73720000
Germany	$100.85	6	$5.95	73720000
Germany	$73.72	4.5	$6.10	73720000
Germany	$70.56	0.2	$0.28	35770000
Germany	$58.45	0.1	$0.17	73720000
Germany	$41.00	4.8	$11.71	73720000
Germany	$20.12	5.4	$26.84	73720000
England	$16.57	0.6	$3.62	73720000
France	$154.62	34	$21.99	35770000
France	$112.90	0.2	$0.18	35770000
Belgium	$12.93	8.1	$62.65	35710000
Ireland	$22.07	1.4	$6.34	73720000
Services	**Sales ($ Million)**	**R&D Expenses 2013**	**Proportion EU High-Tech Svc**	**SIC**
Germany	$1,339.01	143.3	$10.70	73710301
Germany	$363.81	2.7	$0.74	73790200
Germany	$310.88	4.3	$1.38	73710301
Germany	$120.76	3.7	$3.06	73790000
Germany	$78.48	6.6	$8.41	73710301
Germany	$76.69	2.7	$3.52	73710301
Germany	$63.67	1.1	$1.73	73710301
Germany	$53.88	6.5	$12.06	73790200
Germany	$50.94	9.5	$18.65	73710301
Germany	$48.88	7.9	$16.16	73710301
Germany	$23.98	0.2	$0.83	73790000
Germany	$18.66	6	$32.15	73710301
Germany	$16.67	2.8	$16.80	73710301
England	$1,178.23	231.9	$19.68	73790000
England	$438.75	38.8	$8.84	73790000
England	$433.06	29.6	$6.84	73790000
England	$247.21	23.8	$9.63	73790000

England	$70.24	0.5	$0.71	73790000
England	$68.15	13.4	$19.66	73790000
England	$53.56	6.9	$12.88	73790000
England	$48.40	7.9	$16.32	73790000
England	$33.93	2.9	$8.55	73790000
England	$31.68	4.5	$14.20	73790000
England	$29.84	3.9	$13.07	73790000
England	$27.47	3.7	$13.47	73790000
England	$27.16	4.3	$15.83	73790000
England	$23.09	0.7	$3.03	73790000
England	$21.89	4.8	$21.93	73790000
England	$19.55	3.7	$18.93	73790000
England	$18.73	2.2	$11.75	73790000
England	$16.28	4.6	$28.26	73790000
England	$16.11	0.3	$1.86	73790000
England	$10.36	0.2	$1.93	73790000
France	$1,022.46	19.8	$1.94	73710000
France	$1,017.90	16.6	$1.63	73710000
France	$65.08	9	$13.83	73710000
France	$20.24	1.5	$7.41	73710000
France	$16.15	0.7	$4.33	73710000
Sweden	$9.46	0.4	$4.23	73710000
Sweden	$9.40	0.4	$4.26	73710000
Finland	$213.51	48.9	$22.90	73710000
Finland	$169.80	24.1	$14.19	73710000
Finland	$135.66	0.3	$0.22	73710000
Finland	$113.80	16.3	$14.32	73710000
Finland	$52.48	1.2	$2.29	73710000
Finland	$9.79	15.8	$161.39	73790200
Greece	$2,119.18	2	$0.09	73710000
Greece	$56.47	0.6	$1.06	73790000
Greece	$28.62	0.6	$2.10	73710000
Greece	$12.82	0.8	$6.24	73710000
Greece	$10.39	1.6	$15.40	73710000
Greece	$5.01	0.7	$13.97	73710000
Denmark	$43.78	4.2	$9.59	73710000
Scotland	$92.53	6.9	$7.46	73790000
Austria	$45.62	9.5	$20.82	73710300
N. Ireland	$116.48	2.4	$2.06	73790000
Slovenia	$6.08	2.2	$36.18	73710000

Manufacturing vs. Service

RDE Results		
Manufacturing SIC Codes		
35710000	Electronic Computers	5
35720000	Computer Storage Devices	2
35750000	Computer Terminals	1
35770000	Computer Peripheral Equipment, nec	2
35780300	Banking Machines	2
35780301	Automatic Teller Machines (ATM)	1
73720000	Prepackaged Software	11
73729901	Application Computer Software	1
73729902	Business Oriented Computer Software	2
	TOTAL RDE FIRMS	**27**
High-Tech Service SIC Codes		
73710000	Custom Computer Programming Services	7
73710300	Computer Software Development & Applications	11
73710301	Computer Software Development	23
73710302	Software Programming Applications	1
73730000	Computer Integrated Systems Design	11
73730100	Systems Software Development Services	8
73730200	Systems Integration Services	5
73790000	Computer Related Services, nec	5
73790100	Computer Related Maintenance Services	1
73790200	Computer Related Consulting Services	1
	TOTAL RDE FIRMS	**73**

EU Results		
Manufacturing SIC Codes		
35710000	Electronic Computers	3
35770000	Computer Peripheral Equipment, nec	3
73720000	Prepackaged Software	11
	TOTAL EU FIRMS	**17**
High-Tech Service SIC Codes		
73710000	Custom Computer Programming Services	19
73710300	Computer Software Development & Applications	1
73710301	Computer Software Development	9
73790000	Computer Related Services, nec	25
73790200	Computer Related Consulting Services	3
	TOTAL EU FIRMS	**57**

Manufacturing

t-Test: Two-Sample Assuming Unequal Variances

	Proportion RDE High-Tech Mfg	*Proportion EU High-Tech Mfg*
Mean	7.8142673	11.48910114
Variance	91.18367074	225.1532329
Observations	27	17
Hypothesized Mean Difference	0	
df	24	
t Stat	-0.901369485	
P(T<=t) one-tail	0.188174433	
t Critical one-tail	1.71088208	
P(T<=t) two-tail	0.376348866	
t Critical two-tail	2.063898562	

Cannot reject null hypothesis.

