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# Transition of direct public policy toward broadband: A multi-country analysis

Mingchan Cheng<sup>†</sup>

**Abstract:** The process of liberalization and privatization of telecommunications in the 1980s, during which attention was focused on opening up the sector, led to a consensus on entrusting infrastructure financing entirely to the market. Hence, direct public intervention was ruled out and the role of policymakers was limited to regulatory actions. Regulatory interventions are designed by independent regulatory authorities, supervising firms with significant market power. However, when expansion of broadband services was targeted, the high cost of broadband line construction and the low propensity of providers to invest in rural and peripheral areas once again placed the issue of financing telecommunications networks into the hands of policymakers. How the interventions should be implemented became the issue of the debate. Previous studies offer conflicting results regarding the timing and interaction between demand-side and supply-side policies, mainly because the specific conditions and the context in which these tools are applied matter. Thus, by considering the time dimension, this study examines the direct public policies adopted in selected countries and describes how those policies have developed.

**Keywords:** broadband penetration, direct public intervention

## 1 . Introduction

The benefits of broadband use have been widely realized, and broadband diffusion is one of the top items considered in information and communications technology (ICT) public policies worldwide. Broadband penetration is an essential feature in communications infrastructure policy and is treated as a critical economic indicator currently. A World Bank 2009 report on ICT calculates that, for every 100 inhabitants, every additional 10 broadband subscribers correlates with GDP growth, with high income countries seeing GDP growth increases of 1.21% and low- and middle-income countries seeing even higher GDP growth increases of 1.38% (Ovum Consulting, 2009). As early as 2004, the OECD Council adopted the *Recommendation of the Council on Broadband Development*, which calls on member countries to implement a set of policy principles to assist the expansion of broadband markets, promote efficient and innovative supply arrangements, and encourage effective use of broadband services (OECD, 2008). Stimulating

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broadband and ultra-broadband penetration has been a key objective for policymakers in developed as well as less developed countries.

Although all countries could benefit from using broadband, broadband penetration varies widely among countries (Figures 1). A number of countries have developed modern broadband networks—allowing for fast and superfast access to information services—but broadband adoption rates remain low compared to its high availability. Given the crucial importance of broadband for business activities and economic development in general (Zhao and Ruan, 2009; BCDD, 2011), grasping the precise reason broadband connections are still prone to patchy diffusion across countries is a challenging issue for researchers and policymakers.

The level of broadband development and the growth rate of broadband penetration are the complex outcomes of many complementary factors, ranging from socio-economic determinants (including not only income, location, education, family size, individuals' characteristics, but also market structure, technological endowments, and other factors) and regulatory actions (indirect policy) to non-regulatory interventions (direct public policy interventions) (Figure 2).

Socio-economic drivers (i.e., demand-side determinants) of broadband adoption have been highlighted in several studies addressing three main issues: adoption and usage (Chaudhuri and Flamm, 2007; Rappaport et al., 2003; GAO, 2006), rural/urban digital divide (Preston et al., 2007), and medium adoption (the interaction between fixed and mobile broadband) (Bohlin and Westlund, 2008; Hauge et al., 2009). With respect to regulatory factors, Cambini and Jiang (2009) provide a comprehensive literature review of broadband investment and regulation. And the present study focuses on non-regulatory factors, that is, the direct forms of public policy interventions in broadband diffusion (e.g. the financing of an electronic communications network).

Worldwide, countries have been pursuing public policies to promote broadband uptake and the upgrade of existing networks (the ambitious government strategy—National Broadband Network (NBN)—in Australia, for instance). However, the performance of these policies remains to be fully examined. Only a handful of studies have specifically investigated the effectiveness of public policies for broadband promotion, and their conclusions are inconsistent. Furthermore, most of these are qualitative research - empirical studies are rare. Thus, this study further examines the effectiveness of direct public policies and the process of broadband diffusion.

The remainder of this paper is organized as follows. Section 2 presents a survey of the literature on direct public intervention, broken into three main categories: the debate on government intervention in broadband diffusion; categorization of government interventions, focusing on the means by which public policy can directly affect the development of broadband; and the influence of public policy on broadband diffusion, addressing the effectiveness of direct public policy. An analytical framework for ICT innovations diffusion is discussed in Section 3. Section 4 provides a comparative study on broadband policy in the UK (United Kingdom),

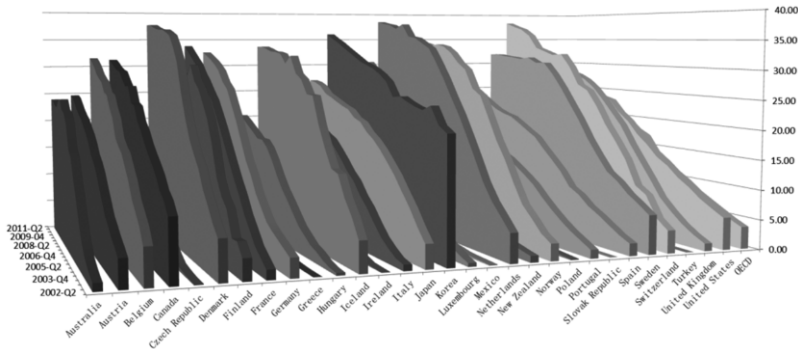


Figure 1 OECD Fixed (wired) broadband penetration rates (2002–2011)  
 Source: OECD, 2012

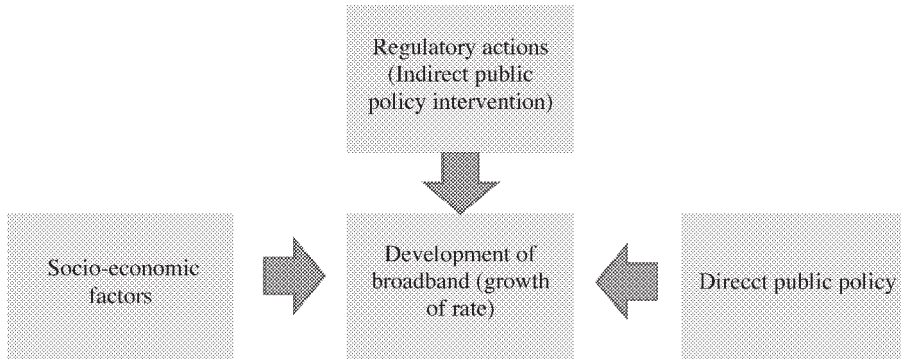


Figure 2 Factors influencing development of broadband

Sweden, South Korea, and Australia, followed by a discussion on the implementation of direct government interventions in the broadband market in these countries. Section 5 presents this study’s hypotheses and conclusions.

