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The impact of competition policies on broad-based adoption of ICT

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A research project submitted to the Gordon Institute of Business Science, University of Pretoria, in partial fulfillment of the requirements of the degree of Master of Business Administration.

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Abstract

ICT is a key driver of employment, growth, and innovation in various economic sectors (Schröder, des IfM Bonn, Wirtschaftsbeobachtung, & im Mittelstand, 2011). It therefore becomes important to understand the factors which impact on the adoption of ICT in order to facilitate adoption and bridge the digital divide between developed and developing markets in the interest of impacting inequality.

A factor often overlooked in the literature is the impact competition policies have on the adoption of ICT. The broad research objective was to determine the impact, if any, of competition enhancing and competition restricting/protecting policies on the level of ICT adoption in various economies, thus providing governments and ICT organisations with the necessary understanding of the dynamics involved.

The research objective required examining the relationship (using regression analysis) between the level of competition policies and the rate of ICT adoption. The literature review found that there is a theoretical link between the level and type of competition policies and the rate of ICT adoption.

The statistical analysis found no relationship between these two variables indicating that competition policies does not have any impact on the rate of ICT adoption or that the influence of competition policy is rendered insignificant when compared to other forces influencing ICT adoption.

Keywords

Competition enhancing/protecting policies
Information and communication technology (ICT) adoption
Developing and developed economies
Product market regulations (PMR) index
Network Service Provider (NSP)

Declaration

I declare that this research project is my own work. It is submitted in partial fulfilment of the requirements for the degree of Master of Business Administration at the Gordon Institute of Business Science, University of Pretoria. It has not been submitted before for any degree or examination in any other University. I further declare that I have obtained the necessary authorisation and consent to carry out this research.

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Gerhard Bester
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1. Introduction

1.1. Research title

The impact of competition policies on broad-based adoption of ICT.

1.2. Research problem

The use of information and communication technology (ICT) has widespread impact on the micro economy and macro economy of a country (Liu & Nath, 2012). ICT is a key driver of employment, growth, and innovation in various economic sectors (Schröder et al., 2011). ICT is also believed to be the most cost effective and efficient tool to help organisations reach a larger customer base and increase their ability to compete on a global scale (Tan, Chong, Lin, & Eze, 2009). This idea was reiterated by Prahalad and Hammond (2002) who found that ICT was an inexpensive way to establish marketing and distribution channels for the harder to reach rural poor. Thus ICT would seem to be a key catalyst for reducing poverty, promoting business and encouraging competitiveness. Still there is a significant gap in usage and adoption between developed and developing economies (Deen-Swarray, Moyo, & Stork, 2013a). It therefore becomes important to understand the factors which impact the adoption of ICT in order to facilitate adoption and bridge the digital divide between developed and developing markets in the interest of impacting inequality.

A factor often overlooked in the literature is the impact competition policies have on the adoption of ICT. Competition policies can be implemented for a variety of reasons but many economists believe that the ultimate goal of competition policy is to maximise social welfare (Buccirossi, Ciari, Duso, Spagnolo, & Vitale, 2011). In developing economies competition policy has the important role of encouraging and promoting healthy competition whilst ensuring the protection of local industries and social redistribution (Hoekman & Holmes, 1999a). Thus it is a difficult balancing act of trade-offs for governments because of the short and

long term social and economic impact. Whilst enhancement of competition will force established operating enterprises to focus on innovation, optimisation (in the form of lower costs resulting in lower prices) and customer needs (Achterberg, 2000), businesses are generally more focused on generating profit than investing in infrastructure for the sake of social welfare. In contrast to this competition policy can also be used to protect state owned enterprises (SOE) to ensure various non-profit goals (e.g. social, employment, or capital formation) are achieved (Sokol, 2009)(Singleton, 1997). Institutions that regulate and enforce various forms of competition policy can also play a role in the effectiveness of implemented policies but it is outside the scope of this research report.

Different countries/economies have different approaches when it comes to implementing competition policies (Sokol, 2009). This can depend on numerous factors, including infrastructure, inequality, and political agendas (Sokol, 2009). Competition policy performance can also vary between developed and developing economies (Rodriguez & DeNardis Ph D, 2007) especially when looking at the network services sector (NSP). The digital divide that still exists between developed and developing economies (Brown & Thompson, 2011) will also cause the benefits from increased competition to differ. In most developed economies there is sufficient infrastructure (Brown & Thompson, 2011) to ensure that the benefits of a high level of competition are maximised. Thus when prices drop (due to an increase in competition) the rate of adoption will increase due to the high participation rate granted by the established infrastructure. When looking at developing economies many still lack the required infrastructure (Brown & Thompson, 2011). The gaps in infrastructure can lead to the concentration of users thus limiting the benefits of competition (e.g. higher participation rate due to lower prices) which can lower the rate of adoption.

Contrasting views of competition policy implementation in the ICT sector can be found when looking at the countries of South Africa and Nigeria, where South Africa used competition protecting policies to increase the use of ICT (Achterberg, 2000) whilst Nigeria used competition enhancing policies (Diga,

Nwaiwu, & Plantinga, 2013). Understanding which of these competition policy implementations work better needs to be explored.

Telkom (the South African telecommunications parastatal) is a good example of using competition policy to protect SOEs that are meant to drive social broad-based economic development (Achterberg, 2000). Telkom was granted the sole network operator license for five years creating a monopoly in the industry. During this period the network operator was tasked with extending its telecommunications services to include the more rural lower income market and help bridge the digital divide. This unfortunately also incentivised the business to charge higher prices and use preferred or associated suppliers due to the monopoly market structure (Achterberg, 2000). When looking at the South African example of using competition protecting policies to ensure better social redistribution by increasing the adoption of ICT, would a competition enhancing policy (increasing healthy competition) not have been a better choice to increase ICT adoption levels?

In contrast to the above example Nigerian competition policy has a stronger focus on enhancing competition in the ICT sector to ensure more affordable telecommunications services (Diga et al., 2013), but Nigeria (as a developing nation) might not have the necessary infrastructure in place to maximise the benefits of enhanced competition which can limit the adoption rate. Thus with further investigation, would the adoption of ICT be higher if the Nigerian competition policy had a stronger focus on social redistribution (protecting) by extending access to the lower income group rather than enhancing competition which tends to focus on the higher income segment? From the two examples examined the below table will provide a high level comparison between competition enhancing and competition protecting policies.

Table 1 - High level competition policy comparison

	Competition protecting policies	**Competition enhancing policies**
Focus	Social redistribution (Musetescu, 2012)	Increased competition and profit

		maximising (Achterberg, 2000; Singleton, 1997)
Market structure	Monopoly or Oligopoly markets (Bush & Bo, 2011)	Monopolistic markets (if organisations are allowed to merge and acquire at all levels then it can also result in oligopoly or even monopoly markets)
Policy examples	Entry restriction, limited operating licenses, anti-competitive behaviour restrictions	Fair trade agreement, low or no entry barriers, liberalisation of previous SOE
Disadvantages	Generally higher prices, lower productivity (Achterberg, 2000)	Increase in competition can lead to anti-competitive behaviour, surplus dumping, price wars (Musetescu, 2012; Singleton, 1997)
Advantages	Execution of non-profit maximizing goals Secure key resources and services (Musetescu, 2012)	Lower prices, greater innovation, freedom of choice (Clarke, 2011)

From the literature it was found that the adoption of ICT is a key catalyst to help grow economies. Thus it is important to understand the impact of various forms of competition policies on the adoption process. Does a more protective group of policies result in higher ICT adoption due to welfare redistribution or does fair competition create a market with greater innovation and lower prices that drive ICT adoption? This is a topic that is very relevant to the current global economic environment as ICT has become the weapon of choice to accelerate the economic and social development process in emerging markets.

1.3. Research objectives

The broad research objective would be to determine the impact, if any, of competition enhancing and competition restricting/protecting policies on the level of ICT adoption in various economies. More specifically the research will make use of ITU and World Bank secondary data to examine four areas of interest. The first is to investigate the various aspects of competition enhancing

and competition restricting policies that can directly or indirectly influence the level of ICT adoption. This will be done in the literature study and will attempt to provide a theoretical link between these two broad concepts.

The second area of interest will examine and compare the implemented competition policies between developing and developed economies. This will be done using statistical methods and will provide a better understanding of which policies are implemented for each group of economies. It is important to examine this comparison to better understand the context of competition policies implemented.

The third area of interest is to establish which of the two competition policy groups (protecting or enhancing) results in the highest rate of ICT adoption. This will also be done using statistical analysis and will show which of the two competition policy groups has (on average) a greater positive influence on the rate of ICT adoption.

The last area of interest will examine the relationship between the level of competition policies (is the policy more focused on enhancing competition or protecting competition) and the rate of ICT adoption. This will be done using regression analysis and will provide a more comprehensive understanding of the influence and level between competition enhancing and competition protecting policies.

The aim of this research report will be to determine the impact of competition policies and regulations on ICT adoption, thus providing governments and ICT organisations with the necessary understanding of the dynamics involved. Developing economies can also benefit from the research by understanding which policy types will ensure a high level of ICT adoption and maximise the benefits of increased ICT use in context of their economy. This research will enable the various ICT stakeholders to make more informed decisions when preparing for, designing and implementing competition policies in the ICT sector.

The research report will focus on the impact of competition enhancing and protecting policies. Competition enhancing policies can be defined as those policies that have the end goal of increased competition by allowing many organisations (local and foreign) to compete in a specific market. Competition protecting policies can be defined as those policies that have the end goal of protecting (via entry barriers, restrictive licenses etc.) certain strategic or key businesses (generally state-owned) to ensure that various other social and economic goals can be met.

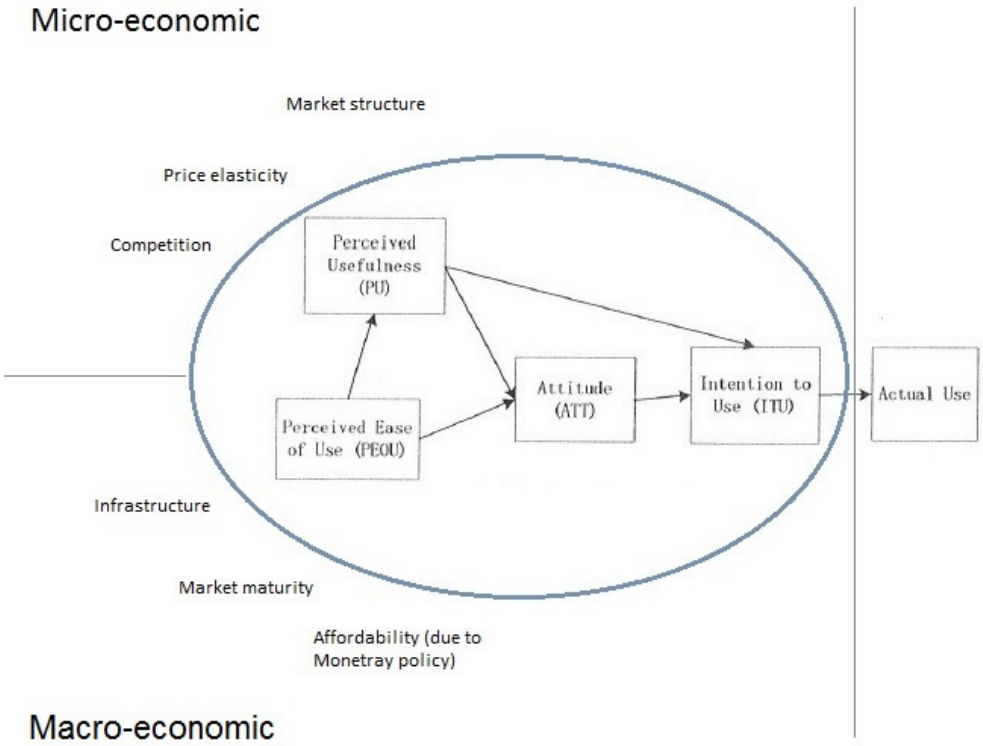
When referring to ICT adoption in this paper the following technologies will be included; mobile-cellular communication, internet, and fixed broadband. The term broad-based adoption in this report will refer to adoption at all levels and is not specific to individuals, demographic or business.

2. Literature review

2.1. Introduction

The major theme of this report is the adoption of ICT. There have been numerous studies to better understand the factors that influence ICT adoption with a strong focus around the personal or individual space (e.g. the Technology Adoption Model – TAM), but there is significantly less research on the contextual aspects affecting the adoption process (see figure 1). As mentioned in section 1 there are numerous advantages associated with a high level of ICT usage in an economy. It is thus important to understand all the factors that influence the adoption of ICT to ensure that the benefits of ICT usage is maximised through high participation.

Figure 1 - Examples of contextual aspects for influencing technology adoption (Davis Jr, 1986)



The purpose of this report is to investigate the impact of competition policy (in the ICT sector) on the level of ICT adoption. In addition to the above the report will attempt to build a better understanding of why and how the adoption process is affected by competition policies.

2.2. Competition theory

As the world continues to escalate globalisation the strength of rivalry among business will increase the intensity of both local and global competition (Porter, 2008). Thus it is important to understand how competition evolves to the extent that external intervention (in the form of policies) is required to ensure uncompetitive behaviour or market structure does not damage an industry. It is also important to understand the impact on consumer adoption in the presence of competition that will lead to high levels of participation in key enabling industries (e.g. ICT).

> [Competition is] a constant struggle among firms for comparative advantages in resources that will yield marketplace positions of competitive advantage for some market segment(s) and, thereby, superior financial performance (Hunt, 1999).

This section (in conjunction with section 2.2) will highlight competition and competition policy theories, investigate market context, and debate the impact of competition enhancing and competition protection policies on market development. Today there are two major concepts of competition that exist; classical and neoclassical. Classical competition theory describes competition as each entity acting in their own best interest by competing with other rivals to expand their market position at the expense of their competitors (Tsoulfidis, 2011). Adam Smith in his book *The Wealth of Nations* referred to this phenomenon as the invisible hand indicating that by each individual pursuing their own self-interest promotes social welfare regardless of their intentions (Smith, 1937). Neoclassical competition theory is contained in the model of perfect competition by which firms adopt a price taking behaviour (Tsoulfidis,

2011). Thus in a perfect market where there are numerous small firms (with perfect information about product prices and consumer goods) each firm will produce at a level where profits are maximised which is at the point where the price equals the marginal cost of an item (Tsoulfidis, 2011). In essence the prices and volume are driven by the supply and demand of the market. The neoclassical theory, although sometimes criticised, has been the weapon of choice to take on modern day economics.

Competition also exists in various types of market structures which, in the context of this report, is important to understand. The three major structures that will be discussed are monopoly, monopolistic, and oligopoly. A monopoly market structure is where a firm is the sole producer of goods or services in a particular market (Baye, 2010). This usually exists when it is a state owned entity providing an essential service to a country. An example of this would be the South African power supplier Eskom.

A monopolistic market structure is where there are many firms (and consumers) with each firm producing product that are slightly different from their competitors (Baye, 2010). Thus the firms in these markets have limited influence on the product (or service) price (which is very close to the perfect competition referred to in the neoclassical competition theory). An example of this market would be the fast moving consumer goods (FMCG) industry where products differ marginally and consumers are highly price sensitive.

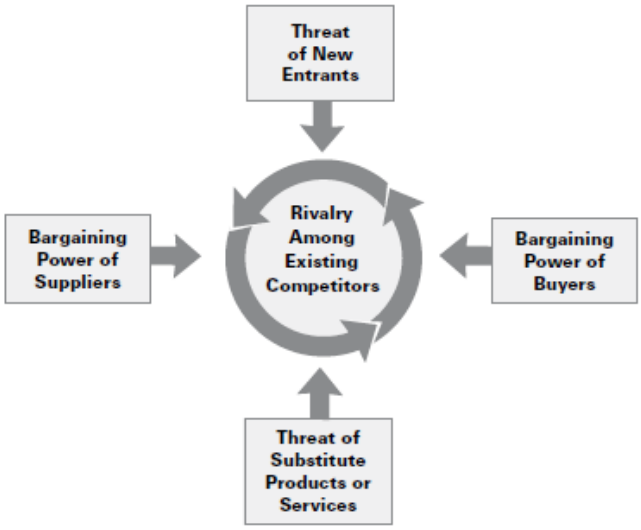
The last market structure is the oligopoly market where a few large firms dominate the market (Baye, 2010). An example of these would be the South African telecoms industries where there are only three large firms competing in the sector (MTN, Vodacom and Cell C). Understanding these market structures is critical to the study because of the impact it can have on both competition and adoption of ICT.

When looking at the NSP sector (also referred to as telecommunications) it is important to understand that the market structure can be a result of implemented competition policies (e.g. competition protecting policies for South

African telecommunications SOE, Telkom). On the other hand the market structure can also drive the type and level of competition policy implemented. For example an oligopoly market might have competition protection policies implemented to ensure that large players do not use uncompetitive strategies to eliminate smaller players in the market. It is thus important to understand how the market structure can affect both competition and competition policies. A monopolistic market structure can lower prices, but some argue that this will limit innovation (Clarke, 2011) which will reduce adoption. A monopoly market structure can result in higher prices for goods or services with lower quality of service (Achterberg, 2000). Warf argues that the NSP sector is generally an oligopoly market due to mergers, acquisitions, takeovers, and buy-outs in the telecommunications sector (Warf, 2003). This will also be discussed in the NSP section of the literature review.

There are various forms of competition that exist in each market segment that can be described using Michael Porter's five forces framework. The five forces summarised by Porter are shown in figure 2 (Porter, 2008). This model will be used in section 2.2 to describe how competition policies regulate the forces that drive competition.

Figure 2 – Porter's five forces that shape industry competition



These forces will drive the type of competition in the market that will form part of an organisation's strategy (Porter, 2008). For example price competition is very common in markets that are highly saturated. Thus consumer price sensitivity is high and businesses in this sector compete on price (or indirectly cost reduction) and optimisation resulting in higher margins. Wal-Mart is a perfect example of a company that has high efficiency and low price as their top priority (Chan, 2011) and has had great success with globalisation. Innovation competition is also a form of competition that will disrupt the market and leave various players behind (Shelanski, 2013). Blackberry in the mobile phone industry is another good example of a business failing to compete on innovation (Karabell, 2011). When firms competing cannot continue to innovate at the tempo of their rivals they will start losing market share.

From the literature it can be seen that various forms of competition can have an influence on the level of product adoption in a specific sector (Weiss, 2003). Lower prices in the ICT sector, due to markets that are highly saturated and competing on price, can lower the barriers to use for users which will increase the adoption of ICT. Certain forms of innovation competition can have the opposite effect on ICT adoption. When firms focus on the higher income group's demand for greater functionality and complexity it reduces the focus on expanding the existing offerings to untapped groups and in turn also raises usage barriers due to increased complexity which can lower the perceived use (Gong, Xu, & Yu, 2004).

2.3. Competition policy theory

There have been numerous studies in the field of competition. There are two broad views on the impact of competition on a specific market; competition can either enhance and develop a market through innovation, productivity and lower prices (Majumdar, 2010) or damage a market through anti-competitive behaviour (Hoekman & Holmes, 1999b). Anti-competitive behaviour is a form of competition that limits other participants' ability to compete and in many cases forces the closure of these participants resulting in a less competitive

environment. Thus competition policy emerged during the nineteenth century in the United States of America when the economic resources were concentrated in the hands of a few large businesses (Musetescu, 2012). To ensure social redistribution governments implemented competition policies (also known as antitrust laws) to protect the smaller businesses from uncompetitive behaviour (e.g. price wars or surplus dumping) of large firms whilst ensuring a healthy competitive environment (Musetescu, 2012).

In many cases organisational institutions are assembled by government to regulate and enforce the competition policy on a specific industry (Clarke, 2011). In this report competition policy will only refer to competition enhancing policies (increased innovation, lower prices, and higher productivity) and competition protection policies (regulating uncompetitive behaviour or ensuring services that are of national interest).

To better understand the impact of competition policies it is important to be able to measure competition policies to the extent that it is possible to determine the level of either competition enhancing or competition protecting policies. The economics department of the Organisation for Economic Co-operation and Development (OECD) build the product market regulations (PMR) indicators and competition law and policy (CLP) indexes to measure the level of enhancing and protecting competition policies (Buccirossi et al., 2011). Whilst PMR indicators measure policies that restrict competition (e.g. what are the entry policies, what is the percentage of government owned industries etc.) the CLP index measures to what extent competition policies promote and enhance competition (e.g. allowance for mergers and acquisitions, level of vertical agreements etc.)(Buccirossi et al., 2011). These measurement methods will be discussed in more detail in the research methodology section.

In the literature there seems to be consensus on the goals of competition policy. Competition policy can help promote competition and/or foster democracy (Singleton, 1997). Competition policy can also be used to serve social and economic interests of a region by regional industry development or export stimulation (Singleton, 1997). As previously stated competition policy can also

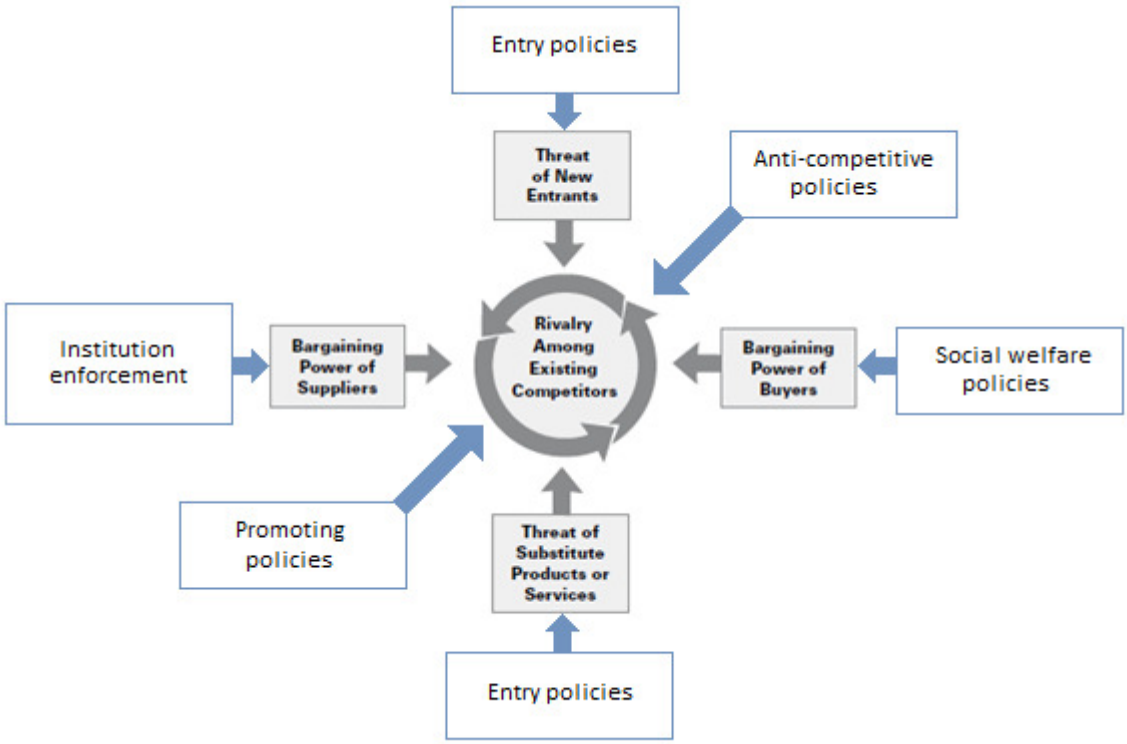
help protect industry from uncompetitive behaviour by preventing firms from colluding or exercising market power (Clarke, 2011). When looking at the NSP sector, historically these competition policies had a very distinct goal of developing infrastructure (Achterberg, 2000), but there has been a shift in competition policy to promote free-market competition due to market pressure for greater innovation at lower prices (Sarkar, Cavusgil, & Aulakh, 1999).

To better understand the role of competition policy Porter's five forces model was adapted to be used in conjunction with the competition and competition policy literature (see figure 3). Thus the table below will describe how these policies regulate the forces that drive competition.

Table 2 - Competition policy regulating Porter's five forces

Force	Policies	Explanation
Threat of new entrants	Entry	Depending on the goal (enhancing or protecting competition) policy will be put in place to regulate the entry of new players into the market (Clarke, 2011).
Bargaining power of suppliers	Institutional	Depending on the economic and social development goals (Singleton, 1997) independent institutions will regulate to which extend government (as the supplier of infrastructure) can execute their goals.
Threat of substitute products or services	Entry	Similar to the threat of new entrants these policies will be used to either enhance or protect competition.
Bargaining power of buyers	Social welfare	To ensure that there is broad-based inclusion and availability of ICT, policies will regulate the demand/buying power of current users to shift focus to expand infrastructure rather than technology development and/or innovation (Sarkar et al., 1999).
Rivalry among existing competitors	Anti-competitive Promoting	Competition policies are used to protect small firms from anti-competitive behaviour from larger firms (Musetescu, 2012). These policies are also implemented to enhance the level of healthy competition by for example removing the "red-tape" when doing business (Musetescu, 2012).

Figure 3 - Porter's five forces adapted for competition policies



But as there is consensus on the goals of competition policies the views on the impact it has on the economic environment are conflicting. Achterberg (2000) states that increased competition due to licensing additional service providers in the network operator industry (a form of competition enhancing policy) will result in improved services, accelerated network expansion and reduced costs. Musetescu (2012) on the other hand indicated that a market that is competitive and not protected will result in firms that are very efficient increasing their own welfare to the extent that social welfare is lowered which can lower ICT use due to an already existing inequality. One study even showed that there was little evidence that competition law had a direct effect on prices (Clarke, 2011). A competitive environment can also lead to an oligopoly market due to uncompetitive mergers and acquisitions (Warf, 2003). Warf indicates that theories have shown that oligopoly markets lead to reduced competition, price collusion, slower technological change, greater market inefficiencies, and narrower consumer choices (Warf, 2003). Thus from the literature it can be

seen that there are conflicting views on the influence of competition policies on the ICT economic environment. This area of interest requires further research which this report will attempt to achieve.

When looking at competition protection policies Singleton (1997) argues that these policies protect large firms that might be of strategic importance for developing an economy. But in the same breath it also protects firms that are inefficient from competitive challenges of more efficient rivals (Singleton, 1997). When competition protecting policies create a monopoly to facilitate economic development (Achterberg, 2000) it increases the social welfare of the economy, but the entity becomes increasingly unable to meet the changing demands of the various user types. For example while a government owned NSP might be expanding the network infrastructure to lower income groups to ensure greater inclusion of technology use, there might be no drive or low agility (due to size constraints) to implement, innovate, and/or develop new technology needed by the existing customer base. While state-owned NSPs, with competition protection policies to protect them, might seem out of date for developed economies with an already existing infrastructure, it is still very relevant to various developing economies that are in need of ICT infrastructure to ensure public services are affordable and available (Jan & Wang, 2010).