Services

t-Test: Two-Sample Assuming Unequal Variances

	Proportion RDE High-Tech Svc	*Proportion EU High-Tech Svc*
Mean	169.3528706	13.00886113
Variance	1815934.564	471.3122044
Observations	73	57
Hypothesized Mean Difference	0	
df	72	
t Stat	0.991106697	
P(T<=t) one-tail	0.162476323	
t Critical one-tail	1.666293696	
P(T<=t) two-tail	0.324952645	
t Critical two-tail	1.993463567	

Cannot reject null hypothesis

Proportion RDE High-Tech Mfg	Proportion RDE High-Tech Svc	
2.185643057	11524.03105	12.49594288
0.198540146	0.965759762	11.55057753
10.44078394	1.573545645	8.235500263
13.60125378	0.38075898	8.506113769
5.539358601	4.339474012	17.06484642
1.704808137	32.58877349	13.60958765
0.389000269	7.424475166	27.92140641
2.212247515	0.798925083	36.09879671
2.530647123	19.46147694	6.709677419
2.862916807	2.821641211	2.879581152
7.468483002	5.78313253	16.60862577
26.64815182	7.595262616	0.276395799
7.355021216	1.184678162	3.705991353
5.041774705	6.475443477	13.53904282
3.914532703	6.43974241	9.324758842
1.014507457	15.21135001	19.95184039
2.934087813	2.272153497	1.948368242
7.32000437	1.151000274	1.730103806
11.0517367	7.483107165	0.23861527
17.05831158	12.10099424	1.795369136
1.434205809	17.56347849	1.656659878
6.735424121	24.33356118	0.563667597
4.385964912	18.31248704	1.750444905
0.714626012	7.794457275	0.215246637
3.963011889	2.506080932	127.6822231
43.55053191	3.101596187	98.81977671
18.72964169	2.460781298	3.706395349
	2.75720813	0.158403295
	0.647825735	3.804911795
	9.033670955	7.090627077
	7.628372993	23.21875711
	3.907234686	52.30693314
	9.230769231	11.15023474
	6.565988181	5.445881552
	5.716004813	14.5137881
	3.84307446	6.460544532
		4.538577912

RDE Results		
Manufacturing SIC Codes		
35710000	Electronic Computers	5
35720000	Computer Storage Devices	2
35750000	Computer Terminals	1
35770000	Computer Peripheral Equipment, nec	2
35780300	Banking Machines	2
35780301	Automatic Teller Machines (ATM)	1
73720000	Prepackaged Software	11
73729901	Application Computer Software	1
73729902	Business Oriented Computer Software	2
	TOTAL RDE FIRMS	**27**
High-Tech Service SIC Codes		
73710000	Custom Computer Programming Services	7
73710300	Computer Software Development & Applications	11
73710301	Computer Software Development	23
73710302	Software Programming Applications	1
73730000	Computer Integrated Systems Design	11
73730100	Systems Software Development Services	8
73730200	Systems Integration Services	5
73790000	Computer Related Services, nec	5
73790100	Computer Related Maintenance Services	1
73790200	Computer Related Consulting Services	1
	TOTAL RDE FIRMS	**73**

Proportion EU High-Tech Mfg	Proportion EU High-Tech Svc	
3.88574995	10.70193651	11.74586225
6.98161859	0.742145625	28.25552826
7.031683362	1.383170355	1.862197393
9.127620734	3.063928453	1.930501931
9.468275504	8.409785933	1.936506074
12.98933978	3.520667623	1.630808527
5.949429846	1.727658238	13.82913337
6.104177971	12.06384558	7.411067194
0.283446712	18.64939144	4.334365325
0.171086399	16.16202946	4.22832981
11.70731707	0.834028357	4.255319149
26.8389662	32.15434084	22.90290853
3.621001811	16.79664067	14.19316843
21.98939335	19.68206547	0.221141088
0.177147919	8.843304843	14.32337434
62.6450116	6.835080589	2.286585366
6.343452651	9.627442256	161.3891726
	0.711845103	0.094376127
	19.66250917	1.062511068
	12.88274832	2.096436059
	16.32231405	6.24024961
	8.547008547	15.39942252
	14.20454545	13.97205589
	13.06970509	9.593421654
	13.46923917	7.45704096
	15.83210604	20.82419991
	3.031615418	2.06043956
	21.92782092	36.18421053
	18.9258312	

EU Results		
Manufacturing SIC Codes		
35710000	Electronic Computers	3
35770000	Computer Peripheral Equipment, nec	3
73720000	Prepackaged Software	11
	TOTAL EU FIRMS	**17**
High-Tech Service SIC Codes		
73710000	Custom Computer Programming Services	19
73710300	Computer Software Development & Applications	1
73710301	Computer Software Development	9
73790000	Computer Related Services, nec	25
73790200	Computer Related Consulting Services	3
	TOTAL EU FIRMS	**57**

Does either group within the same economy show significant differences in mfg/svc?

t-Test: Two-Sample Assuming Unequal Variances

	*Proportion **RDE** High-Tech Mfg*	*Proportion **RDE** High-Tech Svc*
Mean	7.8142673	169.3528706
Variance	91.18367074	1815934.564
Observations	27	73
Hypothesized Mean Difference	0	
df	72	
t Stat	-1.024137286	
P(T<=t) one-tail	0.154599545	
t Critical one-tail	1.666293696	
P(T<=t) two-tail	0.309199091	
t Critical two-tail	1.993463567	

t-Test: Two-Sample Assuming Unequal Variances

	Proportion EU High-Tech Mfg	*Proportion EU High-Tech Svc*
Mean	11.48910114	13.00886113
Variance	225.1532329	471.3122044
Observations	17	57
Hypothesized Mean Difference	0	
df	38	
t Stat	-0.327661256	
P(T<=t) one-tail	0.372483125	
t Critical one-tail	1.68595446	
P(T<=t) two-tail	0.744966249	
t Critical two-tail	2.024394164	