## 2 . Literature review

Numerous studies have shown the social and economic benefits of a broadband infrastructure (Ford and Koutsk, 2005; Lee and Yougwoon, 2005). Broadband has the potential to improve a nation’s quality of health services, education levels, connectedness of its government with the public, employment opportunities, and prosperity (Firth and Mellor, 2005). Some of the activities enabled by broadband include distance healthcare, education, social relations, and entertainment; its immediate benefits include synchronous e-learning, e-government, tele-medicine (e.g., tele-radiology), the creation of Internet communities, and online gaming (Majumdar et al., 2010).

Consequently, countries worldwide have been undertaking public policies to increase broadband uptake and to upgrade existing networks. However, many studies have focused on the broadband infrastructure in regions, laying particular emphasis on either availability or regulations—that is, supply-side issues of broadband (Preston et al., 2007; Falch and Henten, 2010). Fewer studies consider the related direct public policies and broadband demand (Firth and Mellor, 2005; Teppayayon and Bohlin, 2009; Hauge and Prieger, 2010). As such, more attention should be paid to the influence of direct public policy. I now provide an in-depth review of the existing literature on direct public intervention in the promotion of broadband.

### 2.1 The rationale for direct public intervention

Historically, the state has played a leading role in the electronic communications sector in most countries, with the telecommunications infrastructure developed and managed by state-owned organizations in a legal monopoly regime. However, since the second half of the 1980s, the process of liberalization and privatization has affected the electronic communications sector in many countries (Belloc et al., 2012), starting with the reduction in the role of state. This role reduction is mainly attributed to the governments' realization of two major problems with the operations of the regulated service-providing monopolies: (1) Service was relatively poor, and it did not improve at the pace of technological advance made in these industries. (2) Regulators failed to control prices and other charges levied on consumers (Shy, 2001). Against this background, where attention was focused primarily on opening up the market, a consensus favored the idea that infrastructure financing should be entrusted entirely to the market. Direct public intervention was ruled out, and the role of policymakers was limited to regulatory actions designed by independent regulatory authorities supervising firms with significant market power. This view was dominant until a few years ago, implying that broadband emerged in an environment of competition rather than monopoly, and that every broadband provider has from the beginning faced actual or imminent competition. However, that view is now evolving again (Cave and Iain, 2010). The high cost of broadband line construction and the low propensity of providers to invest in rural and peripheral areas once again placed the issue of financing telecommunications networks in the hands of policymakers (OECD, 2008).

In short, when broadband has been targeted, policies seem to step back to the first era of the telecommunications market, which was dominated by government. Thus, the debate focuses not on whether public players should intervene, but on how their interventions should be designed and implemented instead.

### 2.2 Categorizations of direct government intervention

A wide range of policy tools has been adopted in the promotion of broadband. There are also

a number of categorizations of the forms of policy interventions available to governments for broadband promotion.

A study in 2011 by FSR (Florence School of Regulation) ) categorized the supply-side policy tools according to their primary objective, distinguishing between (1) policies aimed at reducing private operators' costs of deployment, including rule-making, fiscal incentives, and long-term loans; (2) policies aimed at enhancing private operators' access to the market, comprising spectrum policies and territorial mapping; and (3) interventions that involve the direct development of broadband infrastructures by public bodies, including investment in the construction of backbone network, creation of a public information infrastructure, and provision of broadband services through municipal utilities. The demand-side policy tools are categorized between: (1) policies aimed at increasing the perceived value of broadband services; and (2) policies aimed at reducing the cost of access to broadband service, including targeted subsidy/tax reductions, demand measurement, and demand aggregation policies.

A study by the World Bank proposes that broadband be viewed as an interconnected, multilayered "ecosystem" that includes its networks, the services that the networks carry, the applications they deliver, and users (Kim et. al., 2010). Each of these elements depends on high-speed connectivity and has been transformed by technological, business, and market developments.

Another key framework is proposed by King et al. (1994). The researchers used the institutional theory to examine government intervention in ICT diffusion. Their model is constructed on two dimensions of potential institutional action: influence and regulation with which institutions might exert supply-push and demand-pull forces, providing a context for government actions. They claim that government intervention can be either influential or regulatory. Influence is the persuasive power that an institution imposes on the practices, rules, and belief systems of those under its sway. Regulation is direct or indirect intervention in the behavior of those under the institution's influence. Under supply-push, intervention concentrates on stimulating the production and application of the innovative product or process itself. Under demand-pull, interventions focus on mobilizing acquisition of the potential demand of the innovative product. The researchers classified these actions into six general kinds: knowledge building, knowledge deployment, subsidy, mobilization, standard setting, and innovation directive. Based on the framework they provided, Choudrie and Papazafeiropoulou (2006) examine the institutional actions taken by the South Korea government and finds that the aggressive broadband diffusion strategy of the Korean government was phenomenally successful, leading to the deployment of a heavy regulatory framework and support of the demand-pull forces. A later study (Choudrie and Papazafeiropoulou, 2007), incorporated a time dimension into the same framework and found that there was a move from influential, supply-push strategies that allowed competition

to lead the market to more aggressive, demand-pull policies that allowed stronger regulation development in broadband policies in the UK. This change in approach is mainly attributed to the fact that as the government's goal had remained unapproachable with the broadband uptake being relatively low under the initial strategies, the government looked at developing educational programs that enforced the demand-pull while also taking the regulation of the vendors into account.

Trkman and Turk (2009) expand on the main framework of King et al. (1994). In this approach, instead of distributing actions into influence and regulation, first, the supply-side and demand-side are distributed into social and economic activities; next, the actions are distributed based on their influencing factors, namely, enablers and means, usage of information services, and ICT sector environment.

The above literature highlights that public policies generally fall into one of two groups: supply-side policies that primarily intend to increase broadband deployment and demand-side policies that largely work to promote broadband adoption. Thus, in order to examine the transition of direct public policies, according to the targets of a certain program, this study reviews the main forms of these interventions. Since this study focuses on direct public policy of fixed-line broadband, regulatory measures and wireless broadband market will not be covered.

### 2.3 Influence of direct public intervention

The first category of existing studies on the influence of direct public intervention focuses on whether public policies have significant influence on broadband adoption; their results are inconsistent. An empirical study by Bauer et al. (2003), analyzing data on 30 OECD countries of 2001, shows that variables related to public intervention do not turn out to be statistically significant. Furthermore, Aizu (2002), through a more qualitative comparative research of broadband diffusion in Asia, similarly reports that government policies do not have much influence in promoting broadband use. In contrast, a qualitative study by Troulos and Maglaris (2011) find an optimistic conclusion on the influence of public policies. In addition, a comparative study on broadband policy among EU countries by Bohlin and Teppayayon (2010) also suggest that public intervention can be an effective tool under certain conditions.