Thus when looking at the contradicting views in context of this research report, it is clear that competition policies, enhancing or protecting, can impact the level of ICT adoption in an economy due to the effect it has on competition. This requires further research into the level of impact that it can have which this research report will attempt to further research this area of interest.

2.4. The network service provider (NSP) sector

This section will provide a brief overview of the NSP sector and how it operates to better comprehend the context of this paper and how competition policies affect these markets. Note that in the literature the term NSP sector, Internet

Service Provider (ISP) sector, Telecommunication Service Provider (TSP), and ICT sector are used synonymously.

Historically most telecommunications providers (or NSPs) have developed as either regulated monopolies or state-owned/operated enterprises (Sarkar et al., 1999). Due to the demand for lower cost, more diverse and more advanced information and communication technology there was a radical shift in political economic thinking which lead towards bringing free-markets and privatisation of the industry (Sarkar et al., 1999). Lee and Lee (2013) states that with fierce competition a monopoly or oligopoly cannot be sustained. But due to high entry barriers in the NSP sector, in the form of large sunken costs and severe economies of scale (Yang et al., 2013), there still exist a number of oligopoly markets in the NSP sector. Warf also highlights the fact that due to mergers, acquisitions, takeovers, and buy-outs in the telecommunications sector, the convergence toward an oligopoly market is accelerated (Warf, 2003).

ICT markets are far more dependent on technological innovation than that of non-ICT markets (Yang et al., 2013). The ICT market relies heavily on new technologies and a high level of innovation that can directly influence an ICT firm's size and market share (Yang et al., 2013). But competition in many of these sectors are unique in the sense that there is non-cooperative resource sharing (Shrimali, 2010). Thus NSPs will provide various forms of competing products and services whilst using the same telecommunication infrastructure. But as newer technologies emerge new forms of communication infrastructure are implemented by each competing firm.

Network licenses also play an important role in ICT regulation by acting as an instrument for competition enhancing or protecting policies. As the telecommunication industry became more and more deregulated private companies were able to apply for network and more specifically mobile network operating licenses which increased the number of players in the market (Baranes, Benzoni, & Vuong, 2011). As described in the competition literature it is well known that an increase in firms in a specific sector increases competition driving innovation and lower prices. But because of increased competition there

is more mobile interconnection termination rates (where a caller on one NSP can connect to a caller on another NSP) which results in rising rivalry costs which can have a negative impact on ICT adoption (Baranes et al., 2011). Thus the competition policies and regulation that determine the appropriate level of free and fair competition plays a crucial part in ICT adoption.

2.5. ICT sector of developing and developed economies

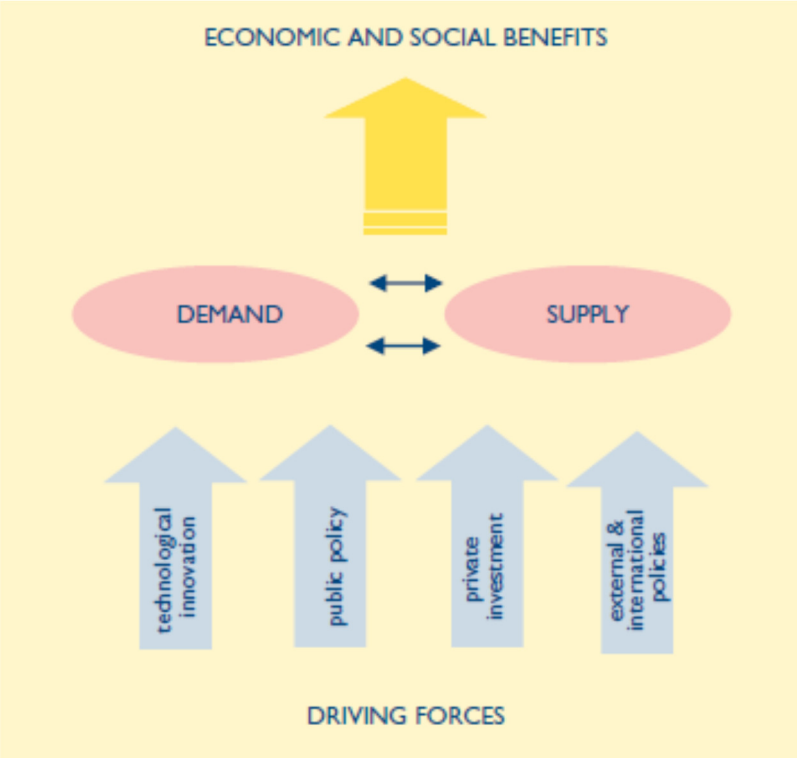
Developing and developed economies can be defined in various ways. Numerous research papers have been published on the variation between the two, but there is limited definition on what exactly constitutes a developing economy. The reason for this is the lack of clear boundaries and parameters that are used to determine a country's category. Whilst most researchers have used a country's economic, social, and political status as a proxy to categorising countries the United Nations argue that there is no established convention for the designation of developed and developing economies ("Composition of macro geographical (continental) regions, geographical sub-regions, and selected economic and other groupings," 2014).

Thus there are various forms of development taxonomy and development thresholds that can be applied to categorise countries. Sheffrin and O'Sullivan (2007) defined a developing economy as a country with a lower living standard, underdeveloped industrial base, and low Human Development Index (HDI) when compared to other nations. Appendix C has the World Bank developing and developed categories. When looking at the United Nations M49 list ("Developed/developing countries," n.d.) (See Appendix C) it was found that 77% of the world's economies are considered developing. This equates to an enormous market that is emerging which again highlights the importance of understanding how these markets operate and develop.

When looking at the definition of developing economies and the benefits of ICT (as described in section 1) it is clear that ICT can assist in addressing many of the social and economic issues in developing economies. ICT is a key driver of

employment, growth, and innovation in various economic sectors (Schröder et al., 2011). It is thus important to understand the factors driving adoption of ICT in developing economies to help increase the living standard and economic environment as well as bridge the digital divide (as shown in figure 4). The well-researched M-PESA phenomena in Kenya is a perfect example of what ICT can do for developing economies when there is a high level of adoption (M-PESA has more than 13 million subscribers in Kenya). The primary of M-PESA was to send and receive money safely and cheaply using a text based service (Maurer, 2012a). This service was created to address a social issue in the country but became an economical success with a large portion of the country's gross domestic product (GDP) now passing through the M-PESA service. In addition to the advantages of individual access to financial services, M-PESA mobile banking services also provides variety of other social benefits for consumer communities (Reeves & Sabharwal, 2013a).

Figure 4 - Conceptual base for ICTs and development (Torero & von Braun, 2005)



The challenge is to determine what affects adoption in developing economies because conventional adoption models do not necessarily assist with adoption theory in these economies. This can be due to a weak institutional environment (Basant, Commander, Harrison, & Menezes-Filho, 2006), educational and income levels (Torero & von Braun, 2005), and cultural differences (Gajendran & Brewer, 2012). Another aspect which many of the adoption models do not cater for is the limited or lack of ICT infrastructure in developing economies (Brown & Thompson, 2011). Developing economies are also much more price sensitive due to a lower disposable income (Reeves & Sabharwal, 2013a).

This report aims to better understand the impact of competition policies in the ICT sector on the level of ICT adoption with the end goal of assisting developing economies with formulating competition policies to maximise ICT adoption and address various economic and social inequalities in their unique contexts.

2.6. Technology adoption and economic development

ICT can be described as a diverse range of technological tools and resources used to communicate, create, disseminate, store, and manage information (Chanyagorn & Kungwannarongkun, 2011). ICT is seen as critical to development and socio-economic growth (Deen-Swarray et al., 2013a) and a key driver of innovation (Lehner et al., 2013). From a business perspective adoption of information technology is important as it can lower production and labour costs, add value to a company's offerings, and increase a company's competitive advantage (Nguyen, 2009). ICT allows businesses to connect and communicate with their suppliers and customers deepening the distribution and procurement channels making them more sustainable (Deen-Swarray, Moyo, & Stork, 2013b).

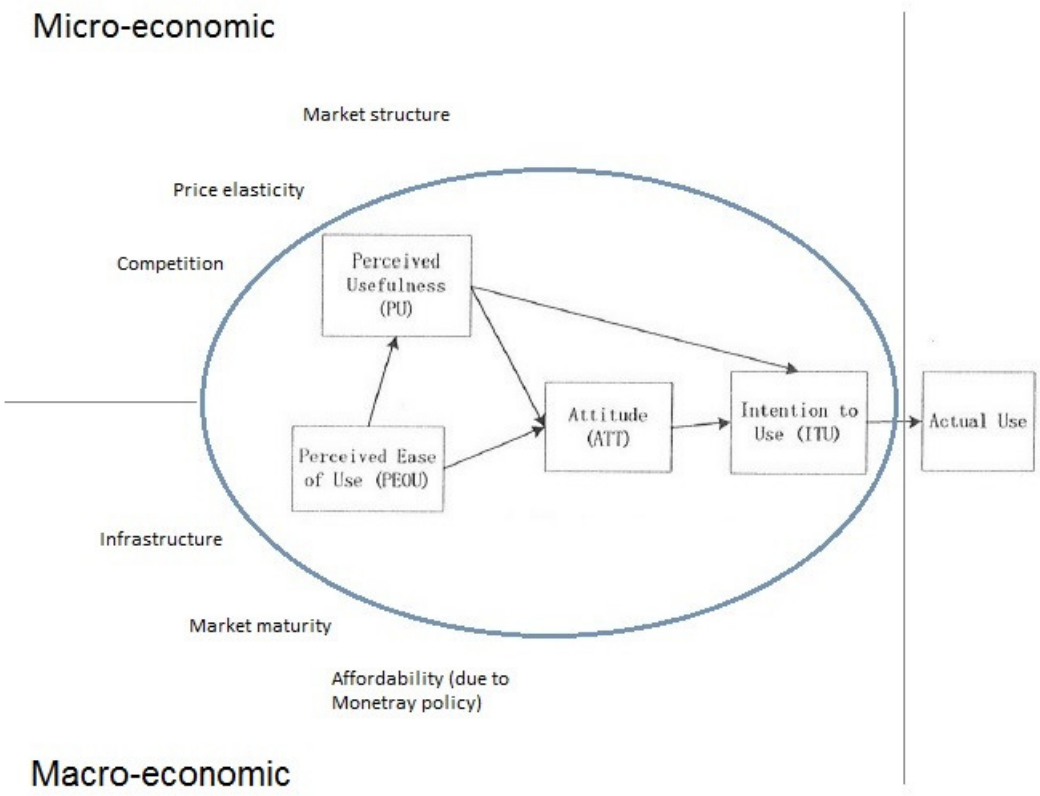
At a macro level broad-based adoption of ICT provides individuals with access to various sets of services, information and products (e.g. mobile phones) which would previously not have been possible (Reeves & Sabharwal, 2013b). For example providing the previously unbanked with access to bank accounts,

loans and value transfer instruments (Maurer, 2012b). In Kenya more than 13 million people use M-PESA, a service that allows individuals to send money to anyone cheaply and securely over their mobile phones (Maurer, 2012b). Again ICT acts as a conduit for these services. Thus with all the positive aspects and impacts of ICT usage it is important to understand what are the various factors influencing ICT adoption. From the literature in section 2.2 it is clear that the impact of competition policy on ICT adoption requires further research which this report will attempt to achieve.

Despite the fact that ICT in various systems and applications has received enormous attention (Eze, Awa, Okoye, Emecheta, & Anazodo, 2013), there still seems to be a difference in opinion when looking at drivers and outcomes of ICT adoption (Aleke, Ojiako, & Wainwright, 2011). Gong, Xu, & Yu (2004) states that numerous theories have been developed to explain the various technology acceptance scenarios, including the theory of reasoned action (TRA)(Fishbein & Ajzen, 1975), the theory of planned behaviour (TPB)(Ajzen, 1991), the technology acceptance model (TAM)(Davis Jr, 1986), and the social cognitive theory (SCT)(Hill, Smith, & Mann, 1986). One of the more popular theories is the TAM which has four factors driving actual use; perceived usefulness, perceived ease of use, attitude, and intention to use (Gong et al., 2004).

Whilst these theories focus on the behavioural and intention aspects of technology adoption, it is the contextual aspects of technology adoption that need to be understood to better comprehend the impact of competition policies on ICT adoption. A contextual aspect will be a factor that can influence the behavioural aspects of technology adoption. An example of a contextual aspect would be ICT infrastructure. If there is either sufficient or a lack of ICT infrastructure it can affect the attitude and perceived usefulness of technology (behavioural aspects) when referring to the TAM model (Gong et al., 2004) as shown in the diagram below.

Figure 5 - Examples of contextual aspects for influencing technology adoption (Davis Jr, 1986)

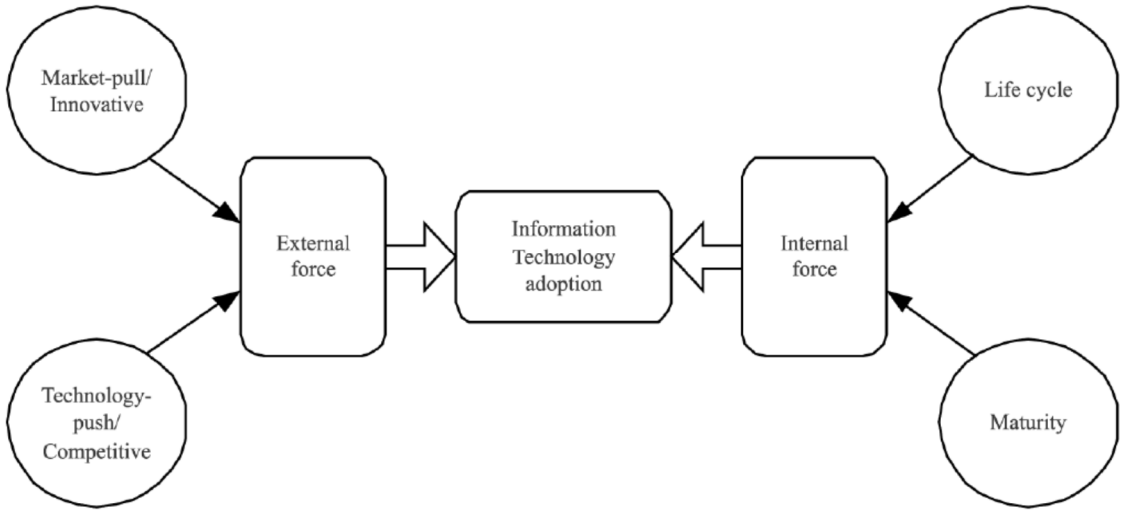


Another contextual factor that can influence the behavioural and intention aspects of technology adoption is the network effect. Beck, Beimborn and Weitzel (2008) looks at the social network effects as drivers of individual technology adoption. They found that some technologies became more attractive the more an individual's social peers use them. Literature has shown that there are numerous reasons for the network effect ranging from social to economic aspects. An example of economic aspects is the use of cellular service providers similar to that of family and friends because of same-network billing rate (Beck et al., 2008). An example of social aspects is the use of technology similar to that of social peers in the presence of technological uncertainty (Sun, 2013). Thus the network effect can act as a multiplier for ICT adoption. Sun (2013) found similar results in his recent paper on herd behaviour in the adoption of technology. This is an important factor to keep in mind when

looking at the impact of competition policies on adoption because both competition protection and competition enhancing policies have the end goal of increasing usage, but each of these policies might have a differing impact on a secondary factor like the network effect.

Nguyen's model for drivers to information technology adoption (Nguyen, 2009) (shown in figure 6) will be used to better understand how the resulting factors from competition policies can impact forces that drive adoption.

Figure 6 - Drivers to information technology adoption model (Nguyen, 2009)



The information technology adoption model was originally developed for small-medium enterprises (SMEs) and suggests that there are two groups of forces (external and internal) that influence the adoption of information technology. External forces would be those that are in the environment outside of the firm (e.g. competition) whilst internal are those forces that are internal to the business (e.g. business life cycle).

Even though Nguyen developed this for SMEs it can be applied to a broad-based level of adoption. Focus will be placed on the impact of competition policy on both the external and internal forces driving information technology adoption as shown in figure 6. Thus when referring to the literature on

competition theory it can be seen that competition enhancing policies result in increased competition which forces businesses to focus on innovation, productivity, and lower costs (Achterberg, 2000) all of which are market-pull and technology-push drivers of external forces. These external forces, according to Nguyen's (2009) information technology adoption model, drives increased adoption of ICT.

Competition protection policies are implemented to ensure protection of local industries, social redistribution and/or achieving economic development goals set out by government (Hoekman & Holmes, 1999a). Competition protection policy can also be used to protect SOEs who, in the NSP sector, can have the primary goal of extending telecommunication infrastructure (Achterberg, 2000). Pham (2010) indicated that one of the factors driving ICT maturity (which according to the information technology adoption model is a driver of ICT adoption) is infrastructure which would indicate that certain types of competition protection policies can be drivers for internal forces of ICT adoption. Nguyen (2009) refers to the life cycle driver of internal forces as stages or responses to changes in the external environment. Thus as there is an increase in services available, due to infrastructure expansion, the life cycle stages and responses will become embedded into the previously unconnected.

By adapting the information technology adoption model it was found that the outcomes of various forms of competition (which according to the literature is influenced by competition policies) can affect the adoption of ICT. The below table will crystalize the adapted information technology adoption model.

Table 3 - Adaption of the Information Technology Adoption Model

Force	**Drivers**	**Competition policies linked to force**	**Aspects that influence drivers**
External	Market pull	Competition enhancing	Competition enhancing policies can help promote competition (Singleton,

	Technology push		1997). With an increase in competition firms are forced to focus on innovation to ensure their survival (Achterberg, 2000).
Internal	Life cycle	Competition protecting	Competition protecting policies can help protect SOEs and other key organisations that assist in accelerating social redistribution. This, in the case of NSPs, can include the expansion of telecommunication infrastructure (Achterberg, 2000) which drives ICT maturity (Pham, 2010).
	Maturity		

2.7. Literature summary

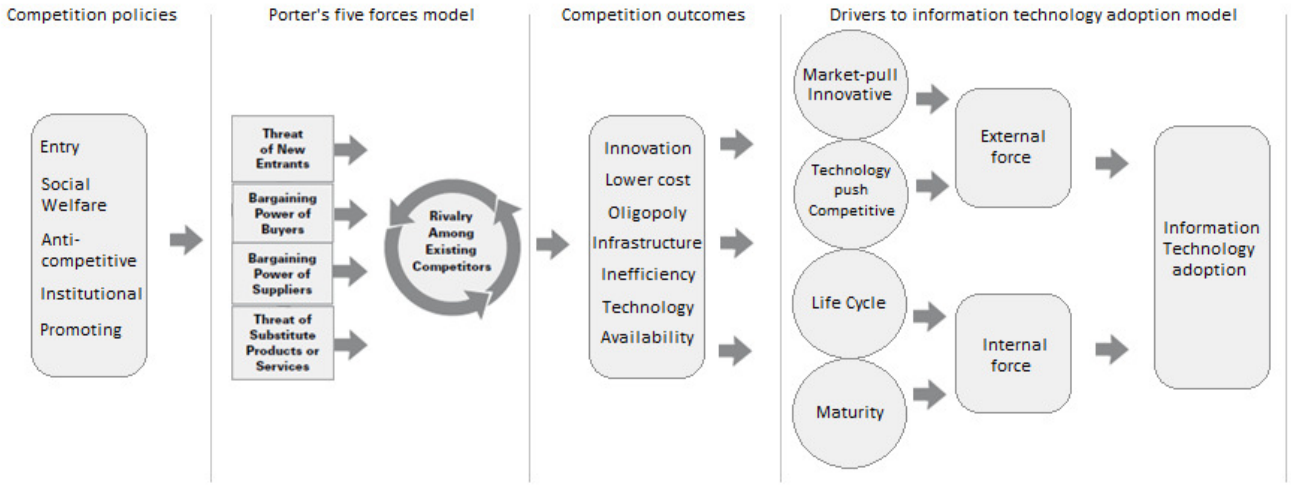
From the literature it is clear that there are multiple factors that can influence the adoption of ICT (e.g. behavioural, contextual etc.) This report will focus on the impact of competition policy on ICT adoption.

The literature review highlighted that competition can have varying effects on a market. It can either enhance and develop a market with healthy competition or damage the market with anti-competitive behaviour (Majumdar, 2010). Thus competition policy was introduced to help promote competition whilst protecting the market from anti-competitive behaviour (Singleton, 1997). It has also helped to ensure that social and economic development goals can be executed. Porter's five forces model (Porter, 2008) was adapted to explain how competition policies regulate the forces that drive competition (refer to table 2 and figure 3).

Using Nguyen's model (Nguyen, 2009) for drivers to information technology adoption it was also found that the outputs from competition (positive and negative) can drive the external and internal forces that impact technology adoption. The theories described can be linked to complete the impact chain as

shown in figure 7. Thus competition policies impact the forces that drive competition (shown in Porter's five forces). As the policies change so does the outputs from market competition. These outputs (positive and negative) will impact the drivers of the external and internal forces that impact ICT adoption.

Figure 7 - Competition policy framework to ICT adoption



But in the literature it was found that there are contradicting views on the impact level of competition policies on ICT adoption. Achterberg (2000) states that increased competition (due to competition enhancing policies) will result in improved services, accelerated network expansion, and reduced costs. But Musetescu (2012) argues that a competitive market that is not protected will result in firms increasing their own welfare to the extent that social welfare is lowered. Thus this research report will attempt to determine the impact that enhancing and protecting competition policies in the ICT sector have on ICT adoption.

3. Research hypothesis

The main focus of this study is to examine the impact of competition policies in the ICT sector on the level of broad-based ICT adoption. In addition to this the literature review highlighted the need to better understand the level of competition policies in developed and developing economies. The literature review provided support for formulating the five hypotheses required to examine and better understand competition policies in the ICT sector and its impact on ICT adoption.

The first two hypotheses will only focus on the level and type of competition policies in the ICT sector whilst the last three hypothesis will correlate and compare the level of ICT adoption when either competition protecting or competition enhancing policies are applied. The last hypothesis will be similar to the fourth hypothesis but will specifically focus on developing economies.

These hypothesis will attempt to achieve the research objectives set out in the first chapter. The formulated research hypotheses are:

3.1. Hypothesis 1 – Developing economies competition policies

This hypothesis will be used to determine if (on average) developing economies prefer to implement either competition protection or competition enhancing policies in their ICT sector. This will be done by comparing the average level of implemented competition policies by developing economies to determine if these policies are more focused on enhancing or protecting of competition.

Competition policy per se is difficult to measure. Thus this report will make use of the PMR indicators (as mentioned in the literature review) to serve as a proxy for the level and type of competition policy implemented. The PMR indicator is an index value scaled from zero to six with zero being a high level of competition enhancing policies and six being a high level of competition protection policies. The scale mid-point (value of three) would indicate that there

is no preference for either competition enhancing or competition protecting policies. The null hypothesis (H_0) states that the mean value of the level of competition policy (μ_{ee}) implemented by developing economies equals the midpoint on the PMR indicator scale (PMR_{mid}).

$$H_0 : \mu_{ee} = PMR_{mid}$$

The alternate hypothesis (H_1) states that the mean value of the level of competition policy (μ_{ee}) implemented by developing economies does not equal the midpoint on the PMR indicator scale (PMR_{mid})

$$H_1 : \mu_{ee} \neq PMR_{mid}$$

3.2. Hypothesis 2 - Developed economies competition policies

Similar to the first hypothesis, hypothesis two will be used to determine if (on average) developed economies prefer to implement either competition protection or competition enhancing policies in their ICT sector. The null hypothesis (H_0) states that the mean value of the level of competition policy (μ_{de}) implemented by developed economies equals the midpoint on the PMR indicator scale (PMR_{mid}).

$$H_0 : \mu_{de} = PMR_{mid}$$

The alternate hypothesis (H_1) states that the mean value of the level of competition policy (μ_{ee}) implemented by developed economies does not equal the midpoint on the PMR indicator scale (PMR_{mid})

$$H_1 : \mu_{de} \neq PMR_{mid}$$

3.3. Hypothesis 3 – ICT adoption rates in the presence of different types of competition policies

This hypothesis will be used to determine if economies that have a higher level of competition enhancing policies in their ICT sector have a higher rate of ICT adoption when compared to economies with a higher level of competition protecting policies in their ICT sector. The null hypothesis (H_0) states that the rate of ICT adoption for economies with a higher level of competition enhancing policies (μ_{ch}) will be equal the rate of ICT adoption for economies with a higher level of competition protection policies (μ_{cp}).

$$H_0 : \mu_{ch} = \mu_{cp}$$

The alternate hypothesis (H_1) states that the rate of ICT adoption for economies with a higher level of competition enhancing policies (μ_{ch}) will be **not** equal the rate of ICT adoption for economies with a higher level of competition protection policies (μ_{cp}).

$$H_1 : \mu_{ch} \neq \mu_{cp}$$

3.4. Hypothesis 4 – Competition policy and ICT adoption relationship

The fourth hypothesis will be used to determine if there is a relationship between the levels of competition policy (i.e. more enhancing or more protecting) in the ICT sector and the rate of ICT adoption. The null hypothesis (H_0) states that there is **no** relationship between the levels of competition policy in the ICT sector and the rate of ICT adoption (r_{xy}).

$$H_0 : r_{xy(\text{all economies})} = 0$$

The alternate hypothesis (H_1) states that there **is** a relationship between the levels of competition policy in the ICT sector and the rate of ICT adoption (r_{xy}).

$$H_1 : r_{xy(\text{all economies})} \neq 0$$

3.5. Hypothesis 5 – Competition policy and ICT adoption (mobile only) relationship for developing economies

The last hypothesis will be used to determine if there is a relationship between the levels of competition policy (similar to hypothesis four) in the ICT sector and the rate of ICT adoption for developing economies. The null hypothesis (H_0) states that there is **no** relationship between the levels of competition policy in the ICT sector and the rate of ICT adoption (r_{xy}) in developing economies (only mobile technology will be used in the ICT adoption rate calculation).

$$H_0 : r_{xy(\text{developing economies})} = 0$$

The alternate hypothesis (H_1) states that there **is** a relationship between the levels of competition policy in the ICT sector and the rate of ICT adoption (r_{xy}) in developing economies.

$$H_1 : r_{xy(\text{developing economies})} \neq 0$$

The ICT adoption rate index is made up of internet usage, broadband usage, and mobile usage. From the literature it was found that both internet usage and broadband usage many times rely on older established infrastructure (e.g. fixed-line telephones) which in many developing economies are not well established. Thus the ICT adoption rate index can be skewed by the addition of these variables which is why hypothesis five has excluded these variables from the ICT adoption rate index.