RDE	R&D Exp.	SIC
China	$1,749,893.0	73710000
China	$278.4	35710000
India	$227.9	73710301
China	$218.7	73710301
India	$154.9	73710301
India	$148.1	73710301
Brazil	$99.0	73790000
China	$94.9	73710301
China	$72.9	35770000
China	$70.8	35720000
China	$43.5	73710301
China	$40.3	73720000
China	$35.6	73710000
India	$32.6	73710300
China	$31.4	73710300
China	$31.2	73730200
China	$26.7	73710000
China	$26.5	73710000
China	$26.2	73730100
China	$22.8	35780301
India	$21.2	73710000
China	$20.4	73730100
China	$18.5	73710301
China	$17.7	73790000
China	$17.1	73710300
India	$15.7	73710300
China	$14.2	73730200
China	$14.0	73710301
China	$13.5	73730000
China	$13.4	73730000
China	$13.4	73730000
China	$13.1	73720000
China	$12.5	73720000
China	$10.9	73710300
China	$10.8	73710300
China	$10.4	35780300
India	$10.2	73710300
China	$9.9	73710301
China	$9.8	73729902

EU	R&D Exp.	SIC
Germany	$3,029.4	73710301
Ireland	$1,133.0	73790000
England	$231.9	73790000
Germany	$143.3	73710301
Germany	$129.5	35710000
England	$80.0	35770000
Finland	$48.9	73710000
Germany	$46.3	73720000
Germany	$43.1	35710000
England	$38.8	73790000
France	$34.0	35770000
England	$29.6	73790000
Germany	$26.3	73710301
Finland	$24.1	73710000
England	$23.8	73790000
France	$19.8	73710000
France	$16.6	73710000
Germany	$16.5	73720000
Germany	$16.4	73720000
Finland	$16.3	73710000
Finland	$15.8	73790200
Germany	$14.5	73720000
England	$13.4	73790000
Germany	$9.5	73710301
Austria	$9.5	73710300
France	$9.0	73710000
England	$8.3	73790000
Belgium	$8.1	35710000
Germany	$7.9	73710301
England	$7.9	73790000
England	$6.9	73790000
Scotland	$6.9	73790000
Germany	$6.6	73710301
Germany	$6.5	73790200
Germany	$6.0	73720000
Germany	$6.0	73710301
Germany	$5.8	73710301
Sweden	$5.7	73710000
Germany	$5.4	73720000

China	$9.1	73729901
China	$9.0	73790000
China	$8.5	35710000
China	$7.7	35770000
China	$7.7	73730200
China	$7.2	73710301
China	$7.0	35780300
China	$6.9	73729902
China	$6.7	73720000
China	$6.7	73730000
China	$6.7	73730000
China	$6.6	73730200
China	$6.2	73790000
India	$6.0	73710300
China	$5.9	35750000
China	$5.8	73730000
India	$5.1	73710301
China	$5.0	73710301

SIC Codes Represented in Both Groups		
RDE Results		
Manufacturing SIC Codes		
35710000	Electronic Computers	2
35720000	Computer Storage Devices	1
35720100	Computer Disks, Drum Drives, & Components	0
35750000	Computer Terminals	1
35770000	Computer Peripheral Equipment, nec	2
35780300	Banking Machines	2
35780301	Automatic Teller Machines (ATM)	1
73720000	Prepackaged Software	4
73729901	Application Computer Software	1
73729902	Business Oriented Computer Software	2
73729904	Home Entertainment Computer Software	0
	TOTAL RDE FIRMS	**16**
High-Tech Service SIC Codes		
73710000	Custom Computer Programming Services	5
73710300	Computer Software Development & Applications	8
73710301	Computer Software Development	12
73710302	Software Programming Applications	0
73730000	Computer Integrated Systems Design	7
73730100	Systems Software Development Services	2
73730200	Systems Integration Services	4
73730201	Local Area Network Systems	0
73790000	Computer Related Services, nec	4
73790100	Computer Related Maintenance Services	0
	TOTAL RDE FIRMS	**42**

EU Results		
Manufacturing SIC Codes		
35710000	Electronic Computers	3
35770000	Computer Peripheral Equipment, nec	2
73720000	Prepackaged Software	6
	TOTAL EU FIRMS	**11**
High-Tech Service SIC Codes		
73710000	Custom Computer Programming Services	7
73710300	Computer Software Development & Applications	1
73710301	Computer Software Development	8
73790000	Computer Related Services, nec	10
73790200	Computer Related Consulting Services	2
	TOTAL EU FIRMS	**28**

RDE SIC		EU SIC
$1,749,893.0	$13.4	$3,029.4
$278.4	$13.4	$1,133.0
$227.9	$13.1	$231.9
$218.7	$12.5	$143.3
$154.9	$10.9	$129.5
$148.1	$10.8	$80.0
$99.0	$10.4	$48.9
$94.9	$10.2	$46.3
$72.9	$9.9	$43.1
$70.8	$9.8	$38.8
$43.5	$9.1	$34.0
$40.3	$9.0	$29.6
$35.6	$8.5	$26.3
$32.6	$7.7	$24.1
$31.4	$7.7	$23.8
$31.2	$7.2	$19.8
$26.7	$7.0	$16.6
$26.5	$6.9	$16.5
$26.2	$6.7	$16.4
$22.8	$6.7	$16.3
$21.2	$6.7	$15.8
$20.4	$6.6	$14.5
$18.5	$6.2	$13.4
$17.7	$6.0	$9.5
$17.1	$5.9	$9.5
$15.7	$5.8	$9.0
$14.2	$5.1	$8.3
$14.0	$5.0	$8.1
$13.5		$7.9
		$7.9
		$6.9
		$6.9
		$6.6
		$6.5
		$6.0
		$6.0
		$5.8
		$5.7
		$5.4