The second category of studies concentrates on how the intervention should be implemented. A case study by Youtie et al. (2007) finds that a combination of demand-side and supply-side interventions leads to more effective results than adopting only supply-side measures, because network availability per se does not stimulate demand, and emphasizes the indispensability of demand-side policies to stimulate broadband uptake. Similar conclusions are reached by Troulos and Maglaris (2011). Furthermore, the literature on network effects (Katz and Shapiro, 1994) concludes that the mere availability of broadband connections, ensured through supply-side



policies, may not be sufficient to stimulate effective adoption. Shim et al. (2006) finds that both Sweden and South Korea have experienced successful interventions and, while they have each exhibited different approaches, both share a commitment to demand-side intervention as well as robust competition and other supply-side factors. Hauge and Priedger (2010) point out that demand-side policies aimed at increasing potential subscribers' perceived value of broadband and/or at decreasing the cost of access to broadband connections may help ensure broadband adoption. A later qualitative study by Belloc et al. (2012), covering 30 OECD countries over the period 1995–2010, shows that while both supply-side and demand-side policies have a positive effect on broadband penetration, their relative impact depends on the actual stage of broadband diffusion.

In fact, the sequence with which supply-side and demand-side policies are adopted has captured researchers' attention. The econometric model in Belloc et al. (2012) finds that effectiveness is greatest when supply-side policies come first and demand-side policies follow. Moreover, when infrastructure is underdeveloped, investing in demand-side policies is likely to be useless. In contrast, Choudrie and Papazafeiropoulou (2007) find that, in Korea, as the broadband market matures, the government is moving from a regulatory demand-pull strategy to a less assertive policy approach, focusing on supply-push. That means that the Korea case, which is regarded as the best practice, seems to go against the results of the empirical research.

Thus, this study has two main objectives. It re-examines the direct public policies of the UK, Sweden, South Korea, and Australia, working under the assumption that direct public policies, both supply-side and demand-side, can positively affect broadband diffusion. Furthermore, it discusses the question, "is the diffusion of broadband likely to be from demand-constraint or from supply-constraint?"

### 3 . An analytical framework for ICT innovations diffusion

One approach for examining the government's role in ICT diffusion is proposed by King et al. (1994), as mentioned in Section 2.2. Table 1 describes this classification in detail.

To focus on direct public policies, I use King et al.'s framework, utilizing the influence dimension. Specifically, I examine how the UK, South Korea, Sweden, and Australia have used certain policy measures to diffuse the broadband technology.

Broadband is considered to be an innovation product—distinct from an invention, since invention refers to technology actually being used or applied for the first time (Utterback, 1974).

In technological context, the drivers of innovation (that is, demand-pull), whether they arise from market demand or technological shifts, have been universally argued in academic research. However, the definition used in the technology-push<sup>1)</sup> and demand-pull (TPDP) spectrum across



Table 1 Dimensions of institutional intervention  
Supply-push demand-pull

Influence	Knowledge building Funding of research projects Knowledge deployment Provision of education services Subsidy Funding development of prototypes Encouragement of capital markets to support R&D activity Provision of tax benefits for investment in R&D Innovation directive Direct institutional operation of production facilities for innovation I	Knowledge deployment Training programs for individuals and organizations to provide base of skilled talent for use Subsidy Procurement of innovative products and services Direct or indirect provision of complementarities required for use Mobilization Programs for awareness and promotion II
Regulation	III Knowledge deployment Require education and training of all citizens Subsidy Reduction in general liabilities for organizations engaging in innovative activity Modification of legal, administrative, or competitive barriers to innovation and trade Standard setting Establishment of standards under which innovative activity might be encouraged Innovation directive Establishment of requirements for investment in R&D by organization	IV Subsidy Procurement support for products and processes that facilitate adoption and use Standards setting Require particular products or processes to be used in any work for the institution Require conformance with other standards that essentially mandate use of particular products or processes Innovation directive Require that specific innovative products or processes be used at all times

Source: King et al., 1994, p. 151

the push and pull sides are inconsistent. For instance, at the firm level, demand-pull is divided into two types: internal demand-pull and external demand-pull. Internal demand-pull forces are derived from primary stakeholders including top management, functional departments, and users who seek innovative opportunities in IT, while external demand-pull arises because organizations adopt information technologies in the anticipation of positioning themselves in markets (Drury and Farhoomand, 1999). Furthermore, even based on the framework proposed by King et al. (1994), the understanding of demand-pull varies throughout the research. One study, analyzing from institutional perspective within the framework proposed by King, examines how government agencies alter the context around the production and diffusion of technologies (Lin and Chiasson, 2008). This research defines demand-pull as demand that emerges from the provision of resources to support organizational preferences. In other words, the target of demand-side

1) Supply-push is referred to as technological-push within the IT literature, which is created by the advent of new technologies (Drury and Farhoomand, 1999).

policy is an organization instead of the end-user, which is consistent with the study of Drury and Farhoomand (1999). In contrast, Choudrie and Papazafeiropoulou (2007) examine the impact of the UK government's policies on broadband adoption and uses the definition of demand-pull in King's paper, in which demand-side intervention concentrates on spurring the users' acquisition of innovations.

However, this study adheres to the description of demand-pull by King et al. (1994), whereby the influence of demand-side forces is exerted on a potential broadband subscriber. Thus, the demand-side forces refer to a pull arising from the willingness of potential users to adopt broadband service, while the supply-side forces are related to a push for broadband deployment/coverage/availability coming from the provision of resources to support operators and the construction of broadband infrastructure. Thus, I apply the description of interventional actions in broadband diffusion as follows.

According to the objective of governmental intervention, direct public policies are categorized as follows in Tables 3 and 4.

#### 4 . Comparative study on broadband policy

This section examines the direct public policies of the UK, Sweden, South Korea, and Australia. These four countries' governments have been involving in the promotion of broadband diffusion since broadband was first introduced into the market in these countries respectively. The four cases represent four different propensities of policy design that public players used to have, and correspondingly different performances in broadband penetration. By in-depth case studies of the four nations, the research attempts to understand the past experiences of broadband stimulation and find out whether broadband policies may explain the variation observed in broadband penetration in the four countries.

##### 4.1 Case study of the UK

The UK has a high population density, at 257 people per square kilometer (inhab/km<sup>2</sup>). It also has a highly urbanized population with 80% of the people living in cities. Until 2003, the broadband uptake had lagged behind the OECD average. By 2004, the figure had increased to 10.2 subscribers per 100 inhabitants, moving ahead of the OECD average (10.1). At 32.7 in 2011, its overall penetration has surpassed the previous leaders Canada (31.8) and Sweden (31.7), while remaining slightly behind South Korea (36.9).