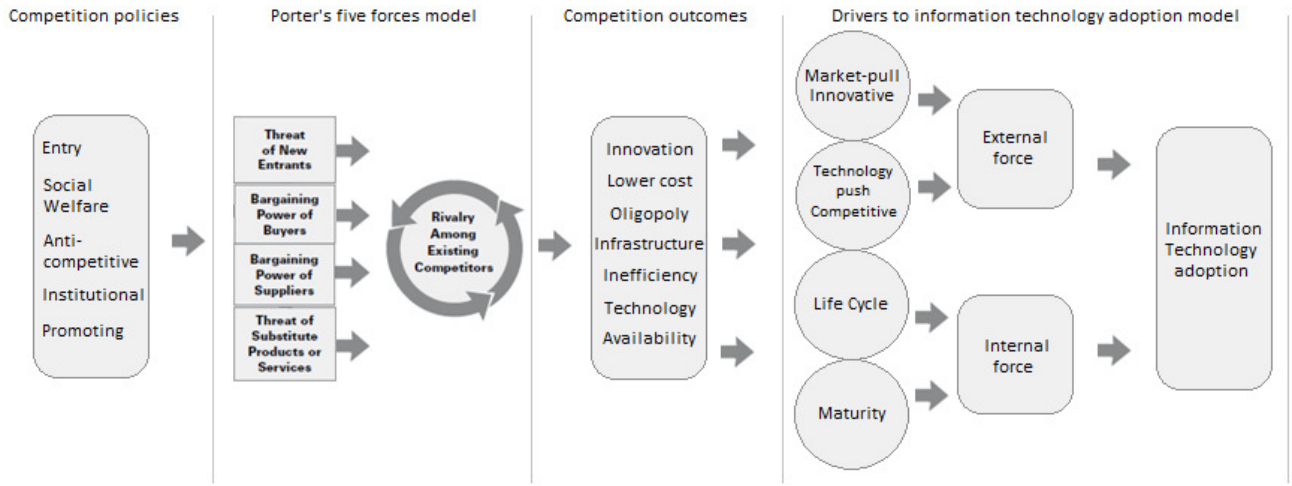
4. Research Methodology

4.1. Research design

4.1.1. Overview

The literature review that was conducted established that the level and type of competition policy implemented in the ICT sector has the ability to influence the rate of ICT adoption, but the nature and level of influence is uncertain. In the literature review the framework found in figure 8 was developed to establish and display the link that will allow competition policy to impact the level of ICT adoption. The primary question that this report will attempt to answer is the impact, if any, of competition enhancing and competition protecting policies on the level of ICT adoption. The research report will also look at the level and type of competition policy (enhancing or protecting) implemented in both developing and developed economies to better understand the context of the impact on the level of ICT adoption.

Figure 8 - Competition policy framework to ICT adoption

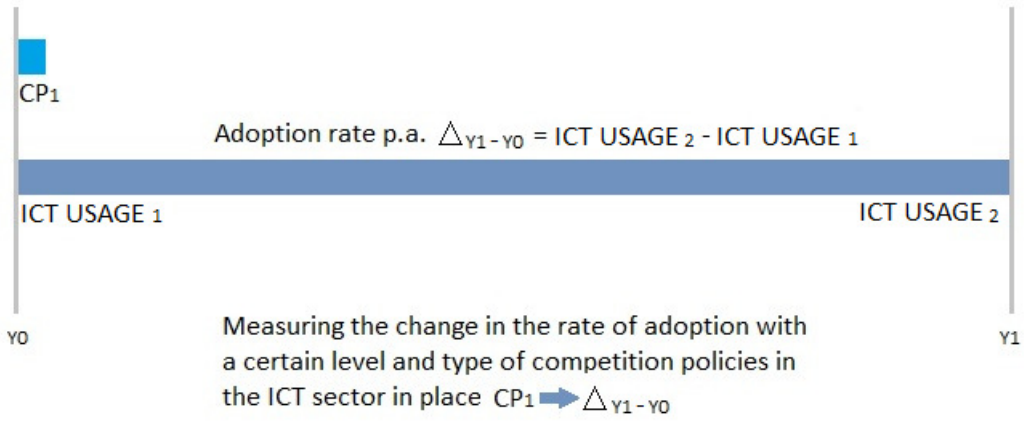


To achieve the research objectives the research will need to compare the level of both competition enhancing and protecting policies across various economies as well as to the actual change in use of ICT technology over a period of time for each respective economy. Thus a descriptive quantitative study will be

followed. A descriptive study is a research design to produce an accurate representation of persons, events or situations (Saunders & Lewis, 2012) whilst quantitative data consist of numbers or data that have been quantified, such as tables or figures (Saunders & Lewis, 2012).

Due to the lag effect of implemented policies a pure cross sectional study would not have been appropriate because the impact of changed policies could be seen only later. Thus longitudinal data will be used in a cross sectional study to look at the impact the independent variable (at a certain point in time) has on the dependent variable (over a certain period of time). The dependent variable is the rate of ICT adoption whilst the independent variable is the competition policy in the ICT sector. The change in the dependent variable will be analysed over a period of one year. From Figure 9 - Measuring competition policy influence on ICT adoption rate it can be seen that the value of competition policy is taken at a certain point in time (Y0) and compared to the change in ICT usage (Δ) over the course of one year (Y1 – Y0). This measurement will be done for various economies over a four year period.

Figure 9 - Measuring competition policy influence on ICT adoption rate



The report will make use of secondary datasets for the research design as the required data will be regional based (competition policies are generally implemented at a country level). Secondary data can be defined as data that is used in a research project that was originally collected for another purpose

(Saunders & Lewis, 2012). One of the major issues with secondary data is that due to its nature it seldom meets the needs of the research using it. The secondary data that was used for this research report also had various limitations that will be discussed in section 4.5. The challenge with secondary data is to tailor it for the need of the research at hand.

Various datasets from both the International Telecommunication Union (ITU) and World Bank have been used. The datasets can be aggregated into two groups; regulatory information (from the ITU) and ICT statistics (from the World Bank). The ITU is the United Nations specialised agency for information and communication technologies ("About ITU," 2014). Regulatory information will include market structure, competition levels, and foreign entry restrictions. The datasets used range from 2009 to 2012 and will include various developing and developed economies. Thus these datasets will be used to determine the level and type of competition policy that has been implemented into the respective economies.

The ICT statistics will include mobile subscriptions, internet usage, and fixed broadband subscriptions (each per 100 inhabitants). The World Bank collects and analyses numerous datasets to better serve their various customers with the end goals of alleviating poverty. The datasets used range from 2009 to 2013 and will include various developing and developed economies. These datasets will be used to determine the rate of ICT adoption. The ITU also provides ICT usage statistics but because the ITU dataset has not included ICT statistics for 2013 it was decided to proceed with the World Bank dataset (which has included the 2013 statistics). Section 4.2 will explain in more detail how these datasets will be compiled and analysed.

To determine the level and type of competition policy for each respective economy the report will make use of the Organisation for Economic Co-operation and Development (OECD) calculation for Product Market Regulation (PMR) indicators (see section 2.2 for a more in-depth examination). The PMR calculation will be adapted to suit the ITU dataset which will create a set of indicators similar to that of the OECD PMR indicators. The PMR indicators are a

set of indicators that measure the degree to which policies promote or inhibit competition (Conway, Janod, & Nicoletti, 2005). Below are some examples of competition policies that promote or inhibit/protect competition:

Table 4 - Examples of competition enhancing and competition protecting policies

Competition policy	Enhancing	Protecting
Merger and Acquisition	No restrictions / policies Allow all forms of cooperation and takeovers to exist thus increasing	Law to provide control for mergers and acquisitions to prevent companies from joining to eliminate competition between them and others ("Mergers," 2014).
Anti-competitive behaviour	No restrictions / policies All forms of competition are allowed to ensure high level of free trade and competition.	Regulation to ensure that dominant businesses do not abuse their power ("Abuse of dominance and monopolisation," 2014). Some examples of abusive practices: Predatory pricing, loyalty rebates, tying and bundling, refusals to deal, margin squeeze, and excessive pricing.
Liberalisation	Privatisation of previously state owned monopolies to ensure greater choice and efficiency ("Liberalisation and competition intervention in regulated sectors," 2014).	N/A
Entry restriction	No restrictions / policies Have no trade barriers and everyone (including foreign owned businesses) can compete in the local market.	Creating market entry regulations to ensure certain key markets are less attractive for large foreign competitors thus protecting local industry (Clarke, 2011).
Monopoly agreements	Implement regulation that will prohibit a natural monopoly from	Allow a state-owned monopoly to exist to achieve various "public

	forming to ensure higher levels of healthy competition.	policy" objectives (Bush & Bo, 2011). Some network operations might be exempted from competition policy to ensure the security of the supply (eg. electricity)

4.1.2. Statistical analysis

To achieve the research objectives three sets of statistical tests will be performed. The first hypothesis will measure the mean value of implemented competition policies (using the PMR indicators) for developing economies in the sample to determine if these economies, on average, implement more competition enhancing policies or competition protecting policies in the ICT sector. The second hypothesis will perform the same statistical test as used in hypothesis one but for developed economies.

Both hypothesis will make use of two-tailed one sample z-tests to measure any significant difference between each respective group's (developing and developed economies) mean value and the mid-value of the PMR indicator scale. As previously mentioned the PMR scale mid-point (value of three) will indicate no preference for either competition enhancing or competition protecting policies. A value lower than the mid-point would indicate more competition enhancing policies have been implemented whilst a value higher than three would indicate more competition protecting policies have been implemented.

The third hypothesis will attempt to determine which of the competition policy types (enhancing or protecting) result in a higher level of ICT adoption. This hypothesis will also make use of a two-tailed t-test for independent variables to measure any significant difference between the mean values of ICT adoption rates for economies with a higher level of competition enhancing policies and economies with a higher level of competition protecting policies.

The fourth and fifth hypothesis will measure the correlation between the competition policies (using the PMR indicators) and the ICT adoption rates (using ICT usage statistics) to determine if there is a relationship between these two variables. The fourth hypothesis will look at developed and developing economies while the fifth hypothesis will specifically look at developing economies. The fifth hypothesis will also **only look at mobile** technology when calculating the ICT adoption rate index. A regression analysis will be used as well as a two-tailed t-test for the significance of the correlation coefficient to determine if there is a relationship between the level and type of competition policy in the ICT sector and the rate of ICT adoption.

4.2. Data collection and analysis

As previously mentioned various datasets from the ITU and World Bank will be used to achieve the research objectives. These datasets can be divided into two main groups; regulatory information and ICT usage statistics. The table below will list the ITU datasets used for the years 2009 to 2012 as well as the World Bank datasets used for 2009 to 2013. The web address for these datasets can be found in Appendix A and Appendix B.

Table 5 - Datasets used in the research

ITU - ICT regulatory information	World Bank - ICT usage statistics
Level of competition	Mobile-cellular telephone subscriptions
Sector structure – private sector participation	Fixed (wired)-broadband subscriptions
	Individuals using Internet

As with many secondary datasets being used these datasets had various limitations. One of the major limitations was that certain data points in the dataset use data from previous years. Thus it was either assumed that the data has not changed or the ITU could not obtain the data. These data points had to be filtered out of the datasets (which decreases the sample size from 780 to

192) as it might have skewed the results when comparing current data with outdated data. Some of the other limitations includes the omission of certain samples from a specific country for a specific year. This will be explained in greater detail in section 4.4.2.

In the level of competition dataset it was also found that many of the samples appear to be outdated even though they are marked as the latest available data by the ITU dataset. This seem to be a trend that occurs in the data when a field in the competition level sample reaches full competition status. This is shown in the figure 12 below which is an extract from the dataset indicating the level of competition in the ICT sector for Botswana (the symbol “C” is used for full competition). The reason for the above observation is most likely because once the competition reaches full competition status there is no need to further resample the level of competition every year (unless there is a severe change). In light of the above findings it was assumed that when full competition was reached this will perpetuate until a drastic change in competition policy has been made which is highly unlikely. Thus this data was also included in the sample to create the PMR index as described in section 4.4.2.

Figure 10 - Outdated sampling observation

ITU/BDT Classification: Africa

Country	Cable modem	Cable Television	Data	Domestic fixed long distance	Fixed Satellite Services (FSS)	Fixed Wireless Broadband	GMPCS (FS	IMT (3G, 4G, etc.)	International Gateways	International Fixed Long Distance	Internet Services	Leased Lines	Wireless L	Local Fixed Line Services	Mobile	Mobile Satellite Services (MSS)	VSAT	DSL
Angola (1)	M		C	C	M	M		C	M	C	C	C	M	C	C	C		C
		2004		2003				2006										
Benin (2)				M						M		M		M	C			M
Botswana	N	N	C	C	C	C	C	C	C	C	C	C		C	C	C	C	C
			1998	1998	1998			1998	2007	2007	1998	1998		2007	1998	1998	1998	2007

4.2.1. Indexes

To achieve the research objectives two indexes will be created. The first is the previously discussed PMR index that was created by the OECD. The second

index is the delta average of three ICT usage statistics. To create these indexes various groups of samples have been averaged together.

4.2.1.1. PMR index

It is difficult to measure the type and level of competition policy implemented in a country as it does not provide a tangible object. Thus to determine the type and level of competition policy implemented the output or result of these competition policies need to be measured. Thus to determine if a competition policy is an enhancing or protecting policy a person would look at the entry regulation and market structure (monopolistic, many new entrants, etc.). The OECD created an indicator that combines all the various outputs from competition policies to provide an indexed number that will serve as a proxy for the level and type of competition policy implemented.

The PMR index was created by the OECD to measure the regulatory environment of various OECD countries. The calculated PMR dataset provided by the OECD could not be used for this research due to two major limitations. The first being the fact that the 34 OECD countries used in the sample are all developed economies which could have the potential of skewing the results of the report. The second limitation was the fact that the PMR indicators were only sampled every five years (1998, 2003, 2008, and 2013) whilst the usage data was sampled on a yearly basis making regression analysis difficult due to assumed interpolation. Another dataset that would have been very applicable would be the OCED competition law and policy (CLP) index, but because the data is only available for 2013 it would require a cross sectional study which will not provide the needed results.

Three main fields from the PMR index (entry regulation, market structure, and public ownership) was derived from the ITU regulatory information dataset (entry restrictions, level of competition, and market structure). Thus the ITU entry restrictions will emulate the OECD entry regulation. Similarly the ITU

market structure emulates the OECD public participation and ITU level of competition emulates the OECD market structure.

Each of these fields consists of a set of indicators that were averaged to provide a value per field. Table 6 below provides the set of indicators used for the level of competition and market structure. The entry restriction field only has one indicator. These fields (entry restrictions, level of competition, and market structure) were then average to provide the **adapted** PMR index.

Figure 11 is a graphical explanation of how the PMR index was created from the OECD PMR calculation with the ITU dataset.

Table 6 - PMR field indicators for ITU dataset

Level of Competition (per sector)	**Market structure**
Data provider	Facility-based operators
Domestic fixed long distance	Spectrum-based operators
Fixed wireless broadband	Local service operators
IMT (3G, 4G, etc.)	Long-distance service operators
International Gateways	International service operators
International fixed long distance	Value-added service providers
Internet services	Internet service providers
Local fixed line services	
Mobile	
DSL	

Appendix B provides the an extract for the PMR calculation from the OECD measurements (Conway & Nicoletti, 2006). To create each of the main fields a set of indicators were averaged (as shown in figure 13). Because all the data points were not always present (as discussed in section 4.5) or outdated it was decided that for each field (entry restrictions, level of competition, and market structure) at least half of the indicators per country was needed to create a field value.

For example if Botswana, in the level of competition dataset, only had three of the ten indicators (shown in table 6) a valid level of competition field would not be created. Thus no PMR value for Botswana for that year could be created. If there were six of the ten indications required a valid competition field will be created (more than 50% of the indicators were present for that country for a specific year).

Figure 11 - PMR index calculation

Level of competition dataset

ITU/BDT Classification: Africa

Country	Cable modem	Cable Television	Data	Domestic fixed long distance	Fixed Satellite Services (FSS)	Fixed Wireless Broadband	GMPCS (FSS/MSS)	IMT (3G, 4G, etc.)	International Gateways	International Fixed Long Distance	Internet Services	Leased Lines	Wireless Local Loop	Local Fixed Line Services	Mobile	Mobile Satellite Services (MSS)	VSAT	DSL
Angola (2)	M		C	C	M	M		C	M	C	C	C	M	C	C	C		C
		2004		2003				2006										
Benin				M						C	P				C			
										2007					1999			
Botswana	N	N	C	C	C	C	C	C	C	C	C	C		C	C	C	C	C
			1998	1998	1998			1998	2007	2007	1998	1998		2007	1998	1998	1998	2007

Market structure and entry restriction dataset

ITU/BDT Classification: Africa

Country	Facility-based operators	No restriction to foreign participation/ ownership	Spectrum-based operators	Local service operators	Long-distance service operators	International service operators	Value-added service providers	Internet service providers	Other categories	
Angola	50[9]		50[9]	50[9]	50[9]	50[9]				La participation directe
Benin										
Botswana	100[7]	Yes	100[7]	100[7]	100[7]	100[7]	100[5]	100[5]		There is no defined
Burkina Faso	100[6]		100[6]	51[6]	51[6]	51[6]	100[6]	100[6]		La société d'Etat a pour

Level of competition

$\overline{\text{Level of competition}}$ Average level (across ten indicators) of competition for a specific country

Market structure

$\overline{\text{Market structure}}$ Average private sector participation (across seven indicators) for a specific country

Entry restriction

$$PMR = \frac{\left(\overline{\text{Level of competition}} + \overline{\text{Market structure}} + \text{Entry restriction}\right)}{3}$$

4.2.1.2. ICT adoption index

The second index created was for the ICT usage. There are two steps in creating this index. The first is to simply average the ICT statistical indicators provided by ITU (e.g. mobile subscriptions per 100 users) for each year (2009, 2010, 2011, 2012, and 2013). The three ICT usage indicators used to create the index are; mobile subscriptions, internet usage, and fixed broadband subscriptions. The second step is to create a delta for each year. An example of the process is shown in table 7 below.

Table 7 - ICT delta index calculation

ICT Statistics 2009 for country X	
Mobile subscriptions per 100 inhabitants	80
Broadband subscriptions per 100 inhabitants	60
Internet users per 100 inhabitants	40
Average 2009	**60**
ICT Statistics 2010 for country X	
Mobile subscriptions per 100 inhabitants	90
Broadband subscriptions per 100 inhabitants	70
Internet users per 100 inhabitants	50
Average 2010	**70**
Delta (Average 2010 – Delta 2009)	**10**

These index deltas will be used to determine the impact of the policy implemented. Thus if there were 80 users of mobile in 2009 and 90 mobile users in 2010 the delta of 10 users would indicate an increase in the level of adoption.

4.2.2. Analysis

To test hypothesis one and two the sample will be divided into developing and developed economies. The PMR indexes from each of these groups will be averaged and tested for any significant difference from the midpoint of the PMR index scale (indicating no preference for either competition enhancing or competition protecting policies). The PMR index ranges from zero to six which means that the midpoint will be three. Any value significantly higher than three will have stronger competition protecting policies and any value significantly lower than three will have stronger competition enhancing policies. A two-tailed one sample z-test will be used to test if there is a significant difference between the PMR mean and the PMR scale mid-point.

The third hypothesis will divide the sample into two groups; economies that have stronger competition protecting policies and economies that have stronger competition enhancing policies. Each group's ICT usage index will be averaged and tested to obtain which of the groups have the higher adoption rate. A two-tailed t-test for independent variables will be used.

The fourth hypothesis will be tested using the Pearson correlation coefficient and regression analysis. Thus all the independent variables (competition policies implemented) will be correlated against the dependent variable (ICT usage) to determine if there is a relationship and how strong it is. A scatter-plot will be used for the regression analysis. To test for significance the correlation coefficient will be converted to a t-statistic (using the formula below) followed by a two-tailed t-test for the significance. In the formula ***r*** represents the correlation coefficient and ***n*** the degrees of freedom.

From the literature review it was found that developed economies have very similar behaviour due to already established infrastructure. For this reason the fifth hypothesis will replicate the fourth hypothesis but will focus on only developing economies. As previously mentioned the fifth hypothesis will also only use mobile subscriptions in the ICT adoption rate index calculation. This is

because of the limited historical infrastructure (e.g. fixed line) in developing economies which has the possibility to skew the results.

$$\mathrm{t} = r \times \sqrt{\frac{n-2}{1-r^2}}$$

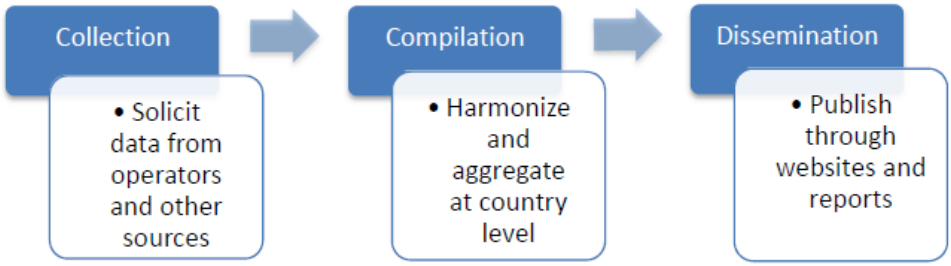
4.3. Unit of analysis

This report will conduct a cross country/economy study by comparing level and types of competition policies implemented as well as the rate of ICT adoption between economies. Thus the unit of analysis for this report is the various developing and developed economies in the sample. To measure the competition level and types the PMR indicator calculation will be applied to the ITU dataset. To determine the rate of ICT adoption various forms of ICT usage statistics were selected to generate an index that can be used to track the difference over a one year period.

4.4. Population and Sampling

The population for this research will be the countries in the ITU sample. A population is a complete set of group members (Saunders & Lewis, 2012). “The ITU collects, verifies and harmonises telecommunication/ICT data from about 200 economies world wide” (“Handbook for the collection of administrative data on telecommunications/ICT,” 2011). The ITU collects three broad sets of data; telecommunication infrastructure and access data, data on household access to (and individual use of) ICTs, and tariff (or price) data. The ITU uses a three step approach in collecting and processing the needed datasets (see figure 12 below).

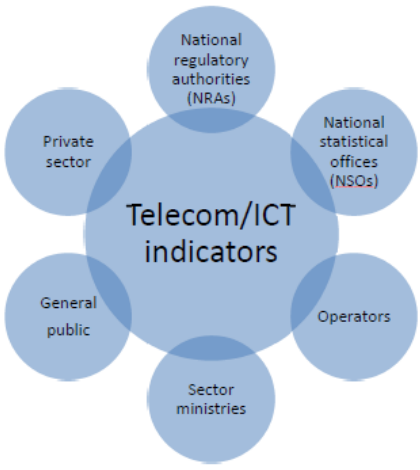
Figure 12 - Indicator processing cycle ("Handbook for the collection of administrative data on telecommunications/ICT," 2011)



4.4.1. Collection

The data collection process is done by making use of various stakeholders responsible for collecting statistics for the ICT and telecommunications sector of a specific country ("Handbook for the collection of administrative data on telecommunications/ICT," 2011). The national telecommunication regulatory authority (NRA) is, in most countries, the "go-to" body for ICT statistics because they are responsible for collecting, compiling, and disseminating statistics in the ICT sector. Each of the stakeholders shown in figure 13 provide some form of statistical data to the ITU that is verified, compiled and published.

Figure 13 - Telecommunication / ICT indicators stakeholders for ITU data collection ("Handbook for the collection of administrative data on telecommunications/ICT," 2011)



The periodicity of the datasets are structured as a time series ("Handbook for the collection of administrative data on telecommunications/ICT," 2011). Thus the ITU tries to ensure that the data is collected and updated at the predetermined interval to allow for trend analysis.

4.4.2. Compilation

The ICT statistics are in most countries solicited through questionnaires after which the data is then aggregated at a country or economy level ("Handbook for the collection of administrative data on telecommunications/ICT," 2011). Each country can have a different set of questionnaires which makes the compilation difficult due to possible conflicting standards. The ITU datasets also provide 81 internationally agreed indicators and sub-indicators. Chapter 3 of the 2011 *Handbook for the collection of administrative data on telecommunications/ICT* provides a detailed explanation of how each of these indicators are derived.

4.4.3. Dissemination

Once the data from all the various stakeholders have been harmonised the datasets are made available on numerous sources of which websites and published reports are the most preferred.

4.5. Research limitations

Due to the nature of this study, and the time constraints of the research project, the following have been identified as limitations:

- Certain data points from the datasets were not obtained each year. These data points are used to create the indexes. Thus the lower the data point count for each index being created the less accurate the index

will be. A minimum of 50% of the available data point count is required to generate the index.

- For the 2009 ITU market structure dataset does not have the entry restriction parameter. This was only introduced in 2010. Thus for 2009 the PMR index was calculated without the entry regulation parameter.

- The financial crash of 2008-2009 has not been factored into the research.

- Novelty adoption of technology in the first few years of availability has not been factored into the research.

- Entry regulation for the PMR indicators should be a sliding scale of zero to six whilst the ITU datasets only have a binary value for entry restrictions. Thus only the extremes of the scale are used.

- The impact of regulatory institutions has been omitted from this research

- It is assumed that policies will not change more than once per year as the datasets are per annum.

- It is assumed that the impact of the competition policy change will be experienced within a one year period.

5. Results

The descriptive analysis of the sample will provide a better understanding of the distribution and context. The results from the various hypothesis testing will be provided in the form of graphs and tables for ease of reference.

5.1. Descriptive analysis of data

A total of 85 different countries were used in this sample. As described in the methodology section the analysis was done over a four year period (2009 - 2012). Depending on data availability, each country could be used a maximum of four times from 2009 to 2012. Thus the total sample size used for this research was 192 which consists the 85 countries with various sample frequencies. Figure 14 to Figure 16 shows the countries used in this sample and their frequency with the vertical axis being the frequency count.