Do top spending RDE firms spend more on R&D?

t-Test: Two-Sample Assuming Unequal Variances

	RDE SIC	*EU SIC*
Mean	30736.24386	136.0846154
Variance	53719230856	259235.4308
Observations	57	39
Hypothesized Mean Difference	0	
df	56	
t Stat	0.996769384	
P(T<=t) one-tail	0.161582072	
t Critical one-tail	1.672522303	
P(T<=t) two-tail	0.323164143	
t Critical two-tail	2.003240719	

Hypothesis 2

RDE Net Profit Margin (%,2013)	EU Net Profit Margin (%, 2013)
17.43	17.17
4.3	2.27
0.57	12.91
22.25	2.57
36.69	2.04
10.98	-4.5
-3.76	9.53
0.69	-31.04
15.63	4.89
18.94	-3.41
-79.17	-10.22
4.61	25.18
8.76	14.67
16.59	-10.48
-23.19	12.42
-38.52	35.42
1.11	3.15
-9.32	5.35
6.49	12.23
2.91	19.43
-9.75	8.12
8.84	15.2
2.49	-10.52
-9.01	1.82
-32.47	0.95
-24.01	0.74
4.52	5.96
10.39	4.25
18.49	4.53
-7.91	2.02
8.22	1.95
1.18	26.57
9.52	4.98
4.91	3.25

27.26	2.42
	8.63
	-3.75
	10.62
	0.12
	-0.81
	6.94
	1.32
	-12.08
	10.39
	20.01
	3.82
	1.43
	-19.12
	-9.46
	9.11

	High-Tech Service SIC Codes	RDE
73710000	Custom Computer Programming Services	5
73710300	Computer Software Development & Applications	7
73710301	Computer Software Development	7
73710302	Software Programming Applications	1
73730000	Computer Integrated Systems Design	3
73730100	Systems Software Development Services	2
73730200	Systems Integration Services	2
73730201	Local Area Network (LAN) Systems Integrator	2
73730300	Computer System Selling Services	2
73790000	Computer Related Services, nec	1
73790200	Computer Related Consulting Services	
	TOTAL FIRMS	32

	High-Tech Manufacturing SIC Codes	RDE
35710000	Electronic Computers	1
35750000	Computer Terminals	1
73720000	Prepackaged Software	1
	TOTAL FIRMS	3

H_2: Firms in RDEs are more profitable compared to firms in EU countries

t-Test: Two-Sample Assuming Unequal Variances - (%,2013)

	RDE Net Profit Margin	*EU Net Profit Margin*
Mean	0.761714286	4.3798
Variance	442.1790734	129.9756347
Observations	35	50
Hypothesized Mean Difference	0	
df	48	
t Stat	-0.927007552	
P(T<=t) one-tail	0.179280252	
t Critical one-tail	1.677224196	
P(T<=t) two-tail	0.358560504	
t Critical two-tail	2.010634758	

RDE Mfg	SIC
0.08	73710000
25.65	73730000
16.71	73730200
5.51	73730000
0.7	73730000
0.87	73710000
17.43	73710300
2.14	73710301
-6.09	73730100
0.57	73730200
22.25	73730200
32.86	73730000
36.69	73710000
10.98	73730000
1.8	73730000
4.05	73710301
-3.76	73730100
0.69	73710301
22.09	73710300
93.93	73710301
15.63	73710300
18.94	73710300
12.83	73710300
-79.17	73730201
30.95	73710301
4.61	73710000
8.89	73710301
8.76	73710301
8.25	73710300
10.55	73710301
11.95	73710300
16.59	73710300
-23.19	73730200
14.49	73710301
-38.52	73710301
9.40	73710301

EU Mfg	SIC
19.78	73710301
13.76	73710301
2.71	73790200
2.88	73790200
5.64	73790200
2.27	73710301
12.91	73710301
2.57	73710301
-10.74	73710301
2.04	73790200
2.92	73790200
6.6	73710301
-18.14	73790200
1.13	73710301
8.5	73710301
9.53	73790000
-31.04	73790000
-3.41	73790200
-10.22	73790200
-21.6	73790000
14.67	73790000
-10.48	73790000
29.55	73790000
12.42	73790000
35.42	73790000
1.96	73790000
7.27	73790000
3.15	73790000
-5.55	73790000
6.41	73790000
6.97	73790000
5.35	73790000
12.23	73790000
-8.5	73790000
8.12	73790000
17.94	73790000

6.74	73710301
1.11	73710301
-9.32	73710301
5.02	73710000
67.89	73710301
3.43	73710301
8.06	73710301
6.49	73710300
-1.21	73730200
0.30	73730100
9.40	73710301
2.52	73790000
2.91	73710301
-9.75	73730300
12.47	73710300
5.18	73710300
2.49	73710300
-9.01	73790000
-32.47	73710000
18.13	73710301
-24.01	73710302
4.52	73710300
10.39	73710000
18.49	73730100
4.49	73710301
0.10	73710000
15.78	73710101
6.20	73710300
1.16	73790000
-7.91	73710301
8.22	73710301
9.52	73730000
4.91	73730000
-91.32	73710000
27.26	73710000