The UK has relied largely on market forces to deploy broadband service, but from a regulatory perspective, several initiatives have been introduced to promote competition this arena. For example, between 1998 and 2000, Oftel<sup>2)</sup> issued a series of statements setting the terms for

Table 2 Definition

Term	Definition	Example
<i>Knowledge building</i>	Financial support for research and development activities of technology.	For instance, the funding of research projects.
<i>Knowledge deployment</i>	The dispersion of key concepts and techniques through education or training programs funded by governments.	The government initiatives aimed at supporting investment decisions by private operators and coordinating the potential demand of consumers so as to ensure optimum resource allocation are knowledge deployment from supply and demand side respectively.
<i>Subsidies</i>	Subsidies are provided whenever an institution uses its resources to defray the otherwise unavoidable costs and risks to operators and users in process of broadband diffusion in use.	Subsidy can be direct, with financial support to all actors involved in the technical innovation, or indirect, with support for infrastructure building.
<i>Mobilization</i>	Mobilization basically expresses the intention of the government to make individuals to perceive the potential benefit of broadband and understand the best practice for spurring them to do.	For instance, programs that aim to raise the awareness, promotional activities such as announcement of national policies and related media reports are representative instruments for mobilization.
<i>Standard setting</i>	It is a form of regulation aimed at constraining options of decentralized actors and organizations in line with larger social or institutional objectives.	Establishment of standards under which innovative activity might be encouraged.
<i>Innovation directive</i>	It is a command to engage in some activity in order to set an example for companies and individuals that tend to use the technology.	For instance, direct institutional operation of production facilities for innovation.

Source: King et al., 1994

wholesale and bitstream access to BT's network; they later expanded the process to encompass local loop unbundling (Benkler et al., 2010). In 2005, functional separations were imposed on BT between its wholesale inputs business and its retail operations, which were described by Ofcom<sup>3)</sup> as one of the key factors leading to greater retail broadband competition in the UK and the falling of average monthly cost of a residential fixed broadband connection (Benkler et al., 2010).

In addition to regulatory measures, the UK government has also employed direct interventions

2) Britain's first independent telecommunications regulator.

3) Independent regulator and competition authority for the UK communications industries.

Table 3 Supply-side policy tools

Objective	Types	Instrument of technology diffusion
Reducing private operators' costs of deployment	Fiscal incentives	Knowledge building, subsidy
	Administrative simplification	Innovation directive
	Long-term loans	Subsidy
Enhancing private operators' access to the market	Territorial mapping	Knowledge deployment
Direct investment of broadband infrastructures	Investment in the construction of a backbone network	Subsidy Innovation directive
	Creation of a public information infrastructure	Knowledge deployment Innovation directive Subsidy
	Provision of broadband services through municipal utilities	Knowledge deployment Innovation directive Subsidy

Source: King et al., 1994; Rossi, 2012

Table 4 Demand-side policy tools

Objective	Types	Instrument of technology diffusion
Increase value of broadband access (vanquish digital illiteracy and increase the perceived value of broadband for non-adopters)	Increase useful content availability	Knowledge deployment Innovation directive
	Increase IT skills	Knowledge deployment
	Increase awareness	Mobilization
Reducing cost of broadband subscription	Subsidy and incentives to private and business demand	Subsidy
	Demand aggregation	Knowledge deployment

Source: King et al., 1994; Rossi, 2012

in a variety of ways, although direct government investment in infrastructure has remained limited. Table 5 outlines the history of these measures.

This table shows that the UK government's direct public policies were initially demand-side, relying largely on market forces to deploy broadband service. Although the UK did establish a national broadband strategy, it has invested considerably fewer resources behind it than Korea, Sweden, or Japan (Atkinson et al., 2008). Direct government investment in infrastructure has been limited. Starting in 2003, the UK government began to implement supply-side policies, when government support projects were initiated and direct investment in broadband infrastructures commenced.

#### 4.2 Case study of Sweden

Sweden has one of the lowest population densities (23 inhab/km<sup>2</sup>) in Europe, and the majority of its population is clustered in its three major cities of Stockholm, Goteborg, and Malmo.

Table 5

1999-2002	Online Centers initiative was announced, seeking to provide access to computers and the Internet by providing staffed technology centers in libraries, Internet cafes, community centers, and even mobile sites on buses.	<i>Subsidy, Innovation Directives</i>
2000	Setting the goal of making UK “the most complete e-commerce market in G7 by 2005” Establishment of the broadband stakeholder group (BSG). The UK Prime Minister pledged 1 billion pounds for e-government initiatives.	<i>Mobilization, Innovation directives</i>
2001	UK launched its national broadband strategy. 2001-2005, via Broadband Fund, UK government gave grants of around \$127 million to more than 13 projects, focusing on rural areas.	<i>Knowledge deployment, Mobilization</i>
2003	2003 Broadband Aggregation Project (BAP): provided more than \$2 billion between 2003 and 2006, to provide broadband connections to primary and second schools and other public entities.	<i>Knowledge deployment, Innovation directives, Subsidy</i>
2004	Directgov <sup>4)</sup> was launched by government, which allows British citizens to access information from a variety of government agencies. Providing subsidies for small and medium enterprises in rural areas (via providing grants to small businesses and organizations in remote areas to cover the fee of broadband subscriptions).	<i>Subsidy, Innovation directive</i>
2005	UK government released digital strategy, focusing on stimulating broadband by promoting virtual learning, universal access to advanced public services, fostering the creation of innovative broadband content, providing communal access point and digital literacy programs, making home PC more affordable. E-learning Foundation, helping parents financing to lease laptops for 4 years with a delay payment scheme.	<i>Knowledge deployment, subsidy, knowledge building</i>
2006	<i>FiberSpeed</i> was undertaken. <i>FibreSpeed</i> is a high performance optical fibre network that directly links North Wales to the World Wide Web placing the region squarely onto the digital map of the world. The network is a partnership between private enterprise and the Welsh Government.	<i>Subsidy</i>
2009	The UK government published its Digital Britain Implementation Plan.	<i>Mobilization</i>
2010	<i>Britain's Superfast Broadband Future</i> is published, the UK government is committed to investing some 530 million pounds of public funds in remote areas and aim to use the public investment to provide a network infrastructure upgrade.	<i>Subsidy, Innovation directive</i>

(Source: Choudrie and Papazafeiropoulou, 2007; Atkinson et al., 2008; SQW, 2005; Benkler et al., 2010)

4) Directgov was the British government's digital service for people in the United Kingdom, which provided a single point of access to public sector information and services. It was replaced along with the Business Link website on 17 October 2012 ([www.gov.uk](http://www.gov.uk)).