Figure 14 - Sample count per country (1 - 29)

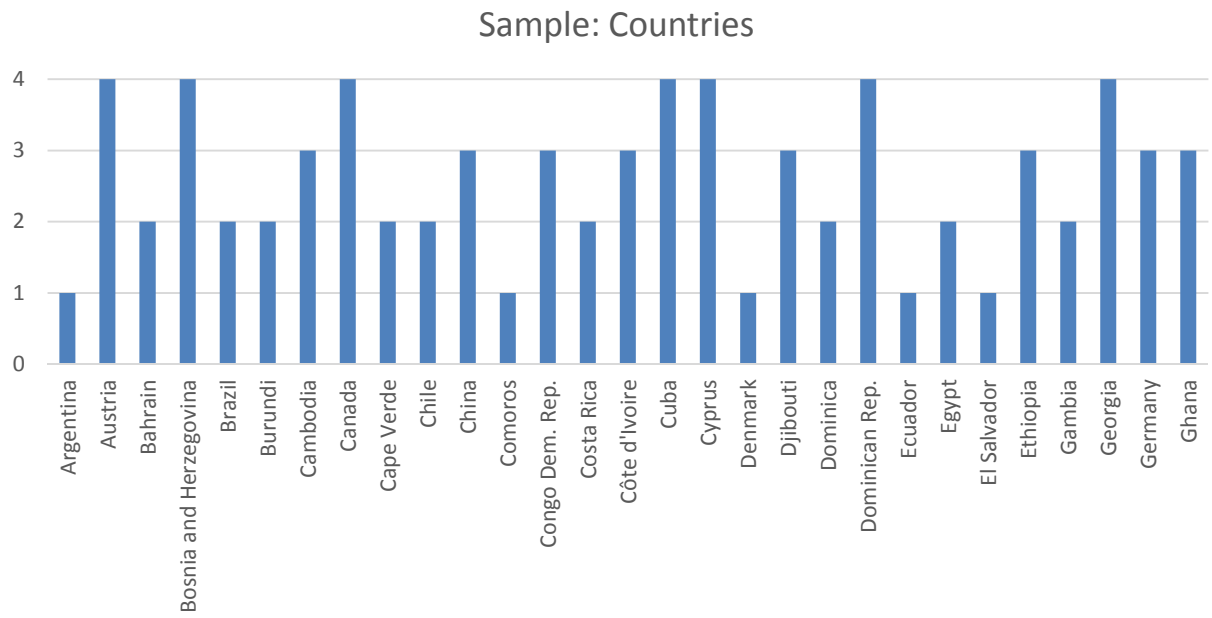


Figure 15 - Sample count per country (30 - 58)

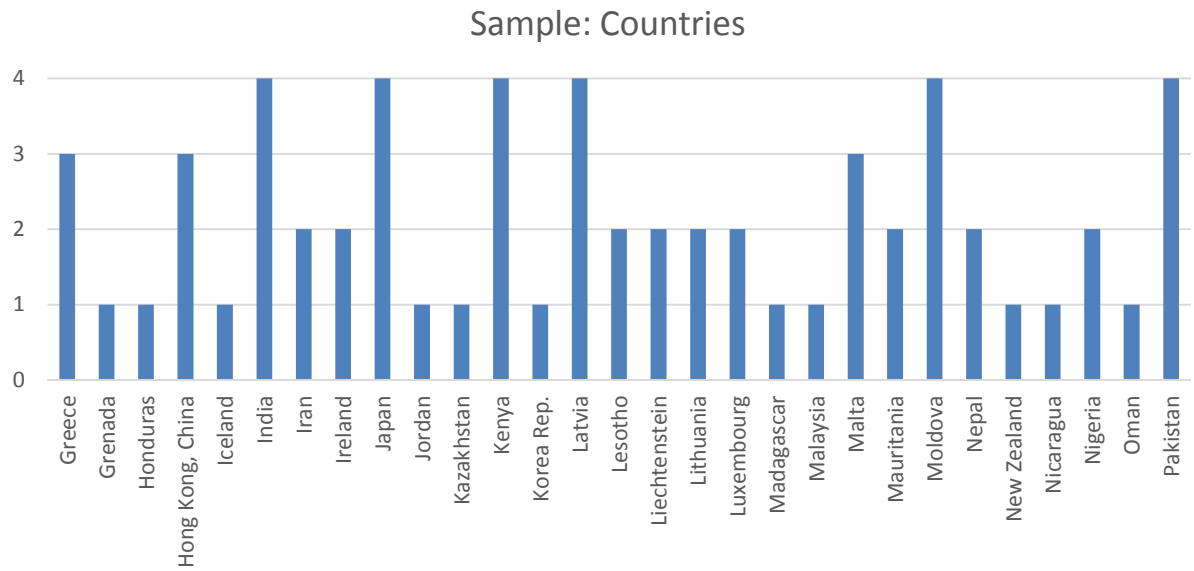
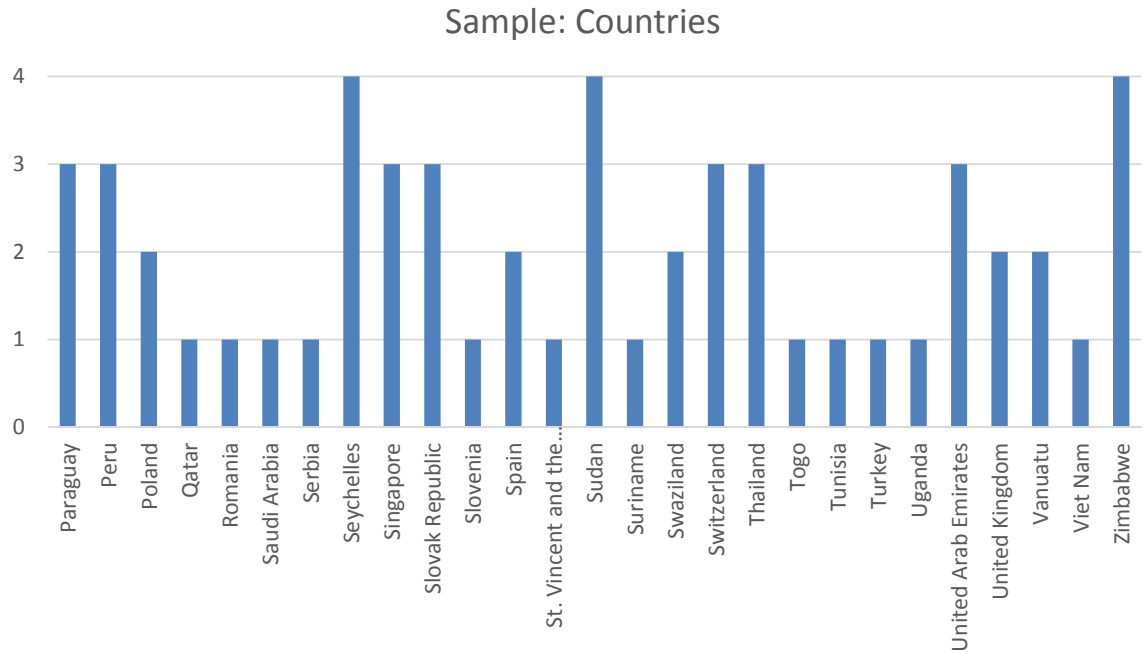


Figure 16 - Sample count per country (59 - 85)



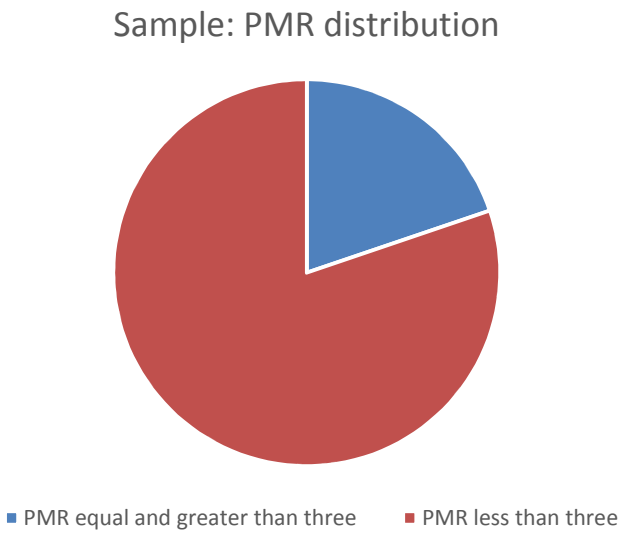
Using the PMR indicator scale it was determined in the literature review that a value higher than the scale mid-point (scale is zero to six with mid-point three)

would indicate competition policies in the ICT sector that is more orientated towards competition protection whilst a value lower than the mid-point would indicate a stronger orientation towards competition enhancing policies. The dataset used in this report has 154 samples with a PMR value of less than three and 38 samples with a PMR value higher and equal to three. This is shown in table 8 and figure 17.

Table 8 - PMR mid-point sample distribution

Total sample	Sample count
PMR equal and greater than three	38
PMR less than three	154

Figure 17 - PMR mid-point sample distribution



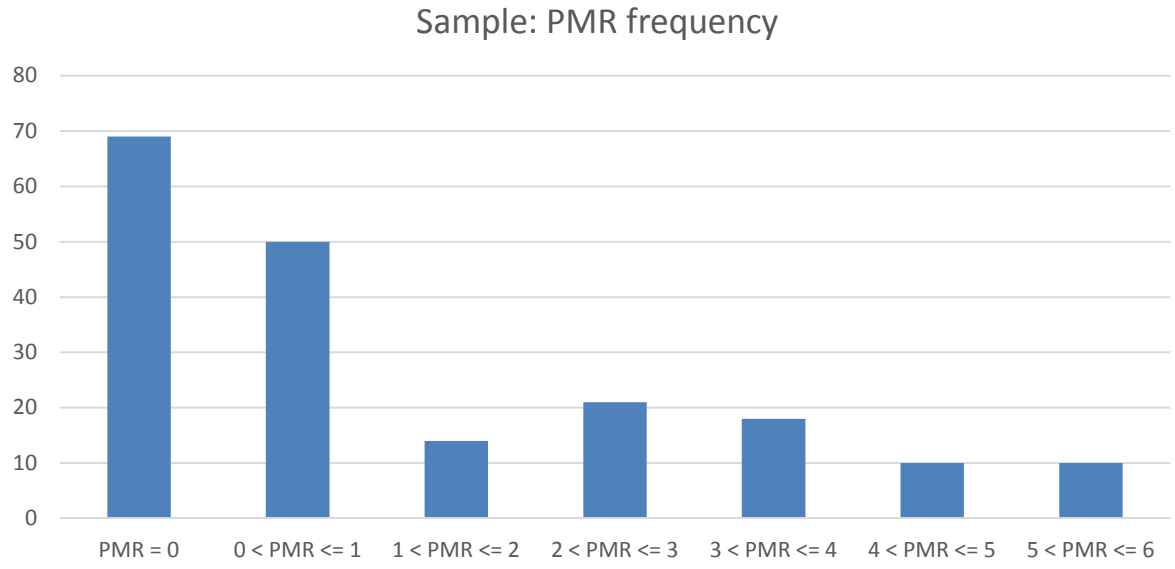
The PMR sample distribution can be further broken down to provide a more granular frequency distribution to better understand the weight of the PMR distribution. Thus a value of zero would indicate the competition policies implemented will be completely focused on maximising the level of competition whilst a value of six would indicate the competition policies implemented will be

focused on completely limiting/restricting the level of competition. This is shown in table 9 and figure 18.

Table 9 - Sample PMR frequency distribution

PMR sample frequency	Sample count
PMR = 0	69
0 < PMR <= 1	50
1 < PMR <= 2	14
2 < PMR <= 3	21
3 < PMR <= 4	18
4 < PMR <= 5	10
5 < PMR <= 6	10

Figure 18 - Sample PMR frequency distribution

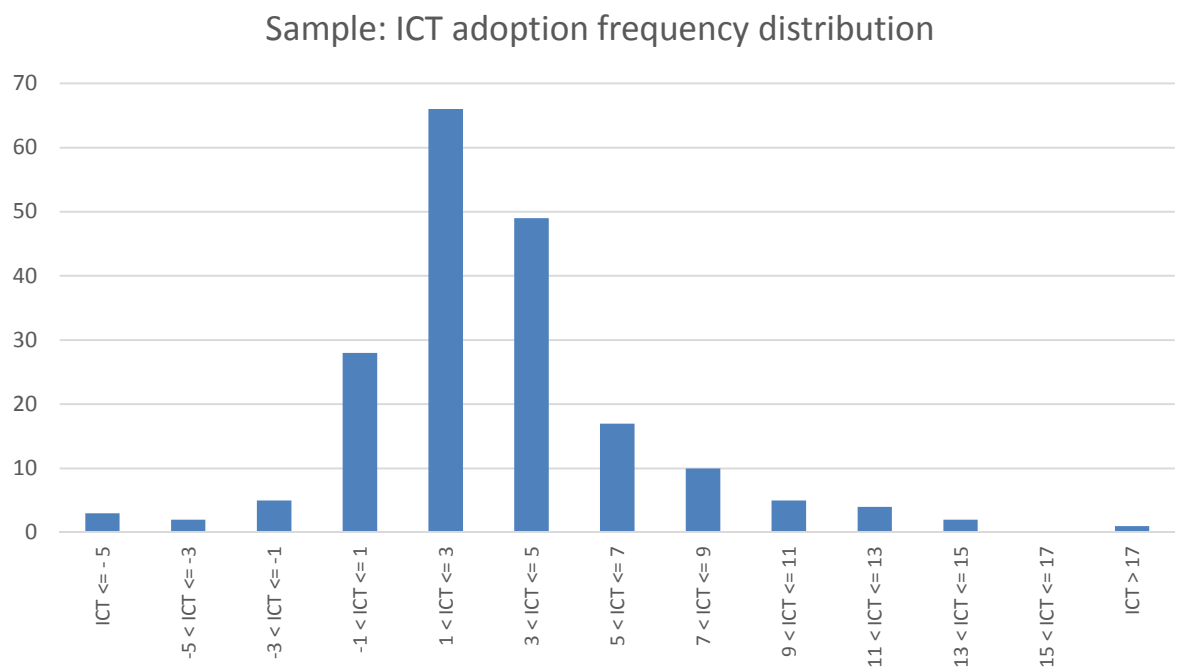


Similar to the PMR frequency distribution the ICT adoption rate frequency distribution is shown in table 10 and figure 19. The values represent the adoption rate of the calculated index per 100 inhabitants.

Table 10 - Sample ICT adoption frequency distribution

ICT sample frequency	**192**
ICT <= - 5	3
-5 < ICT <= -3	2
-3 < ICT <= -1	5
-1 < ICT <= 1	28
1 < ICT <= 3	66
3 < ICT <= 5	49
5 < ICT <= 7	17
7 < ICT <= 9	10
9 < ICT <= 11	5
11 < ICT <= 13	4
13 < ICT <= 15	2
15 < ICT <= 17	0
ICT > 17	1

Figure 19 - Sample ICT adoption frequency distribution

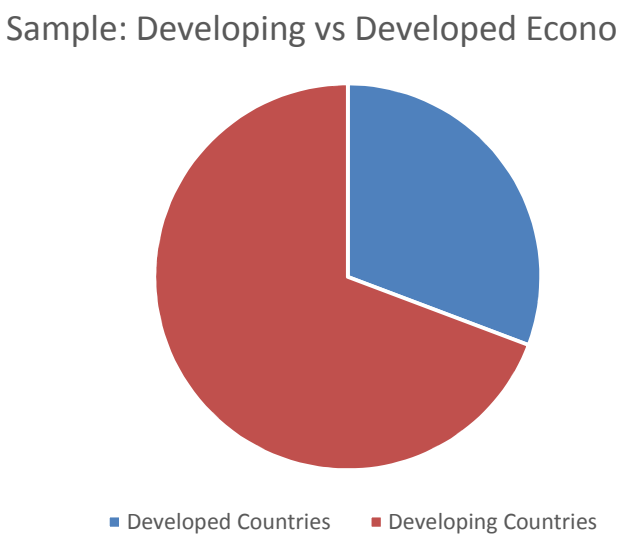


The sample used in the research includes various developing and developed economies as shown in table 11 and figure 20. This is important to note as these two groups have different approaches to competition policy implementation as described in the literature review.

Table 11 - Sample developing and developed economy distribution

Economy category	Sample count
Developed Countries	59
Developing Countries	133

Figure 20 - Sample developing and developed economy distribution



5.2. Hypothesis 1 – Developing economies competition policies

The descriptive statistics for the PMR values of the developing economies group is shown in table 12. It can be seen that a PMR mean value of 1.75 was calculated for the group with a standard deviation of 1.86.

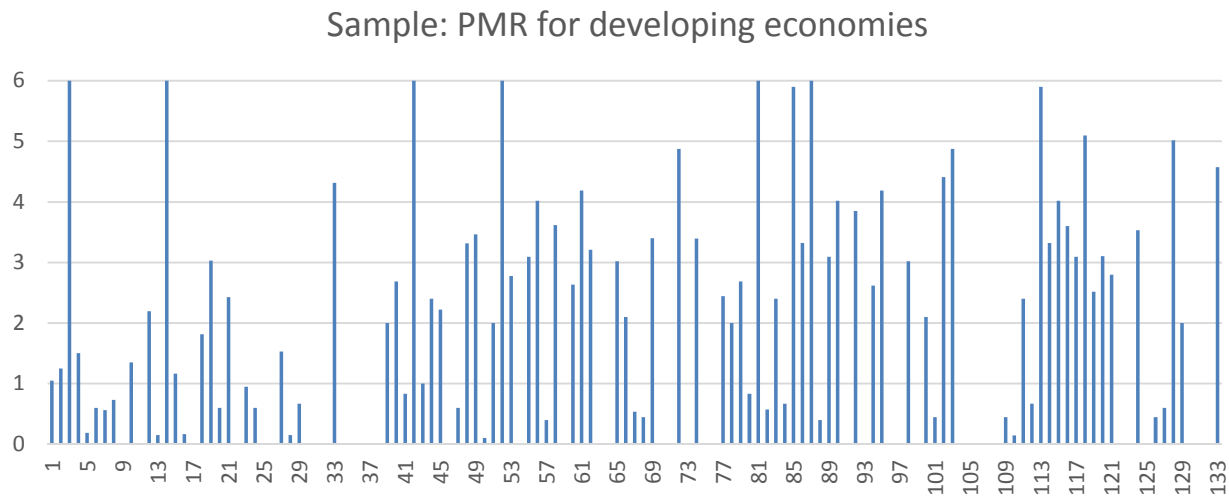
Table 12 - Developing economies PMR descriptive statistics

PMR developing economies	
Mean	1.747566535
Standard Error	0.160967965
Median	0.946666667
Mode	0
Standard Deviation	1.856373135
Sample Variance	3.446121215
Kurtosis	-0.480896489

Skewness	0.804115098
Range	6
Minimum	0
Maximum	6
Sum	232.4263492
Count	133
Confidence Level (95.0%)	0.318410546

The PMR value distribution for the 133 samples in the developing economies group is shown in figure 21.

Figure 21 - Developing economies PMR indicators



For hypothesis 1 a two-tailed one-sample Z-test was performed to determine if the PMR mid-point is significantly different from the sample selected. Thus the one-sample Z-test will provide the probability that the PMR mid-point belongs to the population of values. The one-sample Z-test result is shown in table 13.

Table 13 - Two tailed Z-Test for PMR in developing economies

Sample	PMR developing economies
Population mean	3
Z-Test Two-tailed	5.58353E-12

From the above result it can be seen that the probability that the mid-point belongs to the sample is for all practical reasons zero. Thus the null hypothesis will be rejected and the alternate hypothesis will be accepted because the PMR mean value (1.75) for the developing economies group is significantly different from the PMR indicator mid-point.

5.3. Hypothesis 2 - Developed economies competition policies

The descriptive statistics for the PMR values of the developed economies group is shown in table 14. It can be seen that a PMR mean value of 0.4 was calculated for the group with a standard deviation of 0.74.

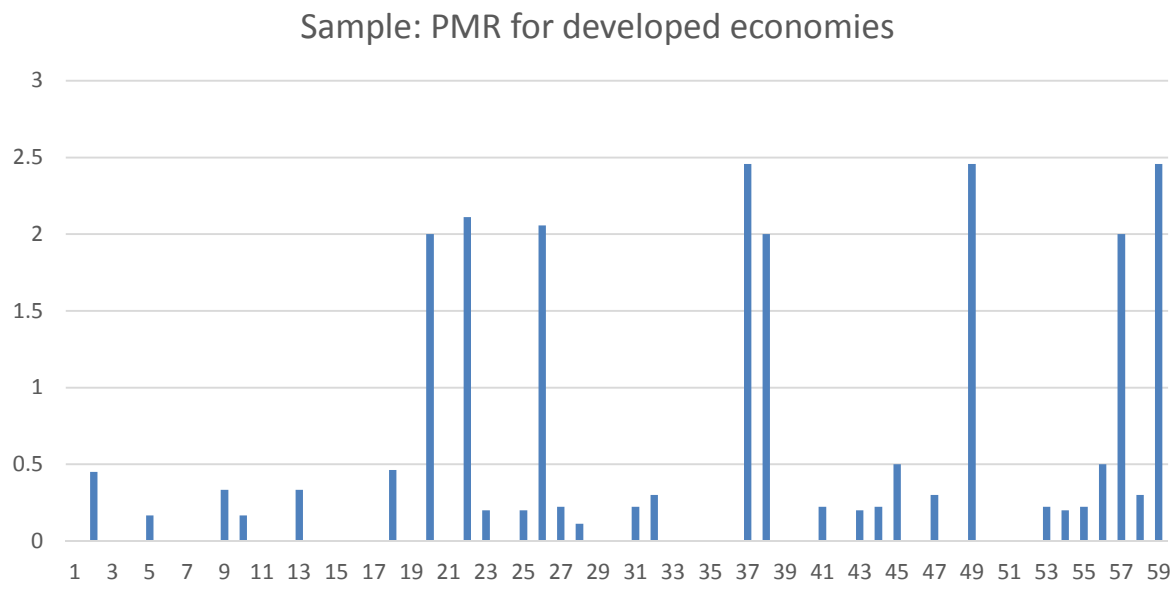
Table 14 - Developed economies PMR descriptive statistics

PMR developed economies	
Mean	0.399947431
Standard Error	0.095633017
Median	0.111111111
Mode	0
Standard Deviation	0.734571143
Sample Variance	0.539594764
Kurtosis	2.766830988

Skewness	2.070965742
Range	2.457114286
Minimum	0
Maximum	2.457114286
Sum	23.59689841
Count	59
Confidence Level (95.0%)	0.191430282

The PMR value distribution for the 59 samples in the developed economies group is shown in figure 22.

Figure 22 - Developed economies PMR indicators



For hypothesis 2 a two-tailed one-sample Z-test was performed (similar to hypothesis 1) to determine if the PMR mid-point is significantly different from the sample selected. Thus the one-sample Z-test will provide the probability that the PMR mid-point belongs to the population of values. The one-sample Z-test result is shown in table 15.

Table 15- Two tailed Z-Test for PMR in developed economies

Sample	PMR developed economies
Population mean	3
Z-Test Two-tailed	0

From the above result it can be seen that the probability that the mid-point belongs to the sample is zero. Thus the null hypothesis will be rejected and the alternate hypothesis will be accepted because the PMR mean value (0.4) for the developed economies group is significantly different from the PMR indicator mid-point.

5.4. Hypothesis 3 - ICT adoption rates in the presence of different types of competition policies

The descriptive statistics for the ICT adoption rates for countries that have a PMR value less than three (implemented competition policies are more orientated towards competition enhancing) is shown in table 16. It can be seen that an ICT adoption rate mean value of 3.41 was calculated for this group with a standard deviation of 3.87 (the unit is users per 100 inhabitants).

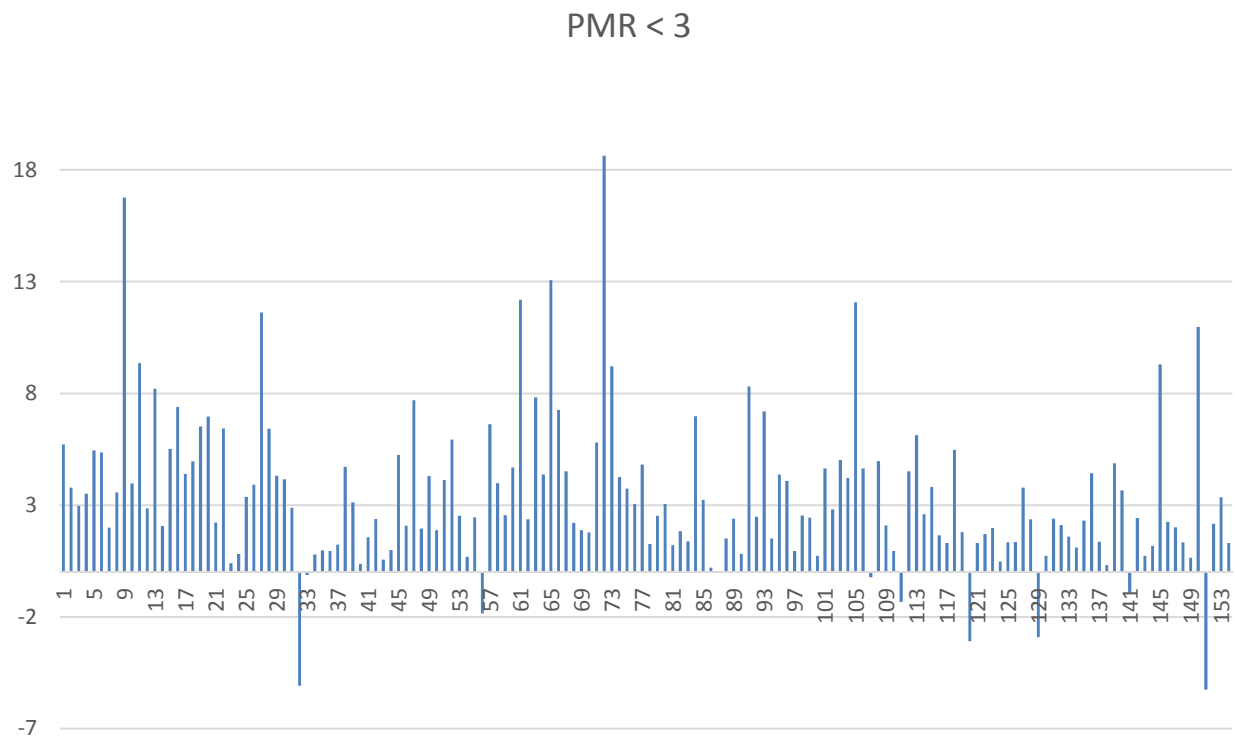
Table 16 - ICT adoption rate for PMR < 3 descriptive statistics

PMR < 3	
Mean	3.4117791
Standard Error	0.2729245
Median	2.5365858
Mode	#N/A

Standard Deviation	3.3869035
Sample Variance	11.471115
Kurtosis	4.0792547
Skewness	1.3243989
Range	23.871303
Minimum	-5.244946
Maximum	18.626357
Sum	525.41398
Count	154
Confidence Level (95.0%)	0.5391869

The ICT adoption rate distribution for the group with PMR < 3 is shown in figure 23.