-10.52	73790000
5.29	73710000
6.07	73710000
1.82	73710000
2.5	73710000
1.19	73710000
5.41	73760000
4.27	73710000
-6.5	73790000
0.95	73710000
0.74	73710000
7.73	73710000
3.16	73760000
4.19	73710000
1.21	73710000
5.96	73710000
4.25	73710000
1.85	73710000
4.53	73710000
1.7	73710000
2.02	73710000
2.9	73710000
1.95	73710000
-2.43	73710000
26.57	73710000
4.98	73710000
3.25	73710000
-10.19	73710000
2.42	73710000
8.63	73710000
-3.75	73710000
7.97	73710000
13.13	73710000
2.4	73710000
0.96	73710000
10.62	73710000
2.11	73710000
1.13	73710000
6	73710000
-4.08	73790200
-0.3	73710000

0.12	73790000
-0.81	73710000
6.94	73710000
1.32	73710000
11.01	73710000
-35.95	73710000
13.03	73710000
10.39	73710000
12.81	73790000
20.01	73790000
3.82	73790000
1.43	73790000
-9.46	73710300
9.11	73790000
14.82	73710000

Manufacturing vs. Service

RDE Results		
High-Tech Service SIC Codes		
73710000	Custom Computer Programming Services	10
73710300	Computer Software Development & Applications	14
73710301	Computer Software Development	23
73710302	Software Programming Applications	1
73730000	Computer Integrated Systems Design	10
73730100	Systems Software Development Services	4
73730200	Systems Integration Services	5
73730201	Local Area Network (LAN) Systems Integrator	1
73730300	Computer System Selling Services	1
73790000	Computer Related Services, nec	3
73790100	Computer Related Maintenance Services	0
73790200	Computer Related Consulting Services	0
	TOTAL RDE FIRMS	**72**
High-Tech Manufacturing SIC Codes		
35710000	Electronic Computers	5
35720000	Computer Storage Devices	0
35750000	Computer Terminals	1
35770000	Computer Peripheral Equipment, nec	0
35780301	Automatic Teller Machines (ATM)	0
73720000	Prepackaged Software	2
73729901	Application Computer Software	0
73729902	Business Oriented Computer Software	1
	TOTAL RDE FIRMS	**9**

Manufacturing vs. Service

EU Results		
High-Tech Service SIC Codes		
73710000	Custom Computer Programming Services	44
73710300	Computer Software Development & Applications	1
73710301	Computer Software Development	9
73710302	Software Programming Applications	0
73730000	Computer Integrated Systems Design	0
73730100	Systems Software Development Services	0
73730200	Systems Integration Services	0
73730201	Local Area Network (LAN) Systems Integrator	0
73730300	Computer System Selling Services	0
73760000	Computer Facilities Management	2
73790000	Computer Related Services, nec	27
73790100	Computer Related Maintenance Services	0
73790200	Computer Related Consulting Services	9
	TOTAL EU FIRMS	**92**
High-Tech Manufacturing SIC Codes		
35710000	Electronic Computers	3
35720000	Computer Storage Devices	0
35750000	Computer Terminals	0
35770000	Computer Peripheral Equipment, nec	2
35780301	Automatic Teller Machines (ATM)	0
73720000	Prepackaged Software	21
73729901	Application Computer Software	0
73729902	Business Oriented Computer Software	0
	TOTAL EU FIRMS	**26**

RDE Svc	SIC
0.04	35710000
1.97	35710000
4.3	35750000
7.09	35710000
3.8	73720000
15.63	35710000
6.74	73729902
8.84	73720000
1.18	35710000

EU Svc	SIC
17.17	73720000
5.04	73720000
-7.01	35710000
-4.5	73720000
2.08	73720000
0.1	73720000
10.37	73720000
-3.05	73720000
2.85	35770000
2.73	35770000
1.42	73720000
4.89	73720000
25.18	73720000
37.66	73720000
3.46	73720000
13.42	73720000
-4.33	73720000
19.43	73720000
0.15	73720000
15.2	73720000
6.64	73720000
6	73720000
-12.08	73720000
-9.66	73720000
-124.59	35710000
-19.12	35710000

Manufacturing

t-Test: Two-Sample Assuming Unequal Variances

	RDE Mfg	*EU Mfg*
Mean	5.553380282	3.431521739
Variance	571.7347027	108.8382394
Observations	71	92
Hypothesized Mean Difference	0	
df	91	
t Stat	0.698205497	
P(T<=t) one-tail	0.243414529	
t Critical one-tail	1.661771155	
P(T<=t) two-tail	0.486829058	
t Critical two-tail	1.986377154	

Services

t-Test: Two-Sample Assuming Unequal Variances

	RDE Svc	*EU Svc*
Mean	5.51	-0.405769231
Variance	22.887775	785.0914334
Observations	9	26
Hypothesized Mean Difference	0	
df	29	
t Stat	1.033901375	
P(T<=t) one-tail	0.154863832	
t Critical one-tail	1.699127027	
P(T<=t) two-tail	0.309727665	
t Critical two-tail	2.045229642	

RDE	RDE Net Profit Margin 2013	SIC
India	93.93	73710301
India	67.89	73710301
China	36.69	73710000
China	32.86	73730000
India	30.95	73710301
China	25.65	73730000
China	22.25	73730200
India	22.09	73710300
India	18.94	73710300
India	18.49	73730100
India	18.13	73710301
China	17.43	73710300
China	16.71	73730200
India	16.59	73710300
India	15.78	73710000
India	15.63	73710300
India	15.63	35710000
India	14.49	73710301
India	12.83	73710300
India	12.47	73710300
India	11.95	73710300
China	10.98	73730000
India	10.55	73710301
India	10.39	73710000
Thailand	9.52	73730000
India	9.40	73710301
India	9.40	73710301
India	8.89	73710301
India	8.84	73720000
India	8.76	73710301
India	8.25	73710300
Malaysia	8.22	73710301
India	8.06	73710301
China	7.09	35710000
India	6.74	73729902
India	6.74	73710301
India	6.49	73710300