Eighty-five percent of the population lives in urban area (World Bank, 2012). However, Sweden has one of the highest percentages for broadband Internet availability and penetration, with 32.3 subscribers per 100 inhabitants compared to 25.8 for the average EU-30 countries (OECD, 2012). Broadband is available in over 99% of households in Sweden (OECD, 2012). High penetration results from well-developed market regulations and broadband strategies.

In 2001, Swedish regulators, Post and Telecom Agency (PTS) introduced local loop unbundling in accordance with EU regulations, and then in 2004, furthered the initiative by mandating that the incumbent telecommunications company, TeliaSonera, provide bitstream access for broadband entrants. In 2008, TeliaSonera was required to functionally separate its network and retail services divisions. These measures taken by PTS were quite successful in terms of increasing the numbers of new entrants in the broadband market while decreasing the number of incumbent market shares (Teppayayon and Bohlin, 2009).

In addition to regulatory initiatives, the Swedish government has long been actively involved in rolling out broadband infrastructure through public investment and supporting initiatives that promote demand for broadband access. As early as 1999, the government recommended that the state take action to stimulate broadband rollout in rural and remote areas with no market deployment. In 2000, the Swedish government published its ICT strategy (Eskelinen et al., 2008), becoming the first European country to implement an active broadband policy. Table 6 outlines the history of Sweden's initiatives.

The Swedish government has been actively involved in rolling out broadband infrastructure through public investment. Supply-side policies to promote broadband diffusion have been widely employed by the Swedish government since 2000, and the penetration has increased from then on. Until 2007, growth slowed as the market matured, and supply-side policies were adopted mainly to support infrastructure development in remote areas. However, it must be mentioned that early in 1998, the Swedish government implemented demand-side policies to increase PC ownership and raise the public's perception of broadband as a better Internet access technology, as previous empirical research showed that higher computer penetration significantly enables broadband uptake.

#### 4.3 Case study of South Korea

South Korea has a high population density (509 inhab/km<sup>2</sup>), with 83.2% of the population living in urban areas (World Bank, 2012). Broadband services were first launched in Korea in 1998. Its broadband penetration rate was the highest in the world from 2000 to 2006. Additionally, the speed with which Korea's broadband market developed is remarkable.

South Korea's success, as a world leader in broadband, was due to the regulatory regime, aggressive government programs, and projects focused on boosting broadband demand. After

Table 6

1998	Swedish government introduced tax reductions on computers bought by companies for their employees' private usage, which greatly increased computer ownership.	<i>Subsidy</i>
1999	Advocating a national broadband strategy, a concerted effort was made to bring the broadband agenda to the populace, then broadband became a well-known term in the public life in Sweden.	<i>Mobilization</i>
2000-2001	The Swedish government committed funds to build an alternative broadband network and 950 million euros had been earmarked for investment to ensure that 98% of all households have a broadband connection by 2005. There were financial support by state funds to build backbone networks and regional networks and for expansion of urban networks.	<i>Knowledge building, Subsidy, Innovation directive</i>
2002	Providing tax incentives to telecommunications operators to spur the broadband infrastructure building in rural and underserved markets. Tax reductions also were provided to households to installing broadband access in the home or apartment.	<i>Subsidy</i>
2006	Territorial mapping programs In order to provide detailed information on the existing broadband coverage and eventually on the potential demand expressed in different geographic locations of the country, the Swedish Information Technology Policy Group has promoted the implementation of a public register of excavations made by local administrations, aiming at supporting investment decisions by private operators.	<i>Knowledge deployment</i>
2008	Between 2009 and 2013, \$500 million grants to encourage the development of broadband infrastructure in areas where non-provider exists, aggressively used subsidies to spur broadband deployment, particularly in rural areas of the country. Tax reductions for broadband access installations in high cost areas, funding to local authorities that establish operator neutral networks in rural and remote. Established a \$26 million project to raise IT literacy among school-teachers.	<i>Subsidies, Innovation directive</i>
2009	Broadband Strategy for Sweden was released, setting a goal that 90% of households should have access to a broadband connection of at least 100 Mbit/s by 2020.	<i>Knowledge Deployment, Subsidy, Mobilization</i>

(Source: Atkinson et al., 2008; Benkler et al., 2010; PTS)

the privatization of the state-run telecommunications provider, Korea Telecom (KT), and the encouragement of new entrants into the broadband market in the late 1990s, DSL and cable broadband services expanded rapidly (Benkler et al., 2010). The broadband sector's regulatory environment evolved in three phases. In the introduction stage, light regulation was a means of promoting competition. Broadband services were classified as value-added services, and all types of broadband-access technology were permitted. Facilities-based competition<sup>5)</sup> started to take off because of the low entry barriers. The second stage was from 2005 to 2007, when



Table 7

1987	Building e-Government infrastructure, digitize information and develop e-Government systems and services, implement the National Knowledge Information Resource Management Project.	<i>Knowledge deployment, Mobilization</i>
1993	KII-initiative KII-G: Constructing a national high-speed public backbone network via long-term loans programs for broadband suppliers and national financing programs. KII-P: Using funding to construct an access network for homes and business. KII-T: Focusing on R&D support.	<i>Knowledge building, subsidy</i>
1997	Cyber Building Certificate system (territorial mapping programs) was built in order to transmit information to telecom operators and provide incentives to real estate developers to coordinate with telcos to include fiber optic connections in new buildings.	<i>Knowledge deployment</i>
1999-2002	Cyber Korea 21 Supporting R&D and technology development activities in IT via government investment and long-term loans. Supporting emerging internet related sectors, including software, digital contents, IT parts and components by tax reductions. Facilitating e-commerce and promoting information sharing between firms in a safe and reliable online business environment. Subsidized training courses were provided and free personal computers are given to schools.	<i>Knowledge building, Subsidy</i>
2000	Ten Million People IT Education Project, providing incentives to private demand (providing free or subsidized training programs to individuals and institutions)	<i>Knowledge deployment, Subsidies</i>
2002-2004	e-Korea vision 2006 and Broadband IT Korea vision 2007 were released. Continuing to support IT venture start-ups and facilitating penetration of overseas IT markets. Further development of the quality of e-Government services and increase of public/business participation in e-Government. Expanding ICT use in school and e-learning opportunities.	<i>Knowledge building, Knowledge deployment, Subsidy, Mobilization, Innovation directive</i>
2004	Broadband convergence Network, IT839 Low-cost loans were provided to broadband providers to build high-speed network, while, government investment into BcN were directed largely into R&D activities.	<i>Knowledge building, Subsidy, Innovation directive</i>
2006-2007	Ubiquitous-IT839 Helping companies to commercialize leading technologies and providing financial support to R&D costs and tax benefits. Taking the lead in global standardization. Supporting cooperation and convergence among companies and establishing u-payment and u-banking systems. Further development and customization of e-learning services and content.	<i>Knowledge building, Knowledge deployment, Subsidy</i>
2007	Cyber-Infrastructure Grid. Providing support in building a high performance research infrastructure that can dynamically collect, integrate, and share distributed and disparate resources, such as supercomputers, large-scale storage, and advanced instruments.	<i>Subsidy, Innovation directive</i>
2009	Ultra Broadband Convergence Network was announced to further upgrade the BcN access network to enable a 1Gbps service speed on the fixed network. Public money will be spent on supporting technology development, building a test-bed environment and verifying new service models.	<i>Knowledge building, Subsidy, Innovation directive</i>

Source: Atkinson et al., 2008; Benkler et al., 2010; Ovum Consulting, 2009

regulation increased as a response to the growing dominance of KT. Price regulations were introduced in 2005 and broadband was reclassified as a facilities-based service. In the third stage, there has been a move back toward lighter regulation in some areas because the market has matured.