Figure 23 - ICT adoption rate distribution for PMR < 3



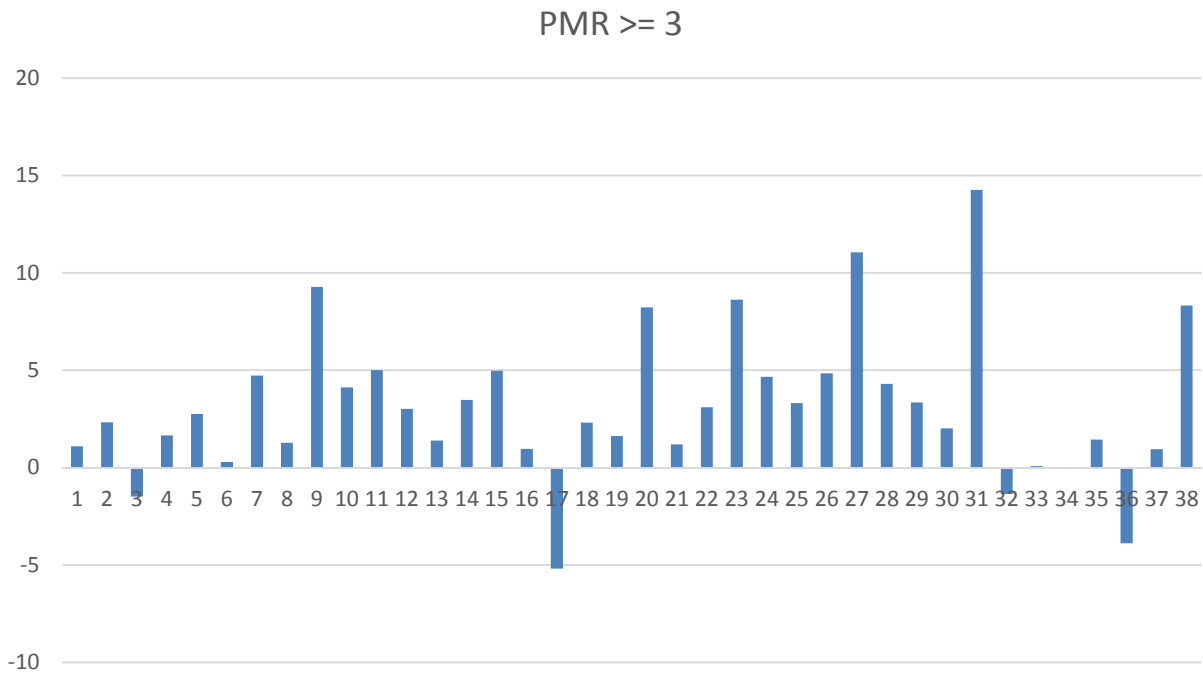
The descriptive statistics for the ICT adoption rates for countries that have a PMR value equal and greater than three (implemented competition policies are more orientated towards competition restriction) is shown in table 17. It can be seen that an ICT adoption rate mean value of 3.11 was calculated for the group with a standard deviation of 3.84 (the unit is users per 100 inhabitants).

Table 17 - ICT adoption rate for PMR >= 3 descriptive statistics

PMR >= 3	
Mean	3.1094803
Standard Error	0.6228227
Median	2.5491494
Mode	#N/A
Standard Deviation	3.8393372
Sample Variance	14.74051
Kurtosis	1.3551313
Skewness	0.6846932
Range	19.426489
Minimum	-5.17106
Maximum	14.255429
Sum	118.16025
Count	38
Confidence Level (95.0%)	1.2619587

The ICT adoption rate distribution for the group with PMR >= 3 is shown in figure 24.

Figure 24 - ICT adoption rate distribution for PMR >= 3



A two-tailed t-test for independent samples was performed to determine if there is a significant difference in ICT adoption rates between countries that have stronger competition enhancing policies (PMR < 3) and countries that have stronger competition restricting policies (PMR >= 3). A confidence level of 5% was used for this test. The results of the tests are shown in table 18.

Table 18 - T-test for competition enhancing and competition restricting policies

t-Test: Two-Sample Assuming Equal Variances		
	PMR < 3	***PMR >= 3***
Mean	3.4117791	3.10948
Variance	11.471115	14.74051

Observations	154	38
Pooled Variance	12.107787	
Hypothesized Mean Difference	0	
df	190	
t Stat	0.479629	
P(T<=t) one-tail	0.3160214	
t Critical one-tail	1.6529129	
P(T<=t) two-tail	0.6320428	
t Critical two-tail	1.9725282	

From the above results it was found that the t statistic value (0.48) is less than the two tailed critical value (1.97) which means there is no significant difference between the two groups. Thus the alternate hypothesis will be rejected and the null hypothesis will be accepted.

5.5. Hypothesis 4 - Competition policy and ICT adoption relationship

The descriptive statistics for the PMR values of the entire sample of 192 is shown in table 19. It can be seen that a PMR mean value of 1.33 was calculated for the sample with a standard deviation of 1.71.

Table 19 - Full sample PMR descriptive statistics

PMR	
Mean	1.333454
Standard Error	0.123619
Median	0.444444
Mode	0
Standard Deviation	1.712912

Sample Variance	2.934069
Kurtosis	0.456836
Skewness	1.214554
Range	6
Minimum	0
Maximum	6
Sum	256.0232
Count	192
Confidence Level (95.0%)	0.243833

The descriptive statistics for the ICT adoption rates for the entire sample is shown in table 20. It can be seen that an ICT adoption rate mean value of 3.28 was calculated for the group with a standard deviation of 3.33 (the unit is users per 100 inhabitants).

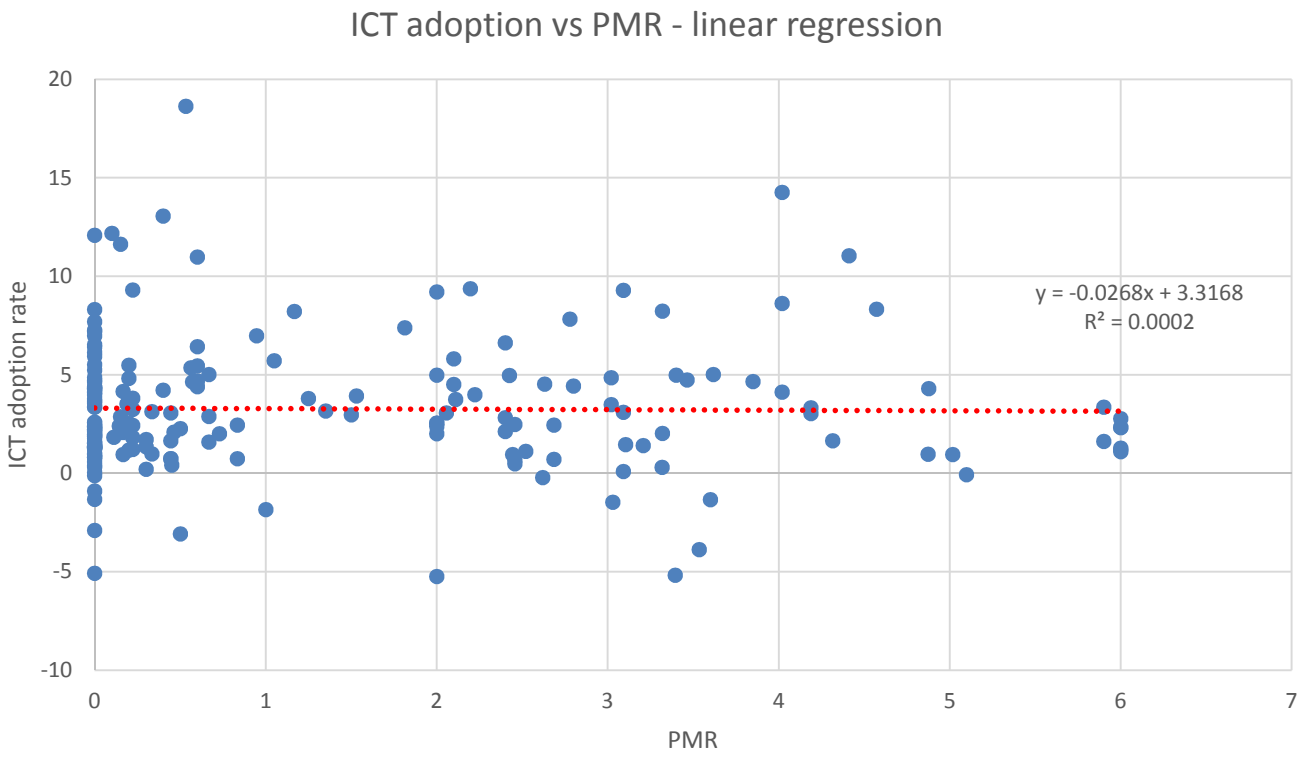
Table 20 - ICT adoption rate descriptive statistics

ICT Adoption Rate	
Mean	3.281116
Standard Error	0.240579
Median	2.536586
Mode	#N/A
Standard Deviation	3.333557
Sample Variance	11.1126
Kurtosis	3.082508
Skewness	1.012022
Range	23.8713
Minimum	-5.24495
Maximum	18.62636
Sum	629.9742
Count	192

Confidence Level (95.0%)	0.474532

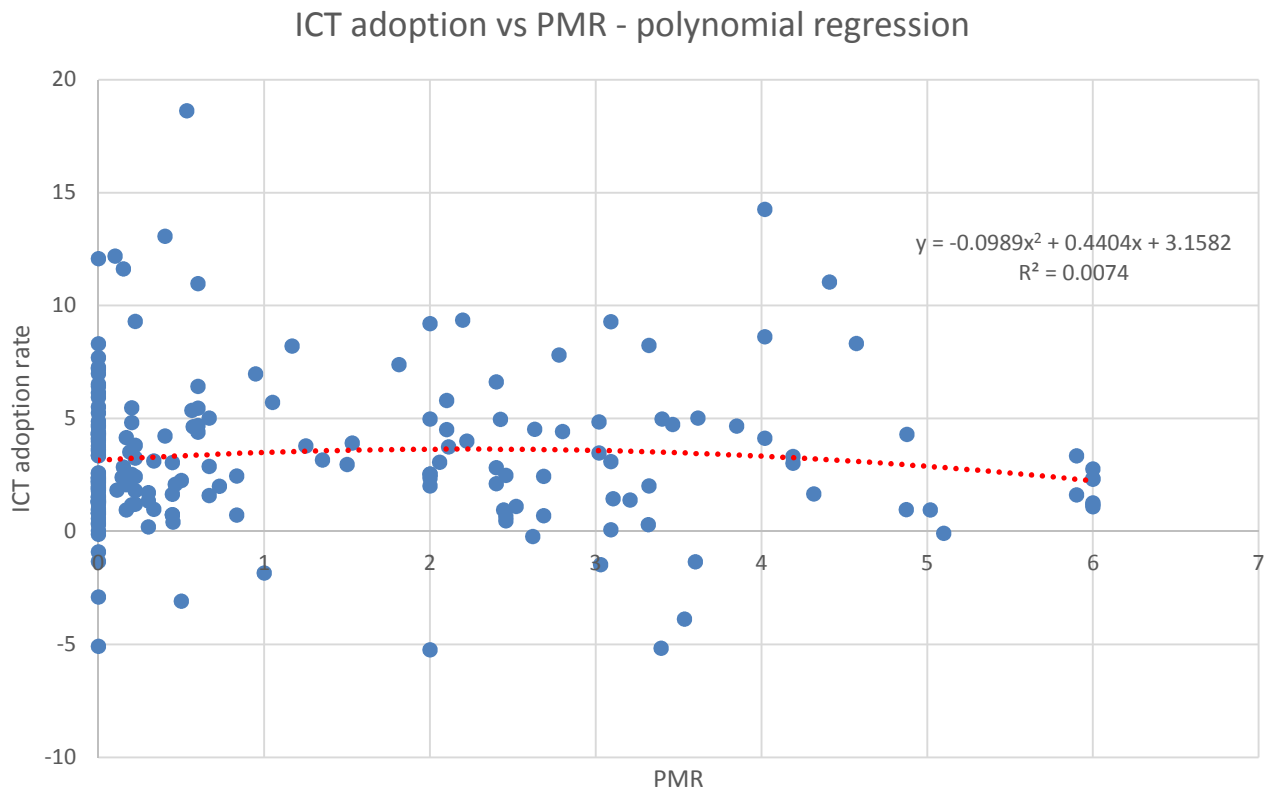
A linear regression analysis was performed on the PMR and ICT adoption rate values for the entire sample. The scatter plot between the two variables is provided below in figure 25. From the graph it can be seen that the coefficient of determination (R^2) is for all practical reasons zero (0.0002), thus indicating no relationship.

Figure 25 - Linear regression: ICT adoption rate vs PMR



A second order polynomial regression analysis was also performed on the PMR and ICT adoption rate values for the entire sample. The scatter plot between the two variables is provided below in figure 26. From the graph it can be seen that the coefficient of determination (R^2) is 0.0074 indicating a very weak to no relationship between the two groups.

Figure 26 - Second order polynomial regression: ICT adoption rate vs PMR



The correlation coefficient of -0.013 was calculated for the two groups and is shown in table 21.

Table 21 - Correlation coefficient for ICT usage rate and PMR

	PMR	**ICT Adoption Rate**
PMR	1	
ICT Adoption Rate	-0.013	1

The significance of the relationship was tested by converting the correlation coefficient to a t-statistic (as set out in the methodology section) and testing for

significance. A confidence level of 5% was used for this test. The results are shown in table 22.

Table 22 - Significance testing for correlation coefficient

Correlation coefficient	0.013
df	190
t-statistic	0.179213
p-value	0.857961

From the results in table 22 it was found that the p-value (0.86) for the test is significantly higher than the required confidence level (0.05). Thus the null hypothesis will be accepted and the alternate hypothesis rejected.

With the rejection of the alternate hypothesis it was decided to do the same test but only use mobile usage for the ICT adoption rate index. The ICT adoption rate index is made up of internet usage, broadband usage, and mobile usage. Both internet usage and broadband usage many times rely on older established infrastructure (e.g. fixed-line telephones) which in many economies are not well established. Thus the ICT adoption rate index can be skewed by the addition of these variables. From the literature review it was found that mobile technology adoption can also greatly be influenced by competition policies in the form of network licenses.

The descriptive statistics for the ICT adoption rates (using only mobile technology) for the entire sample is shown in table 23. It can be seen that an ICT adoption rate mean value of 5.98 (which is almost double that of the ICT adoption index used previously) was calculated for the group with a standard deviation of 8.96 (the unit is users per 100 inhabitants). Refer to table 19 for the PMR descriptive statistics.

Table 23 - ICT adoption rate (mobile only) descriptive statistics

ICT Adoption Rate	
Mean	5.975541
Standard Error	0.646488
Median	4.69678
Mode	#N/A
Standard Deviation	8.958004
Sample Variance	80.24584
Kurtosis	2.53077
Skewness	0.571404
Range	59.96239
Minimum	-22.5149
Maximum	37.4475
Sum	1147.304
Count	192
Confidence Level (95.0%)	1.275174

A linear regression analysis (similar to that in figure 25) was performed on the PMR and ICT adoption rate values for the entire sample with only mobile technology used for the ICT adoption rate. The scatter plot between the two variables is provided below in figure 27. From the graph it can be seen that the coefficient of determination (R^2) is for all practical reasons zero (0.0006), thus indicating no relationship.

A second order polynomial regression analysis (similar to that in figure 26) was also performed on the PMR and ICT adoption rate values for the entire sample with only mobile technology used for the ICT adoption rate. The scatter plot between the two variables is provided below in figure 28. From the graph it can be seen that the coefficient of determination (R^2) is 0.0023 indicating a very weak to no relationship between the two groups.

Figure 27 - Linear regression: ICT adoption rate (mobile only) vs PMR

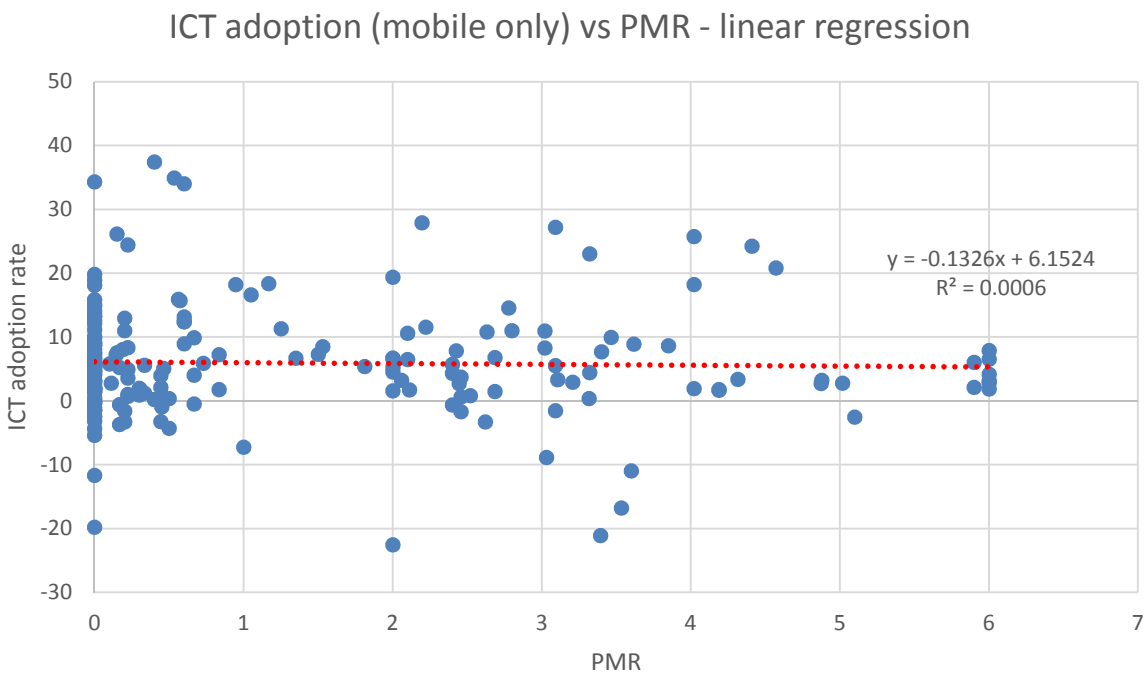
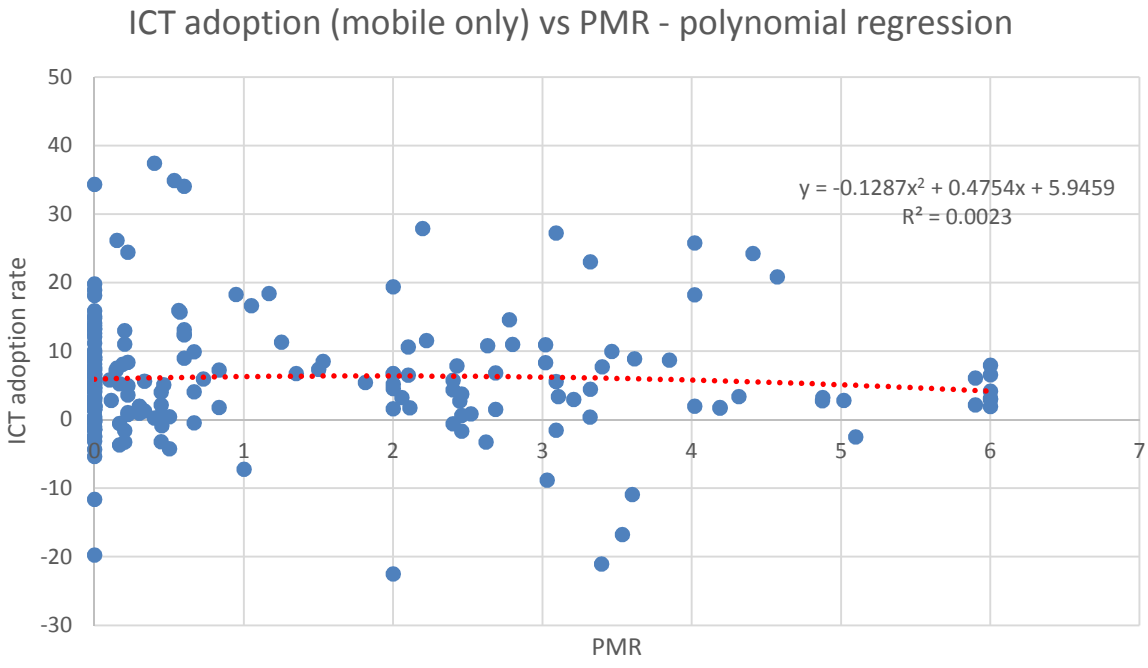


Figure 28 - Second order polynomial regression: ICT adoption rate (mobile only) vs PMR



The correlation coefficient of -0.025 was calculated for the two groups (with ICT adoption rate calculated using only mobile technology) and is shown in table 24.

Table 24 - Correlation coefficient for ICT usage rate (mobile only) and PMR

	PMR	**ICT Adoption Rate**
PMR	1	
ICT Adoption Rate	-0.02536	1

The significance of the relationship was tested by converting the correlation coefficient to a t-statistic (as set out in the methodology section) and testing for significance. A confidence level of 5% was used for this test. The results are shown in table 25.

Table 25 - Significance testing for correlation coefficient (mobile only)

Correlation coefficient	0.025357
df	190
t-statistic	0.349637
p-value	0.726998

From the results in table 25 is was found that the p-value (0.72) for the test is significantly higher than the required confidence level (0.05). Thus the null hypothesis will be accepted and the alternate hypothesis rejected.

5.6. Hypothesis 5 - Competition policy and ICT adoption (mobile only) relationship for developing economies

The descriptive statistics for the PMR values of the developing economies is shown in table 26. It can be seen that a PMR mean value of 1.75 was calculated for the sample with a standard deviation of 1.86.

Table 26 - Developing economy PMR descriptive statistics

PMR	
Mean	1.747566535
Standard Error	0.160967965
Median	0.946666667
Mode	0
Standard Deviation	1.856373135
Sample Variance	3.446121215
Kurtosis	-0.48089649
Skewness	0.804115098
Range	6
Minimum	0
Maximum	6
Sum	232.4263492
Count	133
Confidence Level (95.0%)	0.318410546

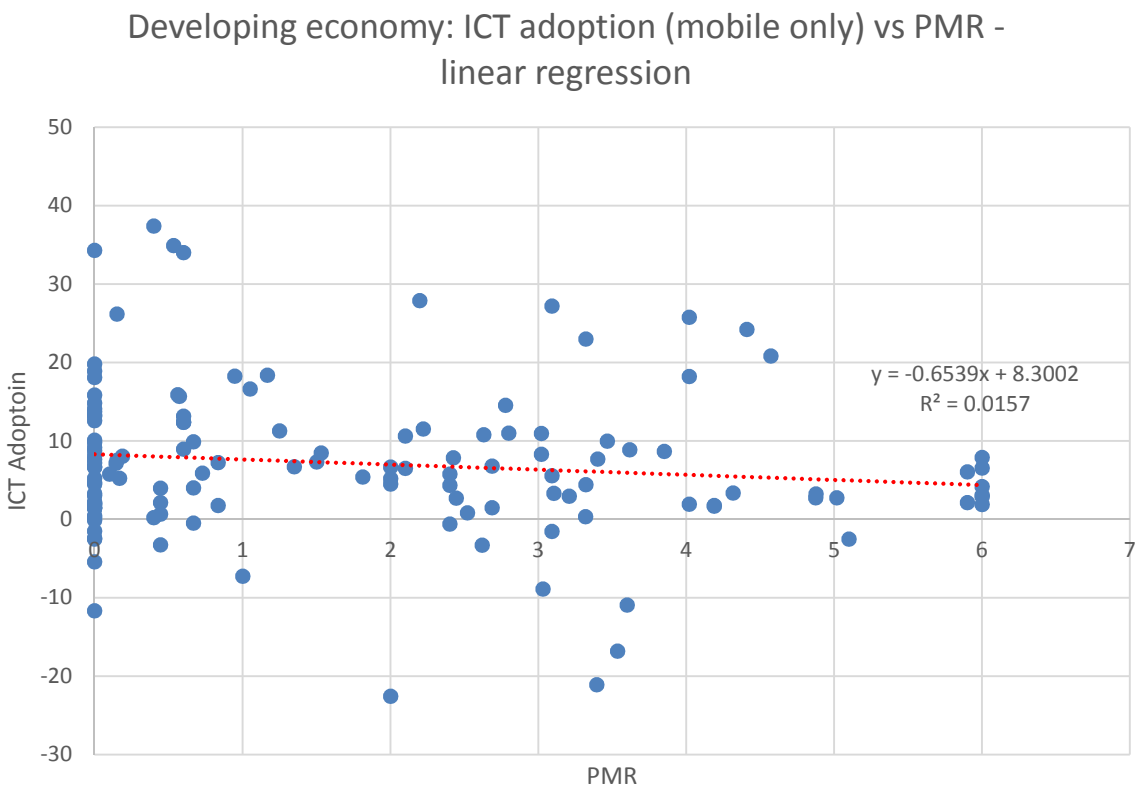
The descriptive statistics for the ICT adoption rates (using only mobile technology) for developing economies is shown in table 27. It can be seen that an ICT adoption rate mean value of 7.16 was calculated for the group with a standard deviation of 9.7 (the unit is users per 100 inhabitants).