India	6.20	73710300
China	5.51	73730000
India	5.18	73710300
India	5.02	73710000

SIC Codes Represented in Both Groups		
RDE Results		
High-Tech Service SIC Codes		
73710000	Custom Computer Programming Services	4
73710300	Computer Software Development & Applications	12
73710301	Computer Software Development	13
73730000	Computer Integrated Systems Design	5
73730100	Systems Software Development Services	1
73730200	Systems Integration Services	2
	TOTAL RDE FIRMS	**37**
High-Tech Manufacturing SIC Codes		
35710000	Electronic Computers	2
73720000	Prepackaged Software	1
73729902	Business Oriented Computer Software	1
	TOTAL RDE FIRMS	**4**

EU	EU Net Profit Margin 2013	SIC
Germany	37.66	73720000
England	35.42	73790000
England	29.55	73790000
Sweden	26.57	73710000
Germany	25.18	73720000
Scotland	20.01	73790000
Germany	19.78	73710301
England	19.43	73720000
England	17.94	73790000
Germany	17.17	73720000
England	15.2	73720000
Slovenia	14.82	73710000
England	14.67	73790000
Germany	13.76	73710301
Germany	13.42	73720000
Sweden	13.13	73710000
Denmark	13.03	73710000
Germany	12.91	73710301
Ireland	12.81	73790000
England	12.42	73790000
England	12.23	73790000
Greece	11.01	73710000
Finland	10.62	73710000
Belgium	10.39	73710000
Germany	10.37	73720000
Germany	9.53	73790000
N. Ireland	9.11	73790000
Sweden	8.63	73710000
Germany	8.5	73710301
England	8.12	73790000
Sweden	7.97	73710000
France	7.73	73710000
England	7.27	73790000
England	6.97	73790000
Greece	6.94	73710000
Italy	6.64	73720000
Germany	6.6	73710301
England	6.41	73790000

France	6.07	73710000
Finland	6	73710000
Italy	6	73720000
France	5.96	73710000
Germany	5.64	73790200
France	5.41	73760000
England	5.35	73790000
France	5.29	73710000
Germany	5.04	73720000

EU Results		
High-Tech Service SIC Codes		
73710000	Custom Computer Programming Services	15
73710300	Computer Software Development & Applications	0
73710301	Computer Software Development	5
73710302	Software Programming Applications	0
73730000	Computer Integrated Systems Design	0
73730100	Systems Software Development Services	0
73730200	Systems Integration Services	0
73730201	Local Area Network (LAN) Systems Integrator	0
73730300	Computer System Selling Services	0
73760000	Computer Facilities Management	1
73790000	Computer Related Services, nec	15
73790100	Computer Related Maintenance Services	0
73790200	Computer Related Consulting Services	1
	TOTAL EU FIRMS	**37**
High-Tech Manufacturing SIC Codes		
35710000	Electronic Computers	0
35720000	Computer Storage Devices	0
35750000	Computer Terminals	0
35770000	Computer Peripheral Equipment, nec	0
35780301	Automatic Teller Machines (ATM)	0
73720000	Prepackaged Software	10
73729901	Application Computer Software	0
73729902	Business Oriented Computer Software	0
	TOTAL EU FIRMS	**10**

Do top performing RDE firms have higher profit margins than EU firms?

t-Test: Two-Sample Assuming Unequal Variances

	RDE Net Profit Margin	*EU Net Profit Margin*
Mean	17.01487805	12.56765957
Variance	280.7680756	60.55496179
Observations	41	47
Hypothesized Mean Difference	0	
df	55	
t Stat	1.559093563	
P(T<=t) one-tail	0.062355192	
t Critical one-tail	1.673033965	
P(T<=t) two-tail	0.124710384	
t Critical two-tail	2.004044783	

t-Test: Two-Sample Assuming Unequal Variances

	RDE Mfg	*RDE Svc*
Mean	5.553380282	5.51
Variance	571.7347027	22.887775
Observations	71	9
Hypothesized Mean Difference	0	
df	65	
t Stat	0.013326859	
P(T<=t) one-tail	0.49470392	
t Critical one-tail	1.668635976	
P(T<=t) two-tail	0.989407841	
t Critical two-tail	1.997137908	

t-Test: Two-Sample Assuming Unequal Variances

	EU Mfg	*EU Svc*
Mean	3.431521739	-0.405769231
Variance	108.8382394	785.0914334
Observations	92	26
Hypothesized Mean Difference	0	
df	27	
t Stat	0.685024697	
P(T<=t) one-tail	0.249583762	
t Critical one-tail	1.703288446	
P(T<=t) two-tail	0.499167524	
t Critical two-tail	2.051830516	

RDE Mfg	SIC
93.93	73710000
67.89	73730000
36.69	73730200
32.86	73730000
30.95	73730000
27.26	73710000
25.65	73710300
22.25	73710301
22.09	73730100
18.94	73730200
18.49	73730200
18.13	73730000
17.43	73710000
16.71	73730000
16.59	73730000
15.78	73710301
15.63	73730100
14.49	73710301
12.83	73710300
12.47	73710301
11.95	73710300
10.98	73710300
10.55	73710300
10.39	73730201
9.52	73710301
9.40	73710000
9.40	73710301
8.89	73710301
8.76	73710300
8.25	73710301
8.22	73710300
8.06	73710300
6.74	73730200
6.49	73710301

EU Mfg	SIC
19.78	73710301
35.42	73710301
29.55	73790200
26.57	73790200
20.01	73790200
17.94	73710301
14.82	73710301
14.67	73710301
13.76	73710301
13.13	73790200
13.03	73790200
12.91	73710301
12.81	73790200
12.42	73710301
12.23	73710301
11.01	73790000
10.62	73790000
10.39	73790200
9.53	73790200
9.11	73790000
8.63	73790000
8.5	73790000
8.12	73790000
7.97	73790000
7.73	73790000
7.27	73790000
6.97	73790000
6.94	73790000
6.6	73790000
6.41	73790000
6.07	73790000
6	73790000
5.96	73790000
5.64	73790000