Aside from regulatory actions, direct public policies have been widely advocated by the South Korean government.

The Korean government has taken great interest and has played a significant role in the country's broadband development by launching a series of related technological initiatives. Korea was the first to establish a national policy to promote the deployment of information technology in the public and private sectors with its "Framework Act on Informatization Promotion" as early as 1987 (Atkinson et al., 2008). At a very early stage, compared to other countries, the Korean government began to promote the use of IT in government agencies and digital literacy. From the mid-1990s on, the government has announced ambitious supply-side policies, such as KII, BcN, and UBcN, to construct an advanced information and communication infrastructure at a national level. On the demand-side, along with the supply-side policies, the Korean government has also implemented a number of initiatives to promote broadband uptake. However, in recent years, the government interventions have been primarily focused on the supply side to support technology development.

#### 4.4 Case study of Australia

Australia has an extremely low population density of less than 3 inhab/km<sup>2</sup> (as compared to 22 in Sweden and 508 in South Korea). Yet, the majority of its citizens are clustered in the major metropolitan centers, with the percentage of urban population at 89%. Broadband in Australia started slowly. Telstra launched the first DSL services in 2000. Australia was well behind the OECD average for total broadband subscribers per 100 inhabitants until 2005.

Many regulatory initiatives were introduced, for example, local loop unbundling was first introduced in mid-1999. However, since the price controls were imposed by regulation, there were several years of continuous conflicts over the pricing of local loop unbundling. Australia was described as having no effective regulated rate by late 2006 (OECD, 2009). By 2008, the dispute was resolved and the subsequent local loop unbundling prices were in line with prices elsewhere in the world (OECD, 2009). Telstra, a vertically and horizontally integrated incumbent that dominates local telecommunications markets, particularly for fixed line services, was required to undertake structural separation of its wholesale and retail fixed line operations in 2009. However, Telstra's fixed line activities are still vertically integrated (Benkler et al., 2010).

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5) Facilities-based competition is the competition among platforms with different or same technologies such as digital subscriber line and cable modem.

The ambitious National Broadband Network (NBN) program, which is state-owned, may face fierce competition from Telstra.

The Australian government also shows great interest in direct public policy. Table 8 details the history of Australia's broadband initiatives.

Australia's direct public policies have largely been implemented as supply-side initiatives, while demand-side policies were not perceived as important for national broadband success. By 2006, demand-side subsidies were introduced to increase broadband adoption. The government continues to show great propensity for building infrastructure, as seen in the large public investment allocated to the ambitious NBN program.

Table 8

2003	National broadband strategy was announced. Coordinated Communications Infrastructure Fund (CCIF), designed to accelerate the rollout of broadband into remote area. Higher Bandwidth Incentive Scheme (HiBIS) was created to provide subsidies to service providers to offer broadband services in regional areas at prices reasonably comparable with those available in urban areas. Demand aggregation initiative was taken and funding was provided to coordinate broadband demand in local areas to attract additional infrastructure investment.	<i>Subsidy, Mobilization</i>
2005	Connect Australia was announced. Three programs were included: Broadband Connect Clever, Networks Backing and Indigenous Ability. Public investment was allocated to connect households to broadband technologies	<i>Subsidy, Innovation directive</i>
2006	A series of programs were established and per-customer subsidies were provided to ISPs offering services in remote areas. An AUD 2 billion Communications Fund was established to fund new technologies in rural areas. Subsidized Telstra to upgrade its fixed line network to FTTN.	<i>Knowledge deployment, subsidy</i>
2008	Digital Education Revolution: Funds have been provided by the federal government to increase computers in schools to one per student in years 9–12 by the end of 2011. The program also supports IT training for teachers, online curriculum tools and resources and funds connections for schools. Backing Indigenous Ability (BIA) aimed to increase awareness, digital literacy and ICT skills	<i>Knowledge deployment, Mobilization</i>
2009	The Australian government announced an ambitious program, National Broadband Network, aims to build a 100Mbps FTTH network to 90% of its citizens. The nationally funded fiber network will be privatized after completion to a fully open access carrier.	<i>Subsidy, Innovation directive</i>

(Source: Atkinson et al., 2008; Benkler et al., 2010; NCF, 2006)

## 5 . Discussion

Through this in-depth comparative analysis that incorporates a time dimension into the framework, the transition of direct policy toward broadband in selected countries can be described as seen in Figure 3.

South Korea and Sweden, as top performers in broadband, have been actively involved in rolling out broadband infrastructure through public investment. The Korean government established a national policy, “Framework Act on Informatization Promotion,” to promote the deployment of information technology in both public and private sectors as early as 1987. This Act created programs that promote both public access to broadband and digital literacy. Later, many more initiative and programs were established, with a substantial amount of money from the government budget to stimulate private investment. Similarly, the Swedish government recommended that the state should take action in rural areas where there was no market deployment and committed over EUR 600 million for the installation of a national backbone as early as 1999 (Benkler et al., 2010). The government has subsidized broadband infrastructure development through a variety of programs and projects, including funding to local authorities that establish operator neutral networks in rural areas, provide tax reductions for broadband access installations in high cost areas, and require state-owned companies to build a high-speed backbone infrastructure for emergency services. The Swedish government has allocated a substantial amount of money to stimulate this infrastructure development.