Table 27 - ICT adoption (mobile only) rate descriptive statistics for developing economies

ICT adoption	
Mean	7.157502
Standard Error	0.840642
Median	6.073001
Mode	#N/A
Standard Deviation	9.694755
Sample Variance	93.98827
Kurtosis	1.988944
Skewness	0.417668
Range	59.96239
Minimum	-22.5149
Maximum	37.4475
Sum	951.9478
Count	133
Confidence Level (95.0%)	1.662873

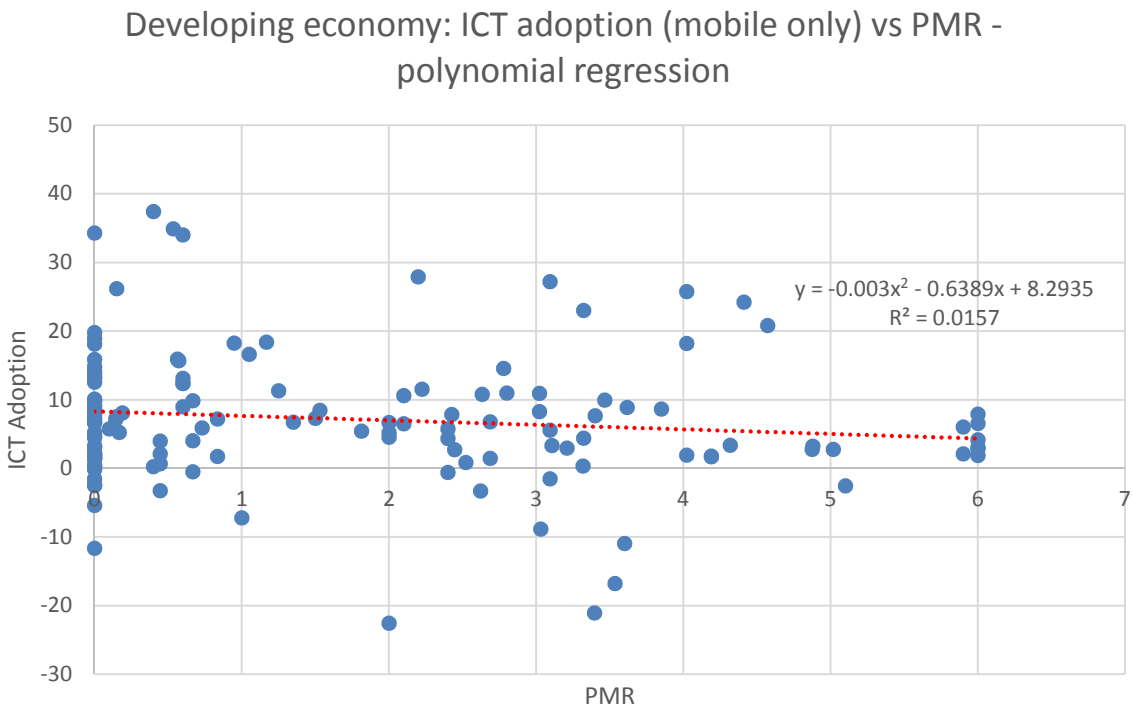
A linear regression analysis was performed on the PMR and ICT adoption rate (mobile only) values for developing economies. The scatter plot between the two variables is provided below in figure 29. From the graph it can be seen that the coefficient of determination (R^2) is for all practical reasons zero (0.016), thus indicating no relationship.

Figure 29 - Linear regression: ICT adoption (mobile only) rate vs PMR for developing economies



A second order polynomial regression analysis was also performed on the PMR and ICT adoption (mobile only) rate values for developing economies. The scatter plot between the two variables is provided below in figure 30. From the graph it can be seen that the coefficient of determination (R^2) is 0.016 indicating a very weak to no relationship between the two groups.

Figure 30 - Second order polynomial regression: ICT adoption (mobile only) rate vs PMR for developing economies



The correlation coefficient of -0.13 was calculated for the two groups and is shown in table 28.

Table 28 - Correlation coefficient for ICT usage (mobile only) rate and PMR of developing economies

	PMR	**ICT adoption**
PMR	1	
ICT adoption	-0.1252013	1

The significance of the relationship was tested by converting the correlation coefficient to a t-statistic (as set out in the methodology section) and testing for significance. A confidence level of 5% was used for this test. The results are shown in table 29.

Table 29 - Significance testing for correlation coefficient

Correlation coefficient	0.125201296
t-statistic	1.444359481
p-value	0.151025408

From the results in table 29 is was found that the p-value (0.15) for the test is higher than the required confidence level (0.05). Thus the null hypothesis will be accepted and the alternate hypothesis rejected.

5.7. Summary of results

The following results were found during the statistical analysis for hypothesis one to four.

- For hypothesis 1 the alternate hypothesis will be accepted with a one sample z-test probability of 5.58353E-12 and confidence level of 0.05

- For hypothesis 2 the alternate hypothesis will be accepted with a one sample z-test probability of 0 and confidence level of 0.05

- Hypothesis 3 will accept the null hypothesis with a t-statistic of 0.479629 and a two-tailed critical value of 1.97

- Hypothesis 4 will accept the null hypothesis with a significance probability of 0.86 and confidence level of 0.05

- Hypothesis 5 will accept the null hypothesis with a significance probability of 0.15 and confidence level of 0.05

6. Discussion of results

Chapter five provided a descriptive analysis of the data used for this research as well as results to the five hypotheses. The descriptive analysis provided some context to the data variability and reliability for both the overall dataset and grouped datasets. The results found that hypothesis one and two rejected the null whilst hypothesis three, four, and five accepted the null. Due to the nature of the aggregated samples used for this research a more detailed analysis is required to unpack and comprehend the various factors that influence the set of results.

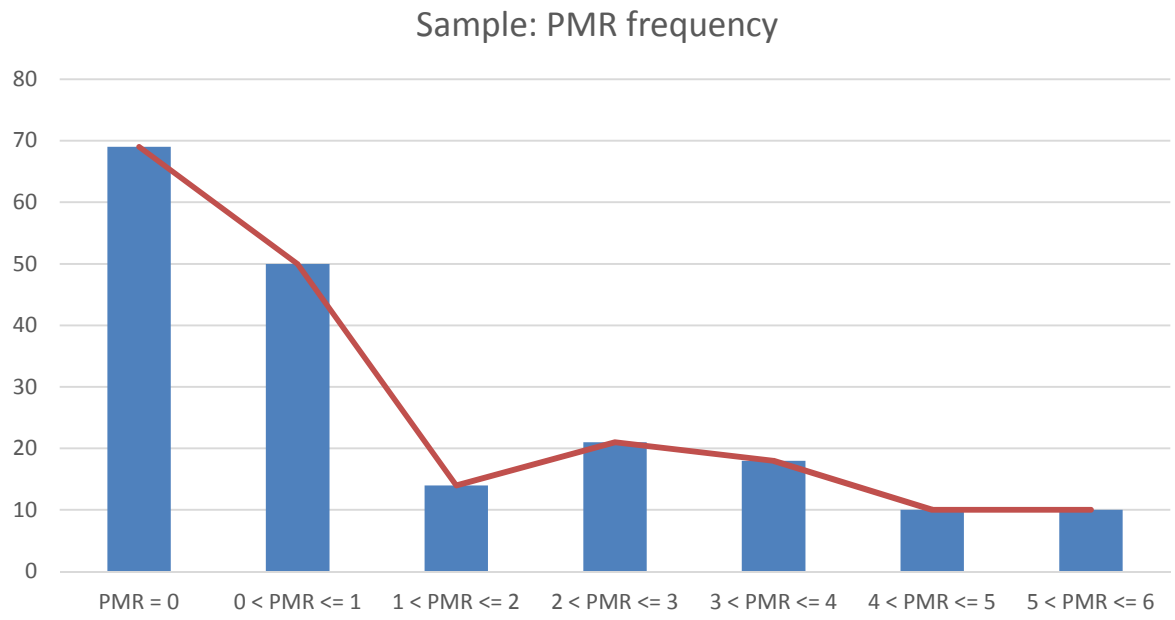
6.1. Descriptive analysis of data

A total of 192 samples were used for this research. This consistent of 85 countries with frequencies between one and four (depending on data availability) for years 2009 to 2012. The economic grouping of the sample used is fairly representative of the population. From table 11 and figure 20 (in section 5) it was found that 31% of the sample was developed economies whilst 69% was developing economies. The ITU uses the United Nations M49 list ("Developed/developing countries," n.d.) which indicates the composition of macro geographical regions, geographical sub-regions, and selected economic and other groupings. From this set of economical groupings 23% of the population is considered developed economies whilst 77% is considered developing economies which relates to the sample used.

When looking at the competition policy implementation it was found that a large portion of the sample implemented competition enhancing policies compared to competition protecting/restricting policies. From table 8 and figure 17 (in section 5) it can be seen that 80% of the countries in the sample implement competition policies (in the ICT sector) that is orientated towards competition enhancing whilst only 20% of the countries in the sample implemented competition policies (in the ICT sector) that promotes competition protection. When adding an average line to frequency distribution of figure 18 (in section 5) is can be seen

that a large percentage of countries in the sample implement policies that will attempt to maximise the amount of competition in the ICT market. This is shown in figure 31 below.

Figure 31 - Sample PMR frequency distribution with average line

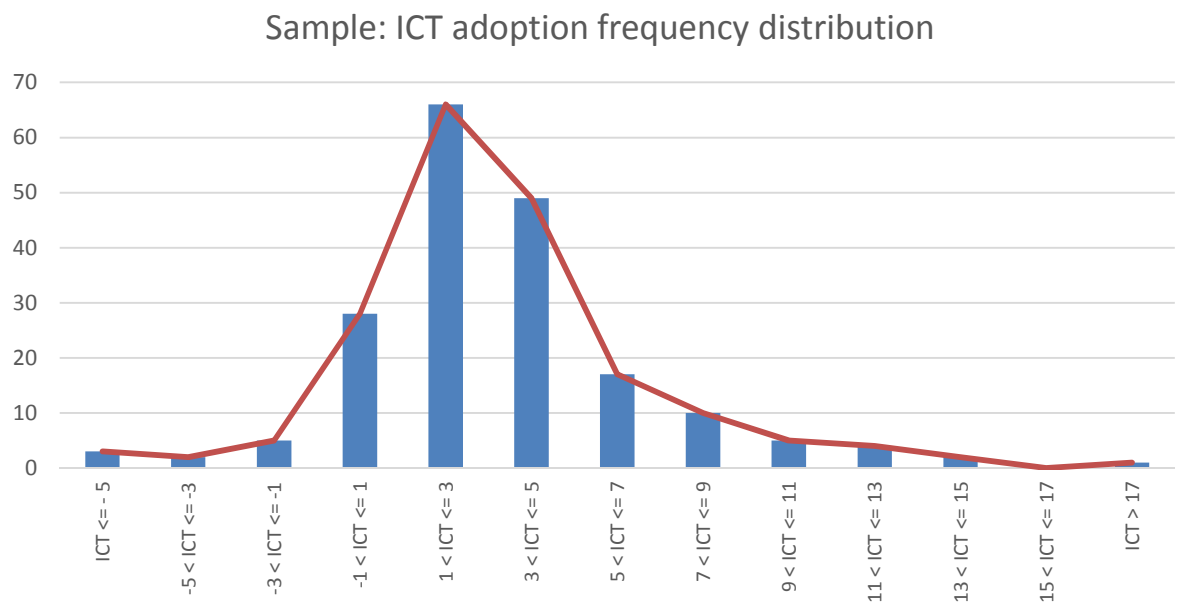


This was confirmed by the descriptive statistics of the entire sample given in table 19 (in section 5.5). It was calculated that the mean of the entire sample is 1.33 with a standard deviation of 1.71, skewness of 1.21, and kurtosis of 0.45. All of the previous statistics also indicate that the normal distribution of the sample is skewed by the large amount of samples having a PMR value of less than one which would support the previous findings.

One of the major reasons for this is the global adoption of neoclassical competition theory for modern day economics (Tsoulfidis, 2011). From the literature review it was found that the ICT sector, which was previously referred to as the telecommunication sector, has also seen drastic privatisation and liberalisation of previous SOEs due to inefficiency. As infrastructure becomes more established in a country, competition enhancing policies are implemented to ensure lower prices, greater innovation, freedom of choice (Clarke, 2011).

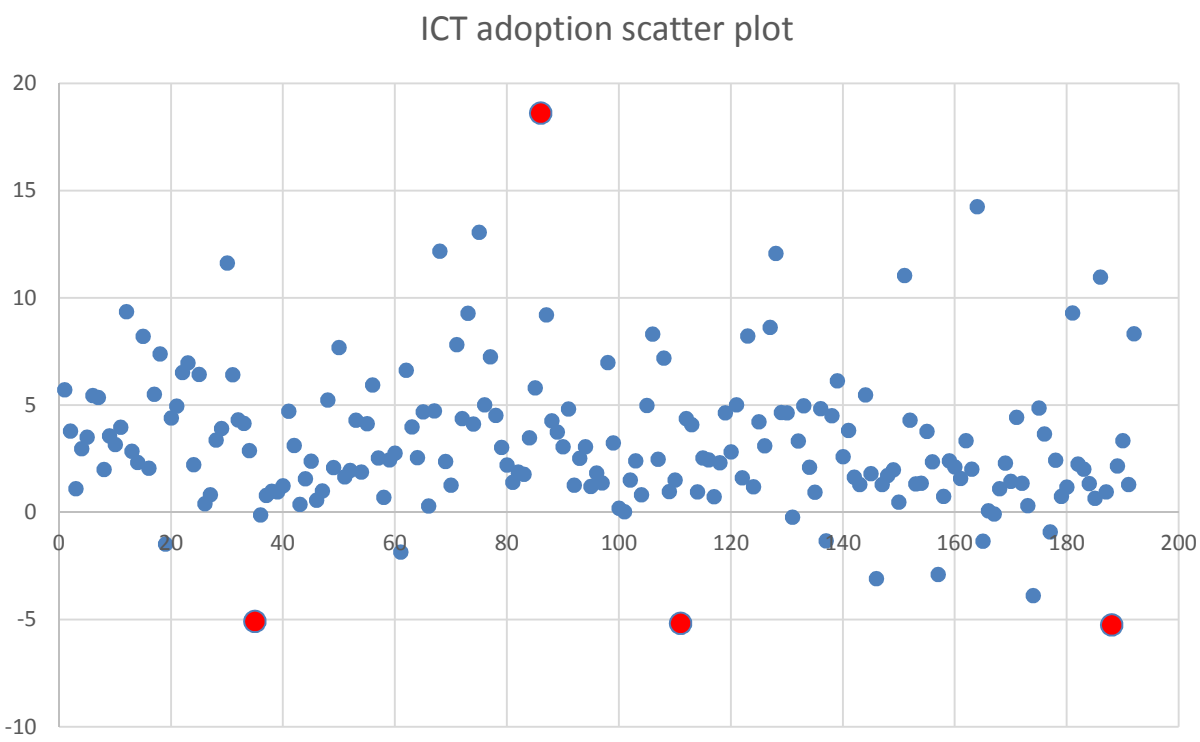
When looking at the ICT descriptive analysis for the entire sample (as shown in table 20 – section 5) it was found that the distribution represents a normal distribution as shown in figure 32.

Figure 32 - Sample ICT adoption frequency distribution with average line



From the descriptive statistics in table 20 (section 5.5) it was found that there are potentially some outliers. With a mean of 3.35 and a standard deviation of 3.47 it would seem that the range of -5.2 to 18.6 is excessive. This can also be seen in the difference between the mean of 3.35 and median of 2.54. These outliers have been highlighted in figure 33 which is a scatterplot of the ICT adoption rate with the y-axis being the actual adoption rate and the x-axis being the sample number.

Figure 33 - ICT adoption outlier scatter plot



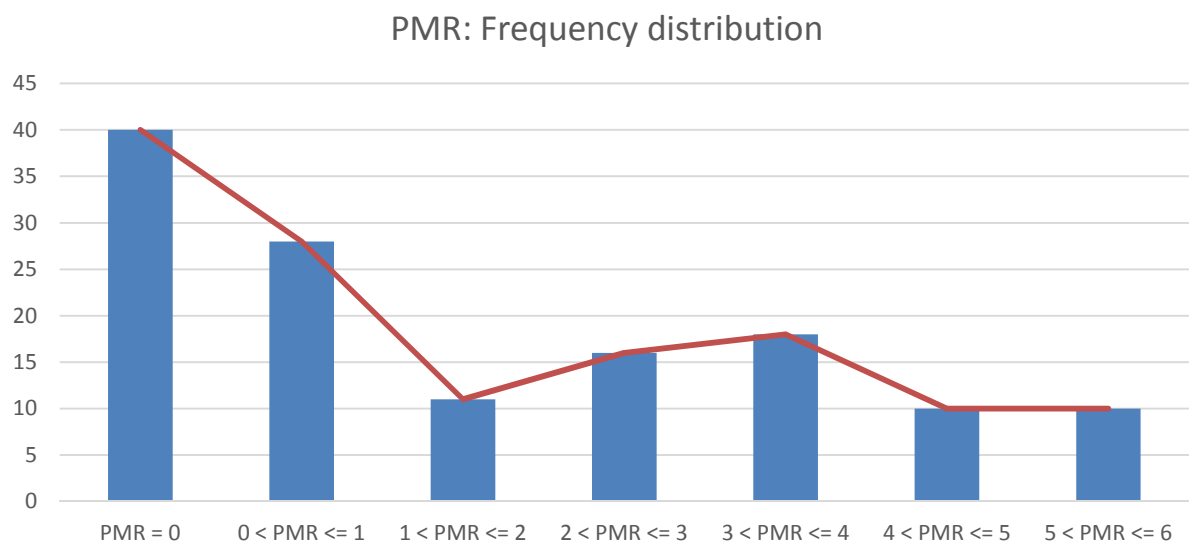
The outlier at the top of the graph which represents and excessive increase in ICT usage was in Kazakhstan from 2010 to 2011. Two major events that year could contribute to this drastic increase in adoption of mobile users in Kazakhstan. The first was the Kazakhstani Agency for the Protection of Competition's investigation into mobile operators charging excessively high international roaming charges ("Kazakhstan mobile phone operators to be fined KZT28 billion?," 2010). The second was the 51% acquisition by Sweden's Tele2 of Kazakhstani GSM mobile operator NeoTelecom ("Tele2 completes Neo acquisition," 2010). That same year NeoTelecom called for all mobile operators to reduce interconnection fees ("NeoTelecom wants main players to reduce interconnection fees," 2010). Thus the lowering of connection fees and increased competition could have resulted in the drastic increase in ICT adoption. Similar research found that the three outliers on the negative ICT adoption side (Germany, Honduras, and Dominica) were due to various justifiable reasons.

From the information described above it was decided that all the outliers will be included in the sample as they were either not excessive and/or provided valid reasoning for the excessiveness. Outliers for the PMR index was not conducted due to the nature of a fixed scale index.

6.2. Hypothesis 1 - Developing economies competition policies

The first hypothesis was developed to better understand the way developing economies implement competition policy in the ICT sector. As described in the descriptive analysis the majority of the sample (69%) consists of developing economies and represents a similar ratio to that of the population. Following the results from the two-tailed one sample z-test it was concluded that the null hypothesis was rejected because the probability that the mid-point belongs to the sample is for all practical reasons zero (5.58353E-12). This indicates that developing economies are not undecided with regards to competition policy implemented. From the mean of 1.75 (found in table 12 – section 5) there is strong evidence that suggests the majority of developing economies implement competition enhancing policies. When looking at the PMR frequency distribution for developing economies in figure 34 it is can be seen that the sample is skewed due to the large portion of countries with a PMR value lower than one (competition policies that have a strong focus on competition enhancing).

Figure 34 - Developing economies: PMR frequency distribution



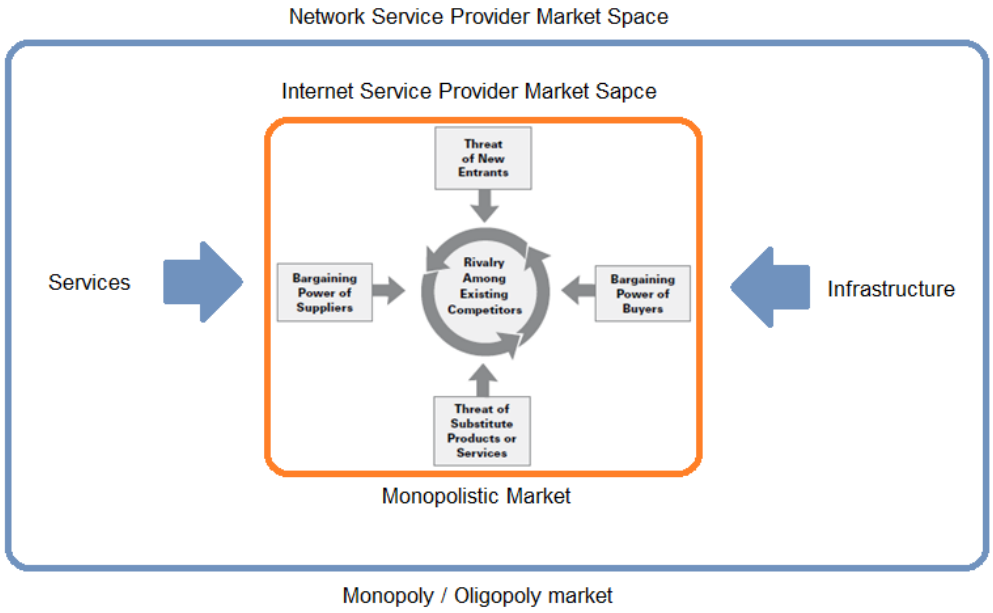
This was confirmed by the skewness statistic for developing economies of 0.8 in table 12. There are numerous reasons for developing economies implementing competition enhancing policies of which the most obvious ones are the benefits from increased competition (Clarke, 2011). Another two reasons which is often overlooked is the economic nature of the ICT sector and different levels of competition that exist in this sector.

The ICT sector is a fast moving industry with high levels of barriers to entry due to constant technology advancements (Yang et al., 2013), oligopoly markets (Sarkar et al., 1999), and required infrastructure. A major factor driving consumer behaviour in this sector is the advancement of ICT with end-users demanding greater choice and flexibility with product offerings (Sarkar et al., 1999). This has led to the introduction of free-markets and privatisation due to the negative aspects surrounding SOE and/or monopoly markets (e.g. increased inability to meet the changing demands of end-users (Achterberg, 2000)). Due to the fast moving pace of technology development in this sector it would seem that “importing” the technology by opening up trade-barriers and more specifically increasing competition with more telecommunication licenses will help that developing economies enter the ICT market at an advanced level. It will also ensure that the pace of technology advancement and knowledge

diffusion will drastically increase when compared to developing the skills “in-house”.

There is also competition in the ICT sector at different levels that contributes to the increase in competition enhancing policies. In many developing economies there are established network infrastructure from previous SOEs (Sarkar et al., 1999). As found in the literature the NSP sector has a unique form of competition that exists. Non-cooperative resource sharing has emerged in this sector in the sense that firms are competing with each other whilst using the same infrastructure or platform (Shrimali, 2010). Thus even though the network infrastructure has competition protection policies (because it is still state-owned or in a monopoly/oligopoly market structure), competition enhancing policies exists in the layer above this market (eg. ISPs using existing cable networks to provide customers with connectivity) to ensure enhanced technology, customer centricity, and lower prices. An example of this is shown in figure 35 where Porter’s model has been integrated to illustrate how the non-cooperative resource sharing competition operates.

Figure 35 - Illustration of competition in non-cooperative resource sharing market (Porter, 2008)



Another observation is the disparity in the PMR values for the developing economies group. This is seen in both the large standard deviation and negative kurtosis. From figure 34 it is seen that there is an increase in samples for the higher PMR values with 20 samples having a PMR value higher than 5 (competition policies that have a very strong focus on competition protection). This indicates that there are still many developing economies that implement competition policies that maximise the restriction of competition to either protect local industries from uncompetitive behaviour by larger firms or protect SOEs and/or key businesses that are strategic importance (Hoekman & Holmes, 1999b; Singleton, 1997). From the literature review Achterberg (2000) highlighted the fact that competition protection policies are implemented in the NSP sector to protect SOEs who have the primary goal of extending telecommunications infrastructure. This can help explain the right side tail (which has a higher PMR value and thus stronger competition protection policies) in the normal distribution.

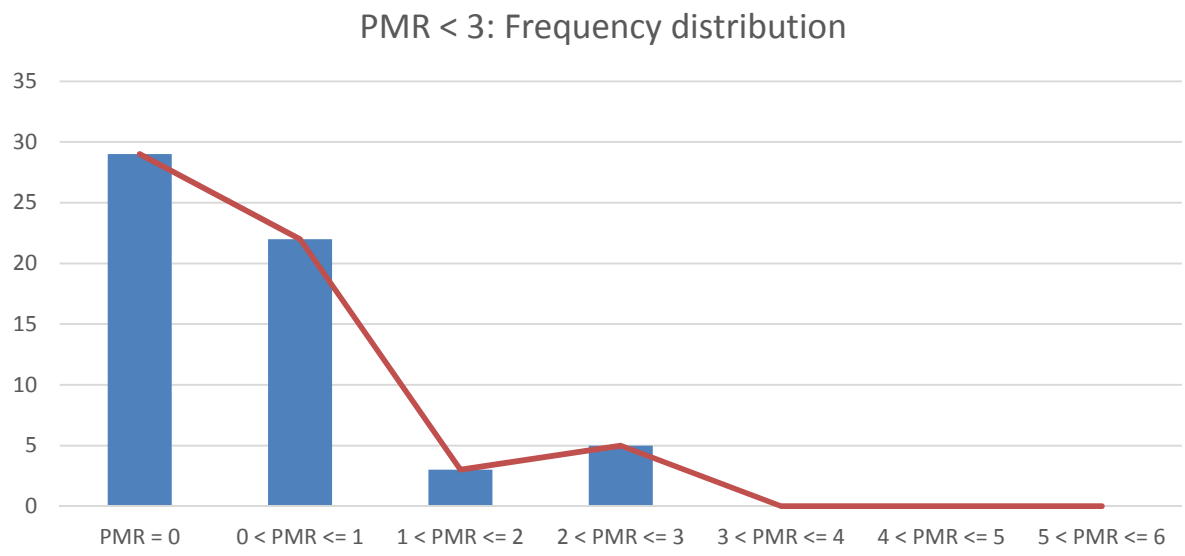
From the calculated results required for this hypothesis it was found that there is clear evidence that developing economies, on average, implement more competition enhancing policies than competition protection policies, but that there is disparity in the data as many developing economies still have strong competition protection policies.

6.3. Hypothesis 2 - Developed economies competition policies

The second hypothesis was developed to better understand the way developed economies implement competition policy in the ICT sector. Developed economies account for approximately 31% of the sample with 59 data points. The first observation is that the PMR mean value of 0.4 is significantly lower than that of the developing economies. The spread of the distribution is also quite low with a standard deviation of 0.73 and kurtosis of 2.77. When combining the above results with the high skewness statistic of 2.07 and low median of 0.11, it provides strong evidence that developed economies, on average, implement competition policies that are focused on significantly

enhancing competition in the ICT sector. This can clearly be seen in figure 36 where none of the developed economies in the sample has a PMR value above three (above three indicates the competition policies are more focused on competition protection).