6.20	73710301
5.51	73710301
5.18	73710301
5.02	73710301
4.91	73710301
4.61	73710000
4.52	73710301
4.49	73710301
4.05	73710301
3.43	73710300
2.91	73730200
2.52	73730100
2.49	73710301
2.14	73790000
1.8	73710301
1.16	73730300
1.11	73710300
0.87	73710300
0.7	73710300
0.69	73790000
0.57	73710000
0.30	73710301
0.10	73710302
0.08	73710300
-1.21	73710000
-3.76	73730100
-6.09	73710301
-7.91	73710000
-9.01	73710101
-9.32	73710300
-9.75	73790000
-23.19	73710301
-24.01	73710301
-32.47	73730000
-38.52	73730000
-79.17	73710000
-91.32	73710000

5.41	73790000
5.35	73790000
5.29	73790000
4.98	73710000
4.53	73710000
4.27	73710000
4.25	73710000
4.19	73710000
3.82	73760000
3.25	73710000
3.16	73790000
3.15	73710000
2.92	73710000
2.9	73710000
2.88	73760000
2.71	73710000
2.57	73710000
2.5	73710000
2.42	73710000
2.4	73710000
2.27	73710000
2.11	73710000
2.04	73710000
2.02	73710000
1.96	73710000
1.95	73710000
1.85	73710000
1.82	73710000
1.7	73710000
1.43	73710000
1.32	73710000
1.21	73710000
1.19	73710000
1.13	73710000
1.13	73710000
0.96	73710000
0.95	73710000
0.74	73710000
0.12	73710000
-0.3	73710000
-0.81	73710000

-2.43	73790200
-3.41	73710000
-3.75	73790000
-4.08	73710000
-5.55	73710000
-6.5	73710000
-8.5	73710000
-9.46	73710000
-10.19	73710000
-10.22	73710000
-10.48	73790000
-10.52	73790000
-10.74	73790000
-18.14	73790000
-21.6	73710300
-31.04	73790000
-35.95	73710000

RDE Svc	SIC
0.04	35710000
15.63	35710000
8.84	35750000
7.09	35710000
6.74	73720000
4.3	35710000
3.8	73729902
1.97	73720000
1.18	35710000

EU Svc	SIC
17.17	73720000
37.66	73720000
25.18	35710000
19.43	73720000
15.2	73720000
13.42	73720000
10.37	73720000
6.64	73720000
6	35770000
5.04	35770000
4.89	73720000
3.46	73720000
2.85	73720000
2.73	73720000
2.08	73720000
1.42	73720000
0.15	73720000
0.1	73720000
-3.05	73720000
-4.33	73720000
-4.5	73720000
-7.01	73720000
-9.66	73720000
-12.08	73720000
-19.12	35710000
-124.59	35710000

t-Test: Two-Sample Assuming Unequal Variances

	RDE Mfg	*RDE Svc*
Mean	12.58655172	5.51
Variance	252.3630756	22.887775
Observations	58	9
Hypothesized Mean Difference	0	
df	42	
t Stat	2.69513533	
P(T<=t) one-tail	0.005037527	
t Critical one-tail	1.681952357	
P(T<=t) two-tail	0.010075054	
t Critical two-tail	2.018081703	

t-Test: Two-Sample Assuming Unequal Variances

	EU Mfg	*EU Svc*
Mean	7.114657534	9.655
Variance	47.40351134	101.6881324
Observations	73	18
Hypothesized Mean Difference	0	
df	21	
t Stat	-1.012200793	
P(T<=t) one-tail	0.161481605	
t Critical one-tail	1.720742903	
P(T<=t) two-tail	0.322963211	
t Critical two-tail	2.079613845	

t-Test: Two-Sample Assuming Unequal Variances

	China	*Rest of RDEs*
Mean	8.101304348	4.518421053
Variance	134.9062209	661.1828992
Observations	23	57
Hypothesized Mean Difference	0	
df	77	
t Stat	0.857326073	
P(T<=t) one-tail	0.196962622	
t Critical one-tail	1.664884537	
P(T<=t) two-tail	0.393925245	
t Critical two-tail	1.991254395	

t-Test: Two-Sample Assuming Unequal Variances

	England	*Rest of EU*
Mean	7.46952381	1.528762887
Variance	149.9361848	273.146713
Observations	21	97
Hypothesized Mean Difference	0	
df	38	
t Stat	1.882802571	
P(T<=t) one-tail	0.033699775	
t Critical one-tail	1.68595446	
P(T<=t) two-tail	0.067399549	
t Critical two-tail	2.024394164	

Hypothesis 3

RDE Total Patents 2012	RDE Adult Population	RDE Patents Granted per capita
932	26.91	3463.3965
2830	136.272	2076.7289
770	12.14	6342.6689
217105	990.902	21909.8357
1667	31.878	5229.3118
634	51.723	1225.7603
4328	826.386	523.7262
2460	20.493	12004.0990
12358	79.5	15544.6541
1111	61.01	1821.0129
32880	101.89	32270.0952
6205	34.45	18011.6110
1008	48.24	2089.5522
1004	50.18	2000.7971

EU Total Patents 2012	EU Adult Population	EU Patents Granted per capita
1439	5.70	25245.6140
795	7.28	10920.3297
101	48.91	206.5017
155	2.88	5381.9444
668	7.14	9355.7423
190	3.64	5219.7802
116	85.80	135.1981
836	3.51	23817.6638
12913	42.24	30570.5492
11332	53.20	21300.7519
291	7.26	4008.2645
190	3.04	6250.0000
5625	38.87	14471.3146
154	1.34	11492.5373
92	2.07	4444.4444
11	0.28	3928.5714
1895	11.09	17087.4662
112	6.93	1616.1616
384	14.00	2742.8571
161	3.89	4138.8175
318	1.43	22237.7622
2720	31.22	8712.3639
999	6.14	16270.3583
6864	41.67	16472.2822