Beyond those supply-side interventions to support broadband infrastructure development, the two governments also created programs to encourage broadband demand. The Korean government enacted a number of successful efforts to spur broadband demand and digital literacy. For instance, the government provided free computers to low-income students with good grades and

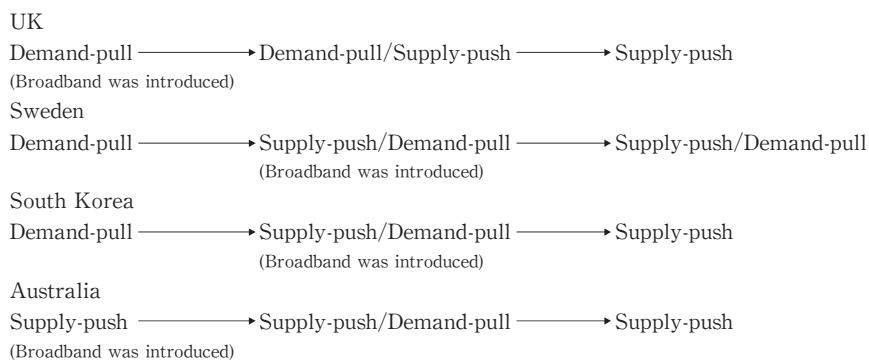


Figure 3 The transition of policies

established programs that require teachers to encourage students' Internet usage via online assignments and email communication. Its digital literacy programs targeted groups less likely to use the Internet. Likewise, in addition to the large number of public investments in infrastructure, the Swedish government also supported initiatives to promote demand for broadband usage by fostering digital literacy, encouraging the use of broadband for education, and increasing access to personal computers. It introduced a \$25 million project to raise IT literacy among schoolteachers in order to increase demand for broadband (Atkinson et al., 2008). Apart from jointly adopted demand-side interventions promoting broadband uptake, both the Korean and Swedish governments established PC diffusion promotion (PC purchase installment plan in Korea in 1999 and tax breaks for companies that supplied employees with PC in Sweden in 1998) before broadband was introduced to the market, since broadband demand would not increase if citizens did not have access to a PC at home.

Compared to Korea and the UK, the Australian government has attempted to achieve broadband diffusion by focusing merely on supply-side initiatives, with little effort to expand demand. Even before 2007, when the government changed, public intervention had shifted back toward higher public investment in telecoms infrastructure. That government (Liberal) established the Communications Fund to generate an annual revenue stream to fund new technologies in rural areas and agreed to provide subsidies for Telestra to upgrade its fixed line network to Fiber To The Node (FTTN). In 2009, the national government announced its broadband strategy, which is called the National Broadband Network (NBN). By establishing a new company to build and operate the NBN, at a cost of USD 36.5 billion, the plan will replace Australia's copper exchange lines with Fiber To The Premises (FTTP) and aims to deliver a download speed of 100 Mbps to 90% of homes and workplaces. The other 10% of the population will get speeds of at least 12 Mbps by other means within 8 years. However, despite the highly supported deployment of broadband infrastructure, the rate of the broadband uptake had long remained under the OECD average. Furthermore, demand-side public intervention is limited. There were few demand programs until the "Digital Education Revolution" established by the federal government in 2008. Most of the funds were being spent to increase the number of computers in schools.

In contrast, the UK, an early leader in reforming telecommunications markets, has relied largely on market forces to deploy broadband service. It established its national broadband strategy through its White Paper, "Opportunity for All in a World of Change," in 2001. Its objective is to have the most extensive and competitive broadband market in the G7 by 2005. The funding was made available through the Broadband Aggregation Project, which aggregated demand for broadband connectivity to make broadband infrastructure deployment more attractive for operators. In 2005, the UK government's digital strategy was released, also focusing on the demand side of broadband by fostering the creation of innovative broadband content,

promoting virtual learning, providing communal access points, providing digital literacy programs for adults, removing access barriers for people with disabilities, and making home computers more affordable<sup>6)</sup>. Since the UK has many rural areas, supply-side intervention has been mainly focused on supporting broadband infrastructure development in rural areas.

Notwithstanding the distinctive difference in policy approaches among the four countries, a more thorough look at them reveals that they have much in common. First, countries with a large amount of support to stimulate broadband infrastructure deployment have succeeded in increasing the coverage rate of broadband. However, it does not necessarily result in a high penetration rate, even though it has been assumed that services taking advantage of broadband will follow once it is supplied. Secondly, countries that are often cited as global leaders in broadband penetration have developed extensive programs to generate demand for broadband service.

Different policymakers have adopted various combinations of instruments in their direct interventions, leading to differing outcomes in broadband penetration. Consequently, questions may arise: Is the diffusion of broadband driven by market demand or supply push? Should demand-side public policies and supply-side public policies have the same impact on the diffusion of broadband?

Innovations researchers have long debated whether innovations are driven by market demand or by technological shifts. The market demand school of thought holds that organizations innovate based on market needs; however, the technology proponents claim that technological change is the major driver of innovation. A research survey of literature on technological innovation regarding technology-push (i.e., supply-push) and demand-pull debate can be found in Chidamber and Kon (1994). The author concludes that, despite inconclusive or even opposite results obtained by innovation researchers, there is one key observation for all the studies: “in the short term, incremental innovations which constitute the bulk of successful innovations, are launched into existing markets, or markets whose near term needs are well known; market demand is clear requisite to success” (Chidamber and Kon, 1994).

However, whether broadband, as an innovation product, is subject to demand-pull or supply-push has not been fully discussed. From the observations of this study, I conclude that countries with commitment to demand-side interventions, or demand-side and supply-side policies jointly implemented, have reached a higher broadband penetration rate more quickly, while countries that relied solely on supply-side policies have lagged behind their counterparts (Figure 4). Thus, a hypothesis is proposed:

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6) The Prime Minister’s Strategy Unit and Department of Trade and Industry, “Connecting the UK: the Digital Strategy,” (March 2005): 8

*Broadband diffusion is more likely to be demand-constrained rather than supply-constrained, and thus, public interventions on the demand side are much more effective than on the supply side.*

This hypothesis has three implications.

1 . Broadband is primarily demand-constrained and market users are the key driving forces.

In light of the fact that government interventions have historically focused on supply-side efforts, the hypothesis may seem surprising. Furthermore, no empirical research demonstrates that market demand is the major factor for broadband diffusion. However, justifications can be deduced from previous research and from the following two observations. (1) Theoretically, broadband is not only an innovation product, but also an incremental product. Since other, less advanced Internet access technologies (e.g., dial-up) had been known by the consumer before, broadband, specifically, should be identified as incremental innovation, since it is a manifestation of technical advance in communications technology. Thus, based on the conclusion in Chidamber and Kon (1994) that market demand is requisite to the success of incremental innovations, it is reasonable to assume that users' demand is the primary factor for the success of innovations and that markets should be the key drivers of broadband diffusion. (2) It can be observed that demand-side initiatives were implemented in both Korea and Sweden, both of which are regarded as top performers in broadband provision and adoption around the world. The demand-side approach was implemented before the supply-side initiatives, in order to raise the demand for broadband services. In contrast, there was little effort to generate demand in Australia. Both Australia's liberal government (before 2007) and the labor government leaned toward the supply-side policies with high public investment in telecommunications infrastructure (Benkler et al., 2010). Consequently, broadband adoption is very low, even though broadband is highly accessible (Figure 4). Thus, it is hardly surprising that Australia was well behind the OECD average for total broadband subscribers per 100 inhabitants in the early 2000s.