Figure 36 - Developed economies: PMR >= 3 frequency distribution

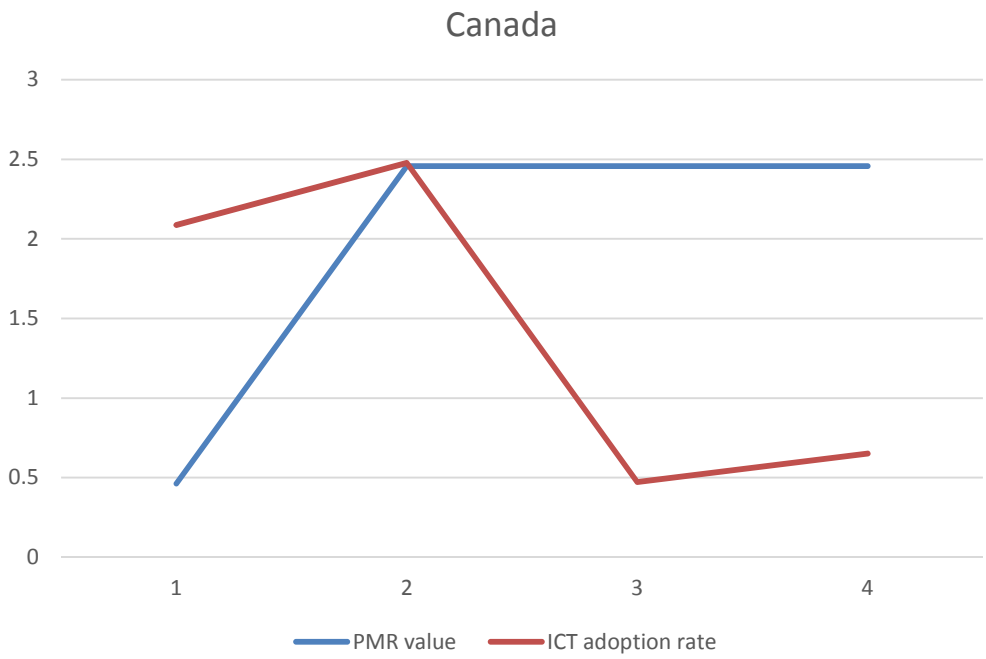


Following the results from the one sample z-test it was concluded that the null hypothesis was rejected because the probability that the mid-point belongs to the sample is zero. This indicates that developed economies are not undecided with regards to competition policy implemented and in fact when looking at the descriptive statistics has a strong orientation towards competition enhancing policies.

There are numerous reasons why developed economies have a strong focus on competition enhancing policies of which the most obvious reasons are the benefits of increased competition highlighted in the literature review. As mentioned in the section 6.1 some of these benefits include lower prices, greater innovation, and freedom of choice (Clarke, 2011). From the literature review it was also found that competition enhancing policies in the ICT sector maximise the benefits of increased competition where there is established

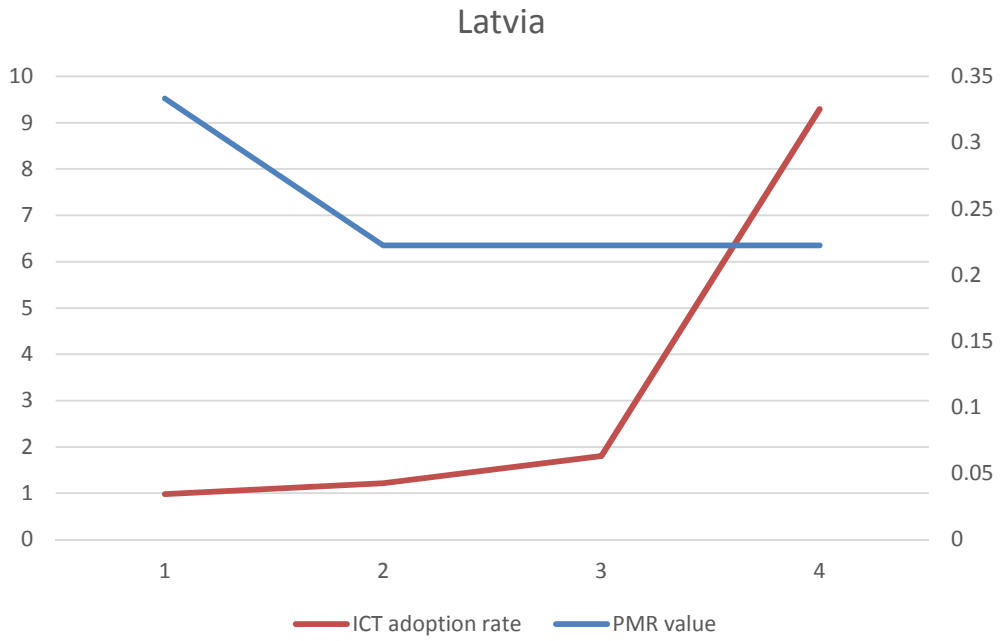
infrastructure to leverage (Brown & Thompson, 2011). Thus results found in hypothesis 2 supports the fact that developed economies would benefit more from implementing competition enhancing policies due to their developed infrastructure. Figure 37 and 38 shows two examples (extracted from the dataset) supporting this result.

Figure 37 - Canada: PMR and ICT adoption rates



Canada, as a developed economy, changed their competition policies in the ICT sector to be more protecting (increase in PMR value) and the impact on the ICT adoption rates can be seen falling after the event. Similar Latvia implemented more competition enhancing policies to leverage their existing infrastructure and saw a drastic increase in ICT adoption rates.

Figure 38 - Latvia: PMR and ICT adoption rates



Unfortunately due to the dataset used there is only limited amount of data points that could be used to investigate the above finding. Most of the developed economies have already gone through the privatisation and liberalisation process by 2009 when the dataset starts. Thus there are not many developed economies in the sample that are transitioning from competition enhancing policies to competition protection policies and vice versa.

6.4. Hypothesis 3 - ICT adoption rates in the presence of different types of competition policies

The third hypothesis was developed to determine if either competition enhancing or competition protecting policies (in the ICT sector) result in a higher ICT adoption rate. From the literature study it was found that both competition enhancing and competition protecting policies in the ICT sector can influence the rate of ICT adoption positively and/or negatively depending on various factors (see figure 7 in the literature review). What was also found is that the focus of the policy (enhancing or protecting) in the context of the environment

(macro-economic factors, infrastructure, etc.) will also influence the rate of ICT adoption (see figure 1 in the literature review). For example implementing competition enhancing policies in a developing economy with limited infrastructure can negatively affect the ICT adoption rate because profit maximising organisations would not necessarily focus on technology inclusion (for example expanding infrastructure), but rather focus on the "low hanging fruit" in the form of high income customers (Achterberg, 2000).

A two-tailed t-test for independent samples was conducted to establish if the means are significantly different from each other. The result of this test concluded that the means for the ICT adoption rate of the two groups (competition enhancing policies and competition protection policies) are not significantly different and thus the null hypothesis was accepted. After further investigation it was found that even though there is no significant difference between the means of the two groups there are various other differences.

As described in the data analysis section it can be seen that only 20% of the sample (see figure 17 in section 5.1) has a PMR value greater than three (indicating that a country is more orientated towards competition protection in the ICT sector). From the descriptive analysis in table 16 and 17 (in section 5.4) it can be seen that both sets of competition policies result in an average ICT adoption rate of between 3 and 3.5 users per 100 inhabitants with competition enhancing policies being marginally higher. Even though both these groups have similar standard deviations it was found that the competition enhancing group's kurtosis is almost four times that of the competition protection group. The normal distribution of both groups can be found in figure 39 and 40 which again reinforces this statement that the spread of adoption rates is lower with a higher level of competition enhancing policy. This indicates that implementing competition enhancing policies can result in more predicated ICT adoption rates as the spread is smaller.

Figure 39 - ICT adoption rates for PMR < 3

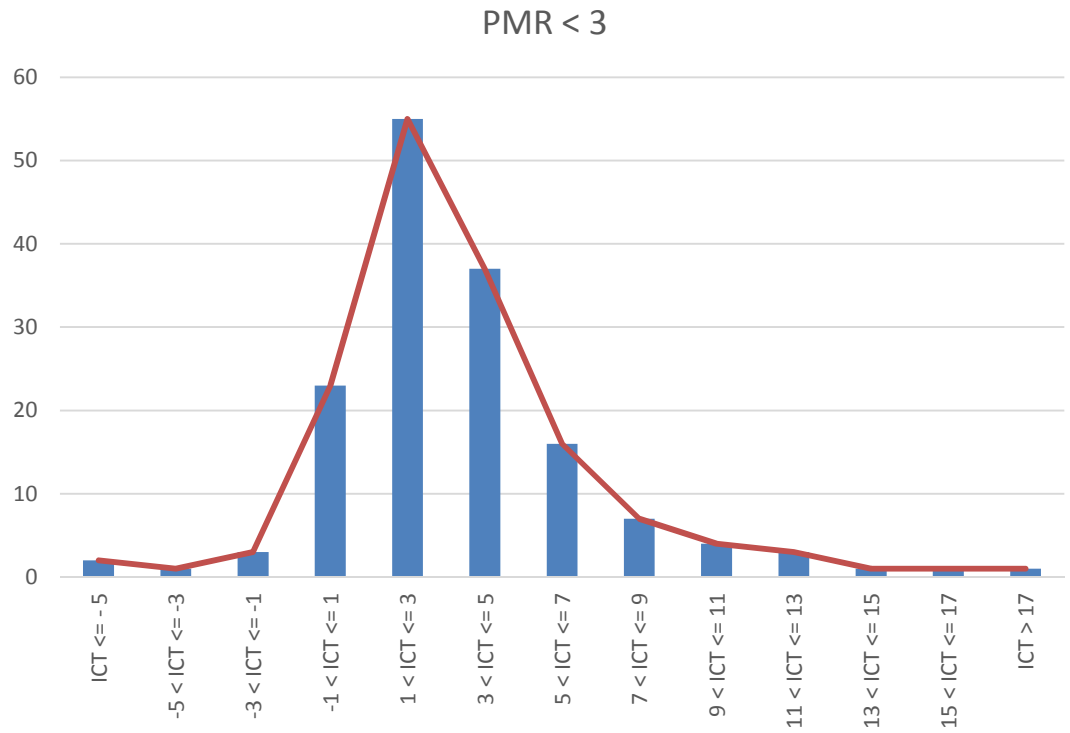
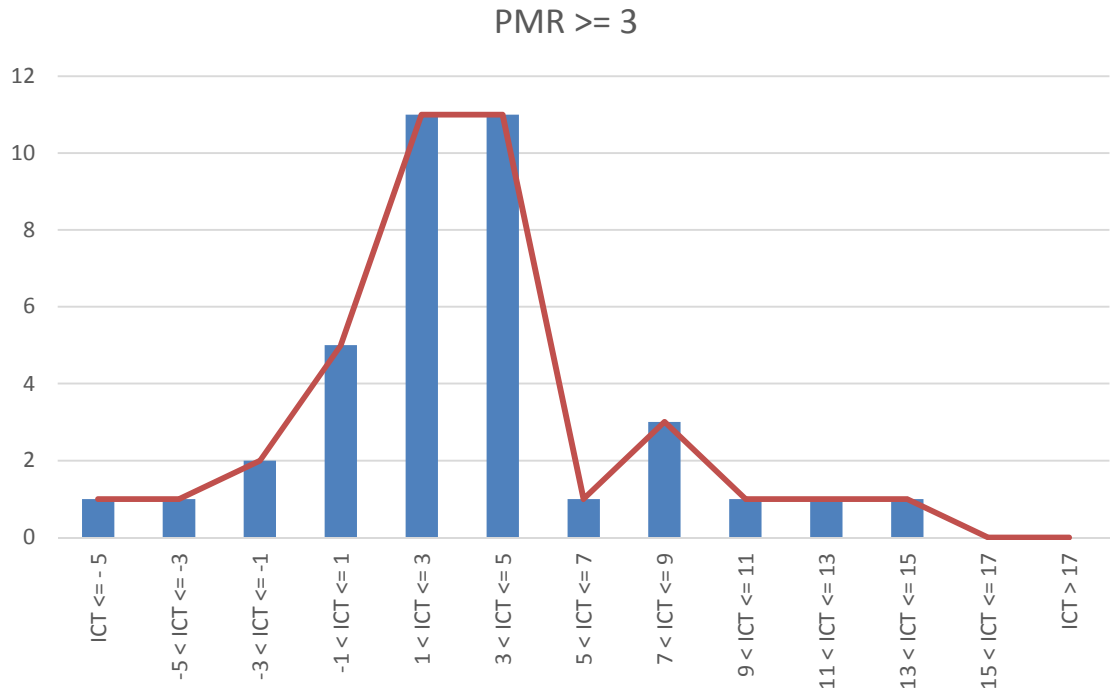


Figure 40 - ICT adoption rates for PMR >= 3



It is important to note that the benefits of increased competition in a developed market with established infrastructure can be offset by having an already

saturated market limiting the rate of ICT adoption. Similarly the negative effects of increased competition in developing markets with limited infrastructure can be offset by low market penetration resulting in a higher rate of ICT adoption. Thus due to diminishing returns the rate of ICT adoption will be lower in economies with an already high level of ICT usage. For example having one mobile subscription is important for ICT access, but the importance and need for a second mobile subscription is significantly less because of the replicated function.

That being said in many developing economies there is a high number of users with more than one mobile subscription which would seem to contradict this theory. A possible explanation for this is when in a highly saturated market (from a competition point of view) consumers become price sensitive (Porter, 2008). This can lead to users having more than one mobile subscription because of different price structures and benefits of the product offerings (e.g. free minutes, lower after hours call rates etc.). It is also important to note that when looking at table 30 (showing the countries with more than 150 mobile subscriptions per 100 inhabitants) it can be seen that the developing economies are almost three times that of the developed economies as price sensitivity is higher due to a lower disposable income.

Table 30 - Mobile subscriptions (2013) above 150 per 100 inhabitants

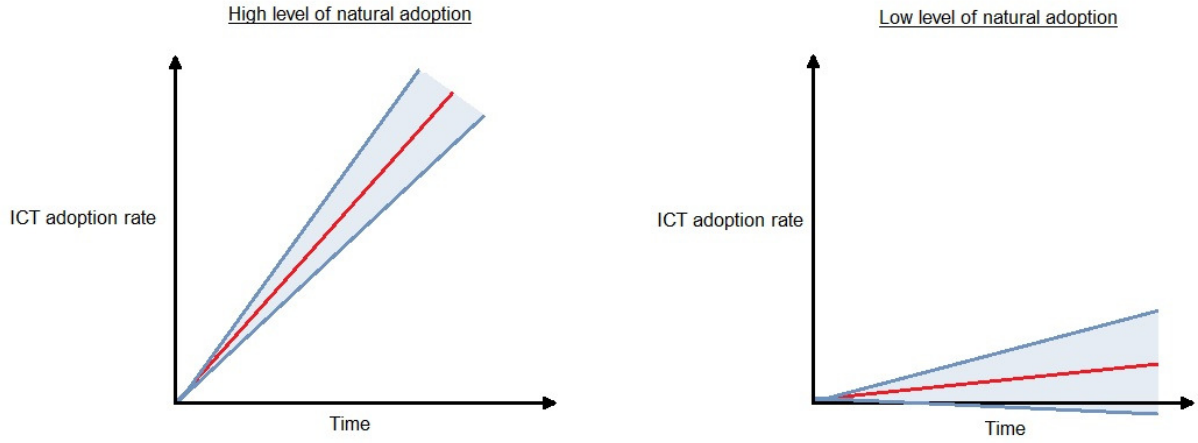
Developing Economies		**Developed Economies**	
Aruba	134	Austria	156
United Arab Emirates	172	Estonia	160
Argentina	159	Finland	172
Bahrain	166	Italy	159
Botswana	161	Lithuania	151
Cayman Islands	168	Montenegro	160
Gabon	215	Poland	150
Hong Kong SAR, China	239		
Kazakhstan	181		

Kuwait	190		
Libya	165		
Macao SAR, China	304		
Maldives	181		
Oman	155		
Panama	163		
Qatar	153		
Russian Federation	153		
Saudi Arabia	176		
Singapore	156		
Uruguay	155		

Another observation was that the data for the competition enhancing policy group is also almost double as skew as the competition protection policy group. This is due to the extended right side tail that is seen in figure 39. This was also confirmed when comparing the maximum ICT adoption rate values for the two groups where the competition enhancing group has a more extreme maximum. This could also indicate that competition enhancing policies can result in a higher extreme rate of ICT adoption which is important to note for developing economies with low ICT adoption rates.

The t-test results show that there is no significant difference between the two means which indicates that, **on average**, it is neither better nor worse from an ICT adoption point of view to implement competition enhancing or competition protecting policies. This contradicts numerous views on the benefits of increased competition over competition restricting (even though those views are in general whilst this report focuses on the ICT sector). A factor that can influence the rate of adoption to the extent that the impact of competition policy is regarded insignificant is the level of natural adoption in the ICT sector. Factors like herd behaviour (Sun, 2013) results in a natural level of ICT adoption which, in some instances, is significantly higher than the impact of competition policy as shown in figure 41.

Figure 41 - Competition policy impact in the presence of natural adoption



This result also does not differentiate between the various levels of competition that can existing in the ICT sector as discussed in section 6.2. It is thus important to note the context of implemented policies to maximise ICT adoption.

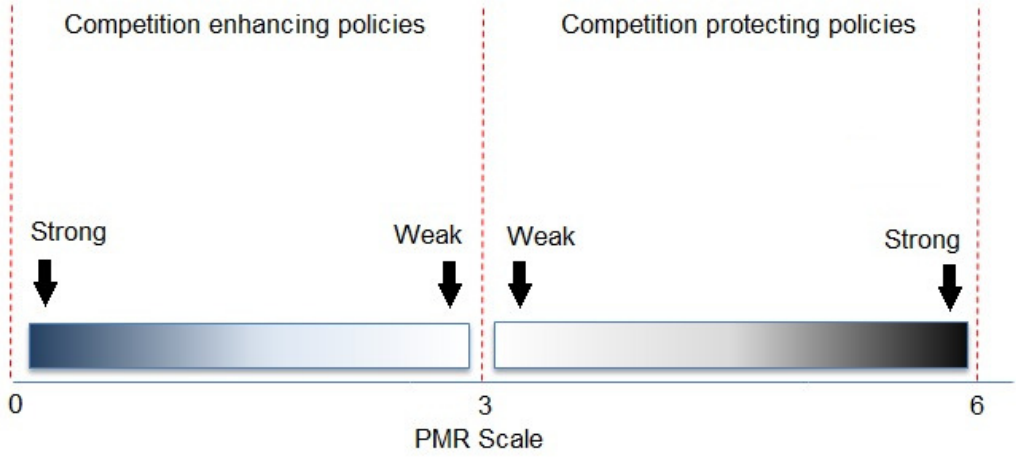
6.5. Hypothesis 4 - Competition policy and ICT adoption relationship

The fourth hypothesis was developed to determine if there is a relationship between the type and level of competition policy implemented in the ICT sector and the rate of ICT adoption. The null hypothesis stated that there is **no** relationship between these two variables whilst the alternate hypothesis stated that there **is** a relationship between them.

The PMR values was correlated to the ICT adoption rates for the entire sample and it was found that there is a very weak or no relationship between these two groups with a correlation coefficient of -0.01375. A linear regression analysis was performed on the dataset and from figure 25 (in section 5) it can be seen that there is for all practical reasons no correlation between the competition policies implemented in the ICT sector and ICT adoption rates.

To create a more granular model of the relationship between these two variables another dimension was added to the PMR scale. The PMR scale was divided into enhancing and protecting policies each with its own level of intensity as shown in figure 42. This allowed for testing relationships of type and level of competition policy implemented in the ICT sector. To test this theory a second order polynomial regression analysis was performed (see figure 26 in section 5). Even though the correlation is still in the weak to no relationship range, it can be seen in figure 26 that there is a slight inverted parabola shape to the regression curve. This can indicate that having a mix of both competition enhancing and competition protecting policies can result in a higher rate of ICT adoption. This can be substantiated by the literature review which indicated that competition enhancing policies can lead to increased competition resulting in higher innovation and productivity as well as lower prices (Majumdar, 2010) whilst competition protecting policies can protect key industries and limit anti-competitive behaviour (Hoekman & Holmes, 1999a).

Figure 42 - PMR scale with additional dimension



The significance of the correlation was also tested by converting the correlation coefficient to a t-statistic (as set out in the research methodology section) and testing for significance with a 5% confidence level. It was found that the p-value was 0.86 which is significantly higher than the 5% confidence level resulting in the rejection of the alternate hypothesis and accepting the null.

From the hypothesis result it is clear that there is no relationship between the PMR value and the rate of ICT adoption, but there are many factors that can influence ICT adoption as was seen from figure 5 and 6 in the literature review. Thus it is very possible that there is a stronger relationship between these variables but that the independent variable (competition policy implemented in the ICT sector) cannot drive the dependent variable (rate of ICT adoption) hard enough to overcome other driving factors. Unfortunately it is difficult to isolate the impacts and effects especially with secondary data that has been aggregated across so many variables and countries.

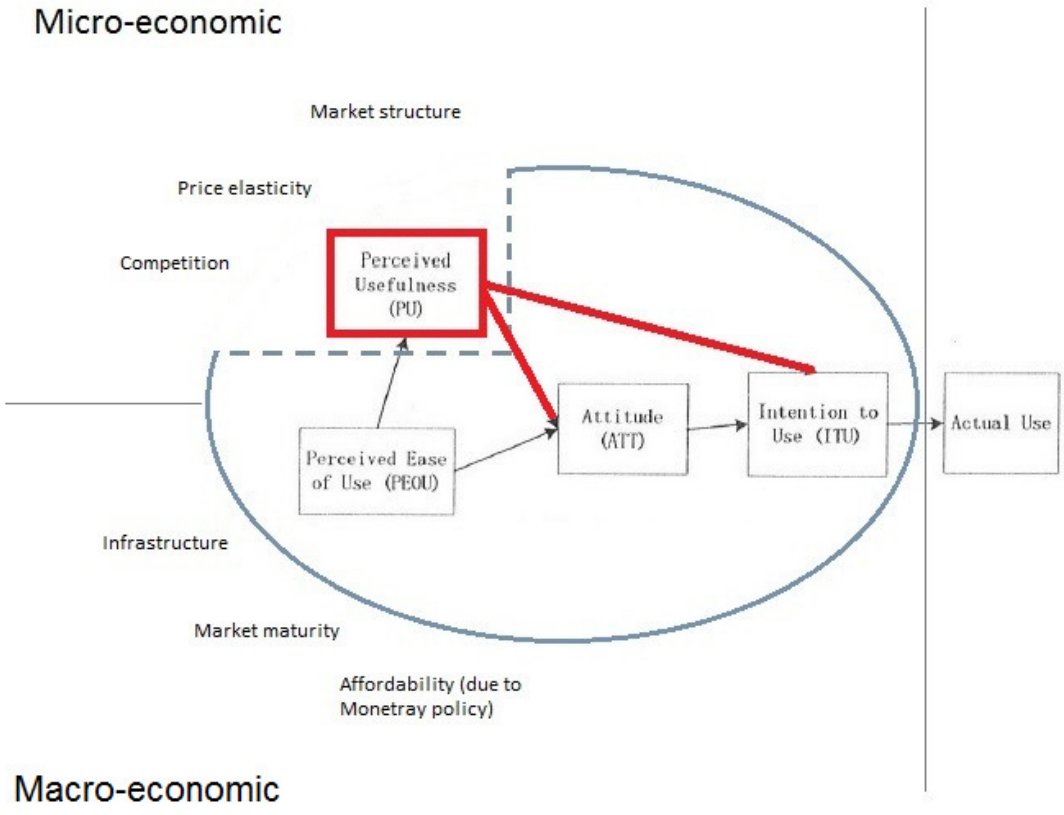
As mentioned in the results section the ICT adoption index has the possibility of skewing the results because of the inclusion of technology (e.g. internet or broadband usage) that many times rely on older fixed line infrastructure. In many economies this infrastructure is lacking which can result in lower adoption rates. Thus only mobile technology was used for the ICT adoption rate index and the same calculations (for hypothesis four) was performed. With mobile only it was found that the mean of the ICT adoption rate is almost double that of the combined ICT adoption rate index (mobile, broadband, and internet). The standard deviation is also almost three times as high using only mobile technology when compared to the combined index. This would indicate that even though the adoption rate of mobile is higher than other ICT, it is also significantly more volatile.

The regression analysis performed on the mobile only ICT adoption rate indicated that the relationship between the dependent and independent variable is almost double as strong (when comparing the correlation in table 21 and 22). Even though the correlation has double it is still for all practical reasons zero at 0.026. Thus there is no clear evidence that the internet and/or broadband technology used in the calculation of the ICT adoption index has skewed the result as the mobile only ICT adoption rate did not show any significant difference when compared to the combined ICT adoption rate index.

One of the major factors driving ICT adoption is the absolute necessity it has become in both a personal and business capacity. From the internet to mobile phones it has become the way we interact with people and businesses. It is because of this that the price sensitivity in the ICT market has dropped significantly over the past two decades. People are willing to pay substantially higher amounts to stay connected and use the latest technology.

To better comprehend this we refer back to the modified TAM model (Gong et al., 2004) and see that one of the factors driving technology adoption is perceived usefulness. This is a personal force that is less affected by the contextual forces created by competition policy. This personal force can play a significant role in the adoption process to the extent that the impact of external factors are dampened (see figure 43). This can help explain the lack of relationship between competition policy implemented in the ICT sector and ICT adoption rates.

Figure 43 - Adapted TAM model with perceived use excluded (Davis Jr, 1986)



Another aspect that can lessen the impact of contextual or external forces is herd behaviour (Sun, 2013) as described in the literature review. From Sun's research he found that there are two main reasons for herd behaviour when adopting new technology; discounting one's own information and imitating others. From the data it can be seen that there is a level of natural adoption that can occur and the results suggest that the impact competition policies have on the rate of adoption is negligible (as was found in the polynomial regression analysis in figure 26 – section 5).

6.6. Hypothesis 5 - Competition policy and ICT adoption (mobile only) relationship for developing economies

As described in the previous sections most of the developed economies have moved to competition policies that maximise competition in the ICT sector. Thus hypothesis five was specifically focused on developing economies of which many still implement competition protecting policies. Thus the last hypothesis was developed to determine if there is a relationship between the type and level of competition policy implemented in the ICT sector and the rate of ICT adoption (using only mobile technology) for developing economies. The null hypothesis stated that there is **no** relationship between these two variables whilst the alternate hypothesis stated that there **is** a relationship between them.