H_3: RDEs acquire more patents per capita compared to EU countries

t-Test: Two-Sample Assuming Unequal Variances

	RDE Patents Granted per capita	*EU Patents Granted per capita*
Mean	88.93803557	110.8446987
Variance	9396.166968	7672.741463
Observations	14	24
Hypothesized Mean Difference	0	
df	25	
t Stat	-0.695939936	
P(T<=t) one-tail	0.24644306	
t Critical one-tail	1.708140761	
P(T<=t) two-tail	0.492886119	
t Critical two-tail	2.059538553	

Hypothesis 4:

RDE High-technology exports (% of manufactured exports)									
Country Name	2005	2006	2007	2008	2009	2010	2011	RDE 2012	Avg
Argentina	6.83	7.05	6.59	9.02	8.69	7.50	7.48	7.70	7.61
Brazil	12.84	12.08	11.87	11.65	13.20	11.21	9.72	10.49	11.63
Chile	..	6.39	6.79	5.88	5.37	5.48	4.61	4.65	5.59
China	30.84	30.51	26.66	25.57	27.53	27.51	25.81	26.27	27.59
Colombia	4.99	4.08	2.91	3.72	5.22	5.06	4.33	5.19	4.44
Egypt, Arab Rep.	0.40	0.55	0.19	0.97	0.84	0.88	0.95	0.58	0.67
India	5.80	6.07	6.40	6.78	9.09	7.18	6.87	6.63	6.85
Malaysia	54.65	53.84	52.28	39.92	46.57	44.52	43.39	43.71	47.36
Mexico	19.64	18.98	17.18	15.73	18.18	16.94	16.51	16.33	17.43
Philippines	70.79	67.71	68.90	66.31	65.53	55.26	46.35	48.86	61.21
Russian Federation	8.44	7.78	6.88	6.47	9.23	9.07	7.97	8.38	8.03
South Africa	6.66	6.46	5.58	5.12	5.35	3.54	4.28	4.55	5.19
Thailand	26.67	27.39	25.96	24.55	25.34	24.02	20.74	20.54	24.40
Turkey	1.47	1.85	1.89	1.62	1.74	1.93	1.84	1.83	1.77

EU High-technology exports (% of manufactured exports)									
Country Name	2005	2006	2007	2008	2009	2010	2011	EU 2012	Avg
Austria	13.74	13.34	11.31	11.00	11.64	11.91	11.67	12.84	12.18
Belgium	8.86	8.40	7.44	7.98	10.43	10.48	10.01	11.36	9.37
Bulgaria	4.77	6.12	5.97	6.55	8.15	7.91	7.47	7.75	6.84
Croatia	11.40	9.85	8.21	8.35	9.76	9.15	7.56	9.91	9.27
Czech Republic	12.95	14.32	13.24	13.56	14.56	15.30	16.28	16.08	14.54
Denmark	23.38	20.18	16.79	15.58	17.91	14.20	13.98	14.24	17.03
Estonia	14.66	12.63	5.80	5.40	5.68	9.27	13.39	10.72	9.69
Finland	25.06	22.31	17.98	17.21	13.96	10.94	9.27	8.55	15.66
France	20.27	21.46	18.48	19.97	22.64	24.92	23.75	25.41	22.11
Germany	17.42	17.14	13.99	13.30	15.26	15.25	14.96	15.80	15.39
Greece	10.58	10.96	7.37	9.31	10.86	10.15	9.66	9.17	9.76
Ireland	34.73	34.53	27.26	25.73	24.26	21.23	21.71	22.59	26.50
Italy	7.98	7.33	6.26	6.40	7.47	7.24	7.37	7.07	7.14
Latvia	5.31	6.82	6.95	6.95	7.76	7.64	8.24	9.78	7.43
Lithuania	6.15	8.06	10.85	11.14	9.99	10.61	10.21	10.42	9.68
Luxembourg	11.86	11.58	8.76	6.42	8.78	8.37	8.81	8.10	9.08
Malta	52.00	58.12	52.44	50.23	47.98	47.08	47.23	45.73	50.10
Netherlands	30.89	28.99	23.31	19.25	20.90	21.29	19.81	20.07	23.06
Portugal	8.88	9.28	8.35	8.14	3.77	3.41	3.53	4.06	6.18
Romania	3.84	4.83	3.48	6.69	9.11	10.95	10.18	6.38	6.93
Slovak Republic	7.44	6.72	5.35	5.26	5.70	6.77	7.10	9.30	6.71
Slovenia	4.93	5.51	5.01	5.82	6.48	5.72	5.80	6.18	5.68
Spain	7.26	6.38	5.11	5.31	6.23	6.36	6.47	6.99	6.26
Sweden	16.94	16.10	11.53	11.20	12.91	13.70	13.38	13.36	13.64
United Kingdom	28.36	32.98	19.36	18.15	23.20	20.88	21.30	21.74	23.25

H$_4$: RDE countries export more high-tech exports than the EU.

t-Test: Two-Sample Assuming Unequal Variances

	RDE 2012	*EU 2012*
Mean	14.69345185	13.34352
Variance	231.5937737	76.48894
Observations	14	25
Hypothesized Mean Difference	0	
df	18	
t Stat	0.30490379	
P(T<=t) one-tail	0.381968414	
t Critical one-tail	1.734063607	
P(T<=t) two-tail	0.763936828	
t Critical two-tail	2.10092204	