2 . The impact of supply-side policies on broadband penetration might be overstated.

It is a fact that governments worldwide have recognized the increasing importance of high bandwidth networks as drivers for economic and social development, and that the public sector is actively involved in the rollout to facilitate timely, sustainable, and nationally available broadband networks (Ruhle et al., 2011). Therefore, it is impossible to trace the performance of broadband diffusion without any supply-side policies being adopted. However, as previously discussed, broadband is assumed to be an incremental innovative product. Demand for broadband existed before broadband was introduced into the market. Thus, it might be reasonable to assume that services utilizing broadband will follow once broadband is supplied, and they will



lead to an increase in broadband penetration. That means the role of supply-side policies in broadband diffusion is a one of facilitator rather than a necessity.

### 3 . Jointly adopted supply-side and demand-side policies are the most effective in promoting broadband diffusion.

It is observed that countries that have implemented supply-side as well as demand-side policies have the greatest performance in broadband uptake. For example, in the case of Korea, which is considered a world leader in broadband, the government has long been involved in the promotion of broadband through both supply-side support, simulating investment in infrastructure deployment, and demand-side programs, generating demand for such services. Sweden, also considered one of the top performers in broadband provision and adoption, has not only been actively involved in rolling out broadband infrastructure through supply-side policies, but has also supported initiatives to promote demand for broadband by fostering digital literacy, increasing access to PCs, and encouraging the use of broadband for education. Subsequently, Sweden has emerged as one of the leaders in broadband penetration, speed, and affordability. Thus, it seems that jointly adopted policies are the most effective in promoting broadband diffusion.

## 6 . Conclusion

The current study conducted an in-depth analysis of public policies at the national level in four countries. It is observed that the four countries have adopted various broadband strategies to boost the broadband diffusion. An hypothesis is presented, informed by these observations of the policy strategies and their associated performance of broadband penetration: demand-side public interventions are much more effective than supply-side interventions.

By discussing the importance of the proposed hypothesis, the study takes a view on the ambitious government strategy to build National Broadband Network (NBN) in Australia. A large number of public investments have been allocated to promote fiber rollout, while demand-side policies were not jointly adopted to spur the market needs. It is reasonable to assume that, as long as consumers' needs can be met by current xDSL or cable, consumers would not switch to ultra-broadband service unless a lower price is provided, despite the available fiber access. Hence, a demand-pull could greatly stimulate the uptake of ultra-broadband service.

Finally, there are some limitations to this study. First, programs included in Section 4 are not exhaustive. Those programs were collected from government websites, institutional sources, and academic papers; it is possible that some relevant programs have been neglected. The study has also been restricted to four developed countries; the next steps should be to increase the number of countries included in the study and to develop a more detailed justification for the

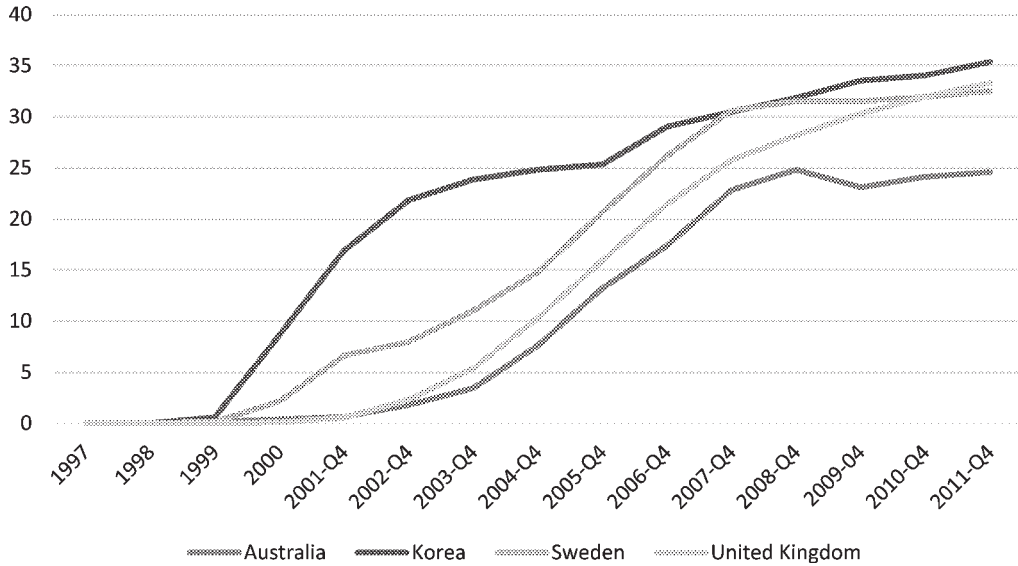


Figure 4 Broadband growth from 1997 to 2011 of selected countries

Source: Author's elaboration on OECD's (2012) data.

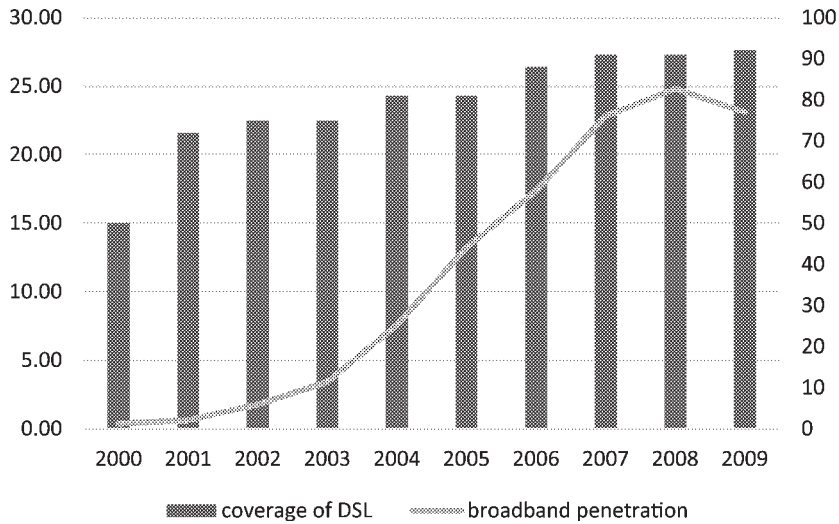


Figure 5 Broadband penetration and DSL coverage (the population covered) in Australia

Source: Author's elaboration on OECD's (2012) data.

hypothesis. Additionally, empirical research is required to test the hypothesis proposed in this preliminary work.

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