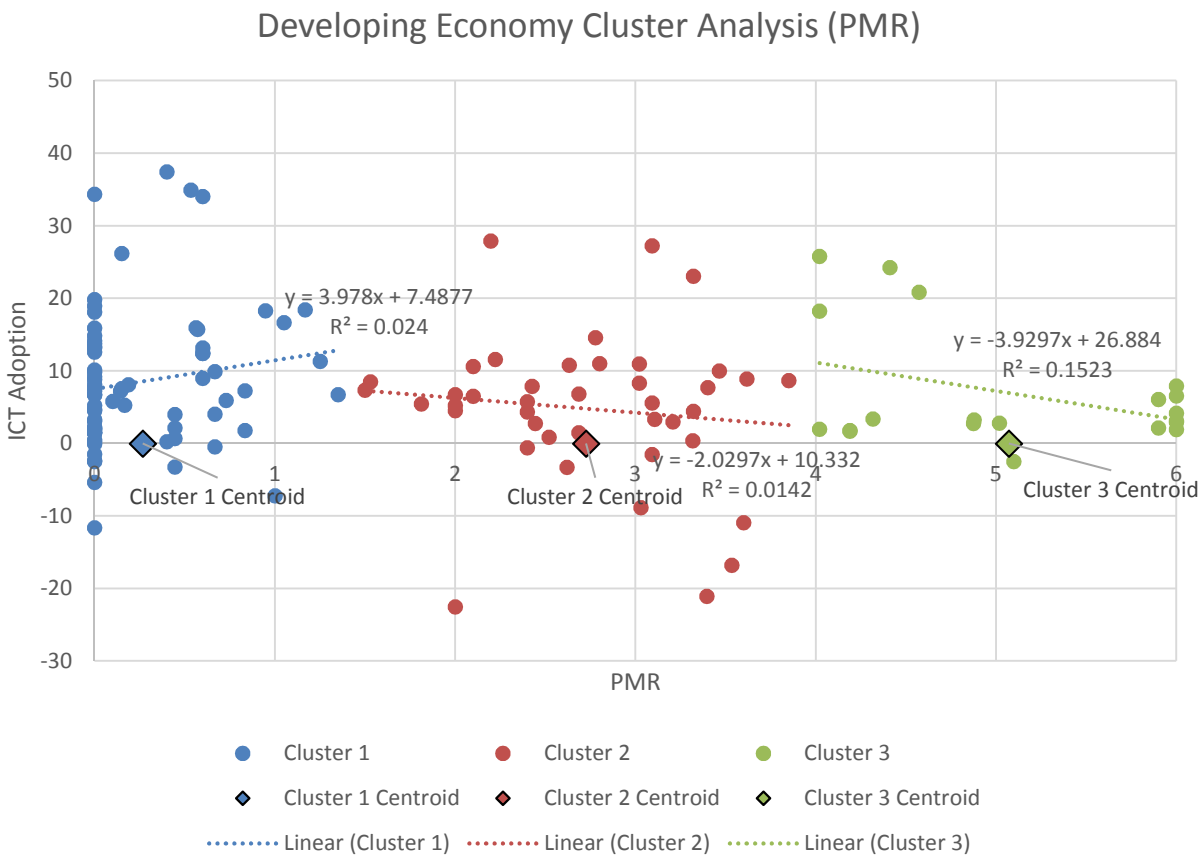
The PMR values were correlated to the mobile only ICT adoption rates for developing economies and it was found that there is a very weak or no relationship between these two groups with a correlation coefficient of -0.125. A linear regression analysis was performed on the dataset and from figure 29 (in section 5) it can be seen that there is for all practical reasons no correlation between the competition policies implemented in the ICT sector and ICT adoption rates.

It was found that even though the correlation between the dependent and independent variable is still low (when using mobile only ICT adoption rates for

developing economies) it is almost 10 times stronger when compared to using the entire sample (developed and developing economies) and the combined ICT adoption index (internet, broadband, and mobile). The correlation is also five times stronger than when using only mobile ICT adoption with the entire sample. Both these observations indicate that developing economies are more sensitive to competition policy changes when compared to developed economies and that competition policies have a higher potential to impact the rate of mobile technology adoption when compared to other technologies that may require legacy infrastructure.

To further unpack these findings a k-means cluster analysis (Neilson, 2011) was performed on the PMR indicators for the developing economies. Three clusters were created with centroids one to three shown in the figure below. A linear regression was performed on each of these clusters.

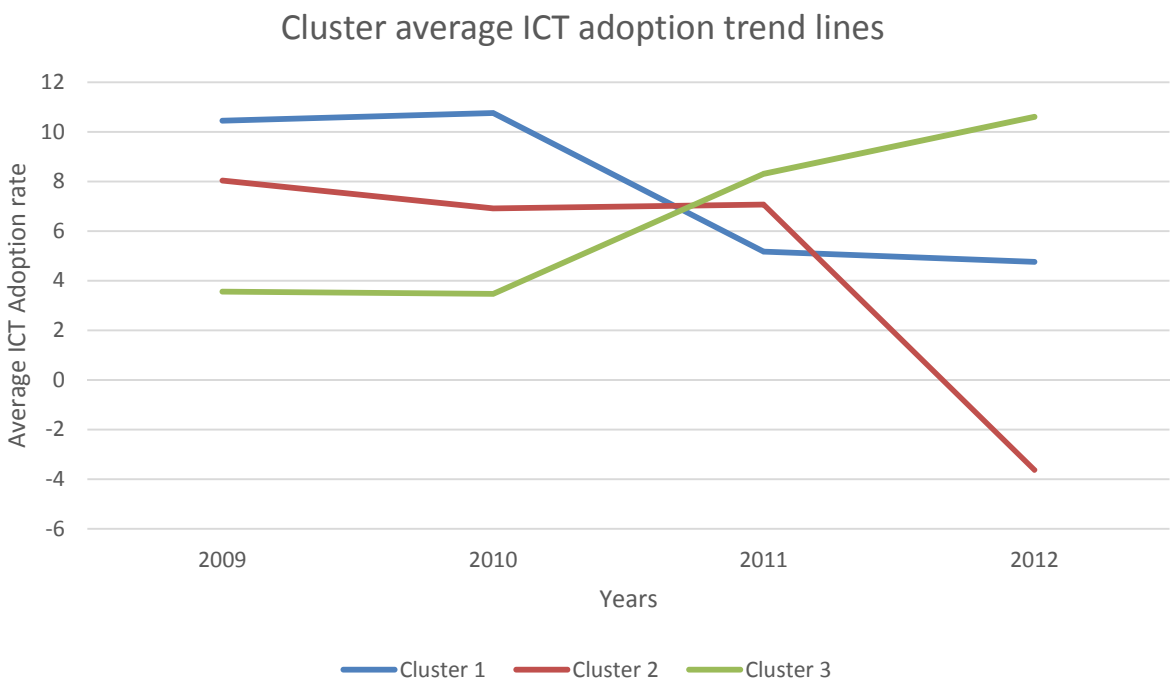
Figure 44 - K-means cluster analysis for PMR values in developing economies



From the linear regression performed on each cluster in figure 44 it was found that at both extremes there is a downward slope for the rate of ICT adoption which substantiates the previous finding that having a combination of competition enhancing and competition protecting policies can result in a higher rate of ICT adoption. It was also found that weak competition enhancing and weak competition protecting policies (when PMR value is near the centre value of 3 - refer to figure 42) result in a lower rate of mobile ICT adoption. From the regression analysis on cluster two it was found that the trend line is on average lower than the trend lines of cluster one and three.

When looking at how these clusters performed over a four year period (2009-2012) it was found that the cluster three (with the higher competition protecting policies) has increased its mobile ICT adoption rate whilst both cluster one and two (with competition policies that are more orientated towards competition enhancing) have experienced a decrease in the level of mobile ICT adoption. This is shown in figure 45 below.

Figure 45 - Cluster mobile ICT adoption trend lines



The above findings would suggest that the adoption of mobile technology in developing economies will increase over time in the presence of competition protecting policies. Achterberg (2000) indicated that historical competition protecting policies had the distinct goal of developing infrastructure and from the previous findings it was determined that ICT infrastructure can have a strong impact on competition policies. In the literature review it was also found that competition protecting policies in various developing economies are still very relevant as it can assist with the development of ICT infrastructure ensuring public services are affordable and available (Jan & Wang, 2010).

7. Conclusion

The research report set out to determine the impact competition policies (in the ICT sector) has on the rate of ICT adoption. As indicated by Schröder (2011) and numerous other researches, ICT is a key driver of employment, growth, and innovation in various economic sectors. ICT (in the form of mobile phones) allows for customers and users to interact in efficient ways which was historically never possible. This in itself has numerous positive secondary affects. The M-PESA success story in Kenya is a perfect example of how ICT can address numerous social and economic issues to better the lives of a country's citizens (Maurer, 2012b). Thus it is important to understand how to maximise the adoption of ICT especially in the case of developing economies.

7.1. Research findings

To achieve the research objectives set out in section 1.3 the report developed five hypothesis that will assist in investigating and better understanding how developing and developed economies implement competition policies in the ICT sector, how the different types of policies impact the rate of ICT adoption, and if there is in fact a relationship between the rate of ICT adoption and the type and level of competition policy implemented.

From the literature review it was determined that both competition enhancing and competition protecting policies in the ICT sector can have positive and negative effects on ICT adoption. Whilst competition enhancing policies might increase competition that can lead to lower prices and innovation (Achterberg, 2000) it can also lead to anti-competitive behaviour (e.g. price wars) that can damage and even destroy local industries (Musetescu, 2012; Singleton, 1997). Competition protecting policies on the other hand can protect key industries that will allow the market to develop resulting in infrastructure expansion (Achterberg, 2000), but it can also lead to inefficient businesses lowering innovation and customer choice (Singleton, 1997).

The dataset used to measure competition policy type and level was extracted from the ITU regulation information dataset (see Appendix A for the web links). To measure the type and level of competition policy the report used an algorithm developed by the OECD that would incorporate entry policies, market structure, and private/public participation in the industry (see Appendix B for the calculation). The dataset used to measure ICT adoption was extracted from the World Bank ICT database (see Appendix B for the web links). To measure the level of ICT adoption the calculated users of mobile, internet, and broadband were averaged followed by a first order differentiation across one year.

The first hypothesis was developed to determine if developing economies implement, on average, competition policies in the ICT sector that is more orientated toward protection of key entities and/or businesses or more toward enhancing competition in the industry. The statistical analysis found that there is a significant difference between the PMR scale mid-point (which indicates that a country has implemented the same amount of competition enhancing and competition protecting policies) and the PMR mean value of developing economies in the sample.

The mean also showed that developing economies, on average, are more likely to implement competition enhancing policies than competition protecting policies in the ICT sector. It was also clear that there was a large spread of PMR values when compared to developed economies (results from hypothesis 2) indicating that even though the majority of developing nations implement competition enhancing policies there are still numerous developing economies implementing competition protecting policies. In the results and literature review it was determined that two of the major factors that can contribute toward the level of competition enhancing policies implemented (in the ICT sector), is the different levels of competition in this industry and the global movement towards privatisation and liberation of previous SOEs.

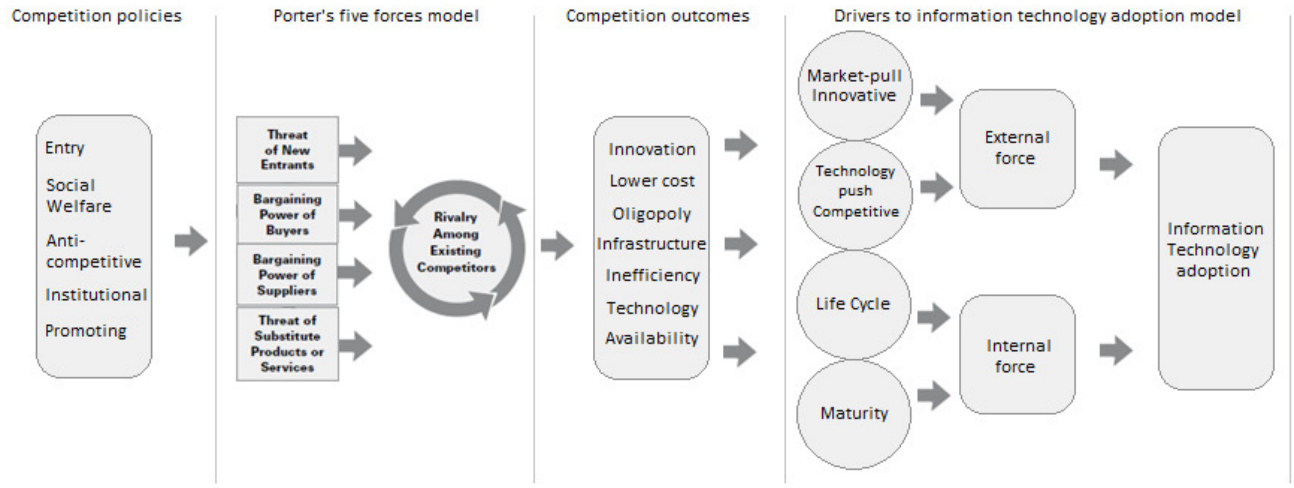
The second hypothesis was developed to repeat the analysis of the first hypothesis but for developed economies. Thus the report set out to determine if developed economies implement, on average, competition policies in the ICT

sector that is more orientated toward protection of key entities and/or businesses or more toward enhancing competition in the industry. The statistical analysis found that there is also a significant difference between the PMR scale mid-point (which indicates that a country has implemented the same amount if competition enhancing and competition protecting policies) and the PMR mean value of the developed economies in the sample.

The mean of the developed economy group in the sample again indicated a preference toward implementing competition enhancing policies in the ICT sector. When comparing this to the mean of the developing economy group it was found that developed economies, on average, have a significantly lower PMR value indicating a higher probability of implementing competition enhancing policies. It was determined that the major contribution factor that could have impacted the type and level of competition policy implemented is the fact the developed economies have more establish infrastructure which can be used to leverage the benefits of increased competition (Brown & Thompson, 2011).

The third and fourth hypothesis was developed to address the core objectives of the research report. In the literature review is was found that there are conflicting views regarding the impact of competition on the economic environment. Achterberg (2000) believed that increased competition will benefit the economic environment whilst Musetescu (2012) stated that an unprotected market, free to unregulated competition, will see lowering of social welfare due to self-enrichment. These statements were based on general competition, but this report has focused these conflicting views on the ICT sector. In the literature review the framework linking competition policy and ICT adoption was created (as shown below in figure 46) which allowed the report to investigate the indirect impact of competition policy (in the ICT sector) on the rate of ICT adoption.

Figure 46 - Competition policy framework to ICT adoption



Hypothesis three would determine if either competition enhancing or competition protecting policies in the ICT sector will result in a higher level of ICT adoption. From the sample two groups were formed. The first are countries that have stronger competition enhancing policies implemented in their ICT sector whilst the second group is more orientated towards competition protection in the ICT sector. The result found that there was no significant difference in the level of ICT adoption between the two groups indicating there is no clear evidence that implementing either competition enhancing or competition protection policies in the ICT sector would result in higher ICT adoption.

The fourth hypothesis confirmed this by indicating that there is for all practical purposes no relationship between the type and level of competition policy (in the ICT sector) and the level of ICT adoption. Both a linear regression and second order polynomial regression analysis was done with practically the same result. It was found that the polynomial analysis showed a slight inverse parabola that provides evidence that having a mix of competition enhancing and competition protecting policies in the ICT sector could result in a marginally higher level of ICT adoption.

The last hypothesis was focused around mobile technology and developing economies. This is because most of the developed economies have already

moved to competition enhancing policies that aim to maximise competition in the ICT sector. Mobile technology was the only variable that was used in the ICT adoption rate calculation as many developing economies lack historical infrastructure which could affect the adoption rate of the other variables used in the ICT adoption rate index calculation (broadband and internet usage). This hypothesis again proved that there is no clear evidence that there is a relationship between competition policy and ICT adoption. It was also found that having a mixture of competition enhancing and competition protecting policies in developing economies result in the highest level of mobile adoption, but at either extreme of the additional dimension (shown in figure 42), i.e. a policy that is too strong or too weak, can result in a lower mobile adoption rate.

Hypothesis five provided evidence that implementing competition protecting policies in the ICT sector of developing economies can result in increased mobile adoption rates when compared to competition enhancing policies. From the literature review and results it was found that telecommunication infrastructure can play a significant role in ICT adoption and thus having competition protecting policies in developing economies (in need of ICT infrastructure) can assist in increasing the level of ICT (mobile only) adoption (Achterberg, 2000).

From the literature review and results it was also found that the environment or context of the implemented policies plays an important role to determine the impact level of competition policies on the rate of ICT adoption. For example Brown & Thompson (2011) found that infrastructure plays an important role to maximise the benefits of increased competition (an output of competition enhancing policies) which was confirmed in the results.

To summarise the major findings of the research:

- Both developed and developing economies, on average, implement competition enhancing over competition protecting policies in the ICT sector with developed economies implementing a higher level of competition enhancing policies when compared to developing economies.

- No clear evidence was found that there is a relationship between competition policies in the ICT sector and the level of ICT adoption. There was also no clear evidence found that competition enhancing policies result in a higher level of ICT adoption when compared to competition protecting policies and vice versa.

- The impact that competition policy can have on the rate of ICT adoption can be minimised by other more pertinent factors of technology adoption.

- Contextual and environmental aspects (e.g. maturity of ICT infrastructure) can play an important role in determining which policies to implement to maximise benefits of competition policy outcomes.

7.2. Future research

From the research it was clear that there are numerous other related fields that require further studying. Due to the time constraints of this report most of these additional fields have been omitted from the research, but would still present an opportunity to add to the body of knowledge.

The first is to determine if regulatory institutions can alter the current research result. Many of the policies implemented are only as effective as the institution regulating and enforcing it.

The second additional research would be to determine why certain countries move from a full competition enhancing policy ICT structure to competition protecting structure. From the data is was seen that certain developed and developing economies do this, but there was no apparent reason for this change. The data suggested that due to modern day economics and privatisation most countries would not return to any form of competition protecting policies once full competition enhancing policies have been implemented.

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9. Appendix A – ITU datasets

Table 31 - ITU datasets

Dataset	Year	Link
Level of competition dataset	2009	http://www.itu.int/net4/itu-d/icteye/FocusAreas.aspx?paramWorkArea=TREG
Sector structure – private sector participation dataset	2009	http://www.itu.int/net4/itu-d/icteye/FocusAreas.aspx?paramWorkArea=TREG
Level of competition dataset	2010	http://www.itu.int/net4/itu-d/icteye/FocusAreas.aspx?paramWorkArea=TREG
Sector structure – private sector participation dataset	2010	http://www.itu.int/net4/itu-d/icteye/FocusAreas.aspx?paramWorkArea=TREG
Level of competition dataset	2011	http://www.itu.int/net4/itu-d/icteye/FocusAreas.aspx?paramWorkArea=TREG
Sector structure – private sector participation dataset	2011	http://www.itu.int/net4/itu-d/icteye/FocusAreas.aspx?paramWorkArea=TREG
Level of competition dataset	2012	http://www.itu.int/net4/itu-d/icteye/FocusAreas.aspx?paramWorkArea=TREG
Sector structure – private sector participation dataset	2012	http://www.itu.int/net4/itu-d/icteye/FocusAreas.aspx?paramWorkArea=TREG

10. Appendix B – World Bank datasets

Table 32 - World Bank datasets

Dataset	Year	Link
Fixed broadband internet subscriptions	2009-2013	http://data.worldbank.org/indicator/IT.NET.BBND.P2
Mobile cellular subscriptions	2009-2013	http://data.worldbank.org/indicator/IT.CEL.SETS.P2
Internet users	2009-2013	http://data.worldbank.org/indicator/IT.NET.USER.P2

11. Appendix C – OECD PMR calculation

Figure 47 - OECD PMR telecommunications services

B. Indicator for telecommunications services

	Weights by theme (b_j)	Question weights (c_k)[1]	Coding of data		
Entry regulation:	1/4		Free entry	Franchised to 2 or more firms	Franchised to 1 firm
What are the legal conditions of entry into the trunk telephony market?		$1/4*w^t*(1-w^m)$	0	3	6
What are the legal conditions of entry into the international market?		$1/4*(1-w^t)(1-w^m)$	0	3	6
What are the legal conditions of entry into the mobile market?		$1/2*w^m$	0	3	6
Public ownership:	1/4				
What percentage of shares in the PTO are owned by government?[2]		$1-w^m$		% government ownership / 100 * 6	
What percentage of shares in the largest firm in the mobile telecommunications sector are owned by government?		w^m		% government ownership / 100 * 6	
Market structure:[3]	1/4				
What is the market share of new entrants in the trunk telephony market?		$1/4*w^t*(1-w^m)$		6-normalised market share[2]	
What is the market share of new entrants in the international telephony market?		$1/4*(1-w^t)(1-w^m)$		6-normalised market share	
What is the market share of new entrants in the mobile market?		$1/2*w^m$		6-normalised market share	
Country scores (0-6)				$\sum_j b_j \sum_k c_k$ answer$_{jk}$	

12. Appendix D – World Bank developing and developed economies

Africa	The Americas	Arab States	Asia & Pacific	CIS	Europe
Angola	Antigua & Barbuda	Algeria	Afghanistan	Armenia	Albania
Benin	Argentina	Bahrain	Australia	Azerbaijan	Andorra
Botswana	Bahamas	Comoros	Bangladesh	Belarus	Austria
Burkina Faso	Barbados	Djibouti	Bhutan	Georgia	Belgium
Burundi	Belize	Egypt	Brunei Darussalam	Kazakhstan	Bosnia and Herzegovina
Cameroon	Bolivia	Iraq	Cambodia	Kyrgyzstan	Bulgaria
Cape Verde	Brazil	Jordan	China	Moldova	Croatia
Central African Rep.	Canada	Kuwait	Dem.People's Rep. of Korea	Russian Federation	Cyprus
Chad	Chile	Lebanon	Fiji	Tajikistan	Czech Republic
Congo (Rep. of the)	Colombia	Libyan Arab Jamahiriya	India	Turkmenistan	Denmark
Congo (Dem. Rep.)	Costa Rica	Mauritania	Indonesia	Ukraine	Estonia
Côte d'Ivoire	Cuba	Morocco	Iran (Islamic Republic of)	Uzbekistan	Finland
Equatorial Guinea	Dominica	Oman	Japan		France
Eritrea	Dominican Rep.	Qatar	Kiribati		Germany
Ethiopia	Ecuador	Saudi Arabia	Korea (Rep. of)		Greece
Gabon	El Salvador	Somalia	Lao P.D.R.		Hungary
Gambia	Grenada	Sudan	Malaysia		Iceland
Ghana	Guatemala	Syrian Arab Republic	Maldives		Ireland
Guinea	Guyana	Tunisia	Marshall Islands		Israel
Guinea-Bissau	Haiti	United Arab Emirates	Micronesia		Italy
Kenya	Honduras	Yemen	Mongolia		Latvia
Lesotho	Jamaica		Myanmar		Liechtenstein
Liberia	Mexico		Nauru		Lithuania
Madagascar	Nicaragua		Nepal		Luxembourg
Malawi	Panama		New Zealand		Malta
Mali	Paraguay		Pakistan		Monaco
Mauritius	Peru		Papua New Guinea		Montenegro
Mozambique	Saint Kitts and Nevis		Philippines		Netherlands
Namibia	Saint Lucia		Samoa		Norway
Niger	Saint Vincent and the Grenadines		Singapore		Poland
Nigeria	Suriname		Solomon Islands		Portugal
Rwanda	Trinidad & Tobago		Sri Lanka		Romania
Sao Tomé & Principe	United States		Thailand		San Marino
Senegal	Uruguay		Timor-Leste		Serbia
Seychelles	Venezuela		Tonga		Slovakia
Sierra Leone			Tuvalu		Slovenia
South Africa			Vanuatu		Spain
South Sudan			Viet Nam		Sweden
Swaziland					Switzerland
Tanzania					The Former Yugoslav Rep. of Macedonia
Togo					Turkey
Uganda					United Kingdom
Zambia					Vatican
Zimbabwe					

Developed	Developing		
Albania	Afghanistan	Gambia	Northern Marianas
Andorra	Algeria	Georgia	Oman
Australia	American Samoa	Ghana	Pakistan
Austria	Angola	Grenada	Palau
Belarus	Anguilla	Guam	Palestinian Authority
Belgium	Antigua & Barbuda	Guatemala	Panama
Bermuda	Argentina	Guinea	Papua New Guinea
Bosnia and Herzegovina	Armenia	Guinea-Bissau	Paraguay
Bulgaria	Aruba	Guyana	Peru
Canada	Azerbaijan	Haiti	Philippines
Croatia	Bahamas	Honduras	Puerto Rico
Czech Republic	Bahrain	Hong Kong, China	Qatar
Denmark	Bangladesh	India	Rwanda
Estonia	Barbados	Indonesia	Sao Tomé & Principe
Faroe Islands	Belize	Iran (Islamic Republic of)	Samoa
Finland	Benin	Iraq	Saudi Arabia
France	Bhutan	Israel	Senegal
Germany	Bolivia	Jamaica	Seychelles
Greece	Botswana	Jordan	Sierra Leone
Greenland	Brazil	Kazakhstan	Singapore
Hungary	British Virgin Islands	Kenya	Solomon Islands
Iceland	Brunei Darussalam	Kiribati	Somalia
Ireland	Burkina Faso	Korea (Rep. of)	South Africa
Italy	Burundi	Kuwait	Sri Lanka
Japan	Cambodia	Kyrgyzstan	Saint Kitts and Nevis
Latvia	Cameroon	Lao P.D.R.	Saint Lucia
Liechtenstein	Cape Verde	Lebanon	Saint Vincent and the Grenadines
Lithuania	Cayman Islands	Lesotho	Sudan
Luxembourg	Central African Rep.	Liberia	Suriname
Malta	Chad	Libyan Arab Jamahiriya	Swaziland
Moldova	Chile	Macao, China	Syrian Arab Republic
Monaco	China	Madagascar	Taiwan, Province of China**
Montenegro	Cocos Keeling Islands	Malawi	Tajikistan
Netherlands	Colombia	Malaysia	Tanzania
New Zealand	Comoros	Maldives	Thailand
Norway	Congo (Rep. of the)	Mali	Timor-Leste
Poland	Congo (Dem. Rep.)	Marshall Islands	Togo
Portugal	Cook Islands	Mauritania	Tokelau
Romania	Costa Rica	Mauritius	Tonga
Russian Federation	Côte d'Ivoire	Mayotte	Trinidad & Tobago
San Marino	Cuba	Mexico	Tunisia
Serbia	Cyprus	Micronesia	Turkey
Slovakia	Dem.People's Rep. of Korea	Mongolia	Turkmenistan
Slovenia	Djibouti	Montserrat	Turks & Caicos Is.
Spain	Dominica	Morocco	Tuvalu
Sweden	Dominican Rep.	Mozambique	Uganda
Switzerland	Ecuador	Myanmar	United Arab Emirates
The Former Yugoslav Rep. of Macedonia	Egypt	Namibia	Uruguay
Ukraine	El Salvador	Nauru	Uzbekistan
United Kingdom	Equatorial Guinea	Nepal	Vanuatu
United States	Eritrea	Neth. Antilles	Venezuela
	Ethiopia	New Caledonia	Viet Nam
	Falkland (Malvinas) Is.	Nicaragua	Virgin Islands (US)
	Fiji	Niger	Yemen
	French Polynesia	Nigeria	Zambia
	Gabon	Niue	Zimbabwe