THE BOSTON CONSULTING GROUP

Socio-Economic Benefits of Assigning the Digital Dividend to Mobile in Thailand

INTRODUCTION

In 2010, GSMA and The Boston Consulting Group released a report on the social and economic benefits of allocating the 700 MHz band to mobile broadband in the Asia-Pacific region. Based on a rigorous and conservative proprietary methodology, we identified a significant uplift in GDP, tax revenues, employment and entrepreneurship resulting from a harmonised mobile band plan relative to its most likely alternative, digital broadcasting.

Since then a number of important developments have been observed in the region. Most notably, an increasing number of countries are committing to the proposed Asia-Pacific technical harmonisation, or APT band plan, most recently Malaysia and Singapore. Long Term Evolution (LTE) technology is being introduced throughout the region and the 700 MHz band allocation is attracting interest from the EMEA region and Latin America.

Thailand has announced plans to complete its digital migration by 2018 – with ~100 new digital TV channels by that date – but the country has yet to make a commitment to allocate the 700 MHz band to mobile.

This report analyzes the socio-economic implications of Thailand's proposed 700 MHz spectrum allocation for Thailand and its neighbours.

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TABLE OF CONTENTS

EXECUTIVE SUMMARY

As the switchover in Asia-Pacific from analogue to digital broadcasting approaches, a growing number of countries have committed to allocating the frequency band 698-806 MHz (the 700 MHz band) to mobile in accordance with the Asia-Pacific Telecommunity (APT) harmonised band plan. The Asia-Pacific region as a whole could take the lead in the implementation of a multi-regional harmonised spectrum band as there is also interest in Latin America as well as Africa, Middle East and Europe. However, as of March 2013, not all countries in the Asia-Pacific region have committed to the harmonised plan.

In Thailand, a roadmap has been announced for the launch of approximately 100 new digital TV channels, 48 of which are to be up and running in 2013 (12 public channels launching in May, 24 commercial channels launching in July-August and 12 community channels by end of year). The first digital broadcasting trials began in January 2013 with a six-month trial run by Thai PBS and the Royal Thai Army. In addition, about 50 more channels are planned for introduction in later years. Analogue switch off is expected by 2018.

The National Broadcasting and Telecommunications Commission (NBTC) plans to expedite digital migration by offering subsidies in form of discount vouchers for converters or digital televisions. The coupon cost would come from the revenue generated from digital broadcast licensing.

However, despite these moves, and the passing of a Royal Thai Government Gazette in December 2012 allowing digital broadcasting in the 510-790MHz band, the NBTC has not formally stated that the band will be exclusively allocated to digital broadcasting. Currently, 700 MHz is allocated to both mobile and broadcasting in Thailand, but no official confirmation has been provided on how the band will be used after analogue switch off.

1 KEY RECENT DEVELOPMENTS

As countries across the Asia-Pacific region recognise the potential benefits to consumers and society, support is strong and growing to allocate the frequency band 698-806 MHz (the 700 MHz band) to mobile in accordance with the Asia-Pacific Telecommunity (APT) harmonised 2x45 MHz APT band plan.

The majority of countries in the region are committed to or have stated their intention to implement the same technical specifications, the FDD option of the APT band plans: collectively, the populations of these countries number nearly 2 billion.

In addition, the decision by a number of countries in Latin America, such as Mexico, Brazil, and Chile, to allocate spectrum in line with the APT band plan, will bring about even further economies of scale in infrastructure and handset equipment costs.

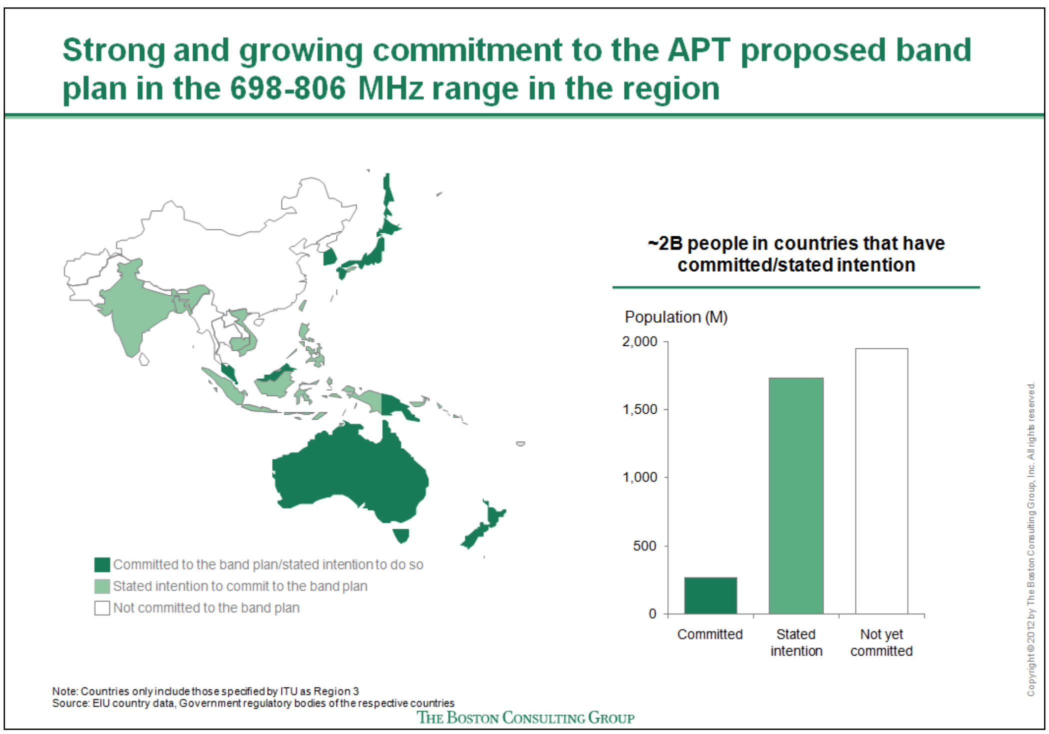

Exhibit 1.1 Commitment to APT band plan

2 THE BENEFITS OF ALLOCATION TO MOBILE

In looking at the impact of harmonisation on GDP growth, productivity, job creation, entrepreneurship, infrastructure investment, and taxation, we believe that the biggest socio-economic benefits are likely to arise by allocating the 700 MHz band to mobile, relative to broadcast services. To estimate the incremental benefit of allocation of the 700 MHz to mobile, we simulated the impact of two types of allocation – the allocation to mobile services and the allocation to broadcasting services (Digital Terrestrial Television, or DTT). We then assessed the incremental benefit of allocating the band to mobile relative to broadcasting.

2.1 Analysis of benefits

For Thailand, allocating the 700 MHz band to mobile would result in higher penetration rates, particularly in rural areas, driven by lower prices and quicker rollout[1]. The economic impact of the allocation to mobile is likely to be seen in four areas – GDP growth, employment, entrepreneurship and tax revenues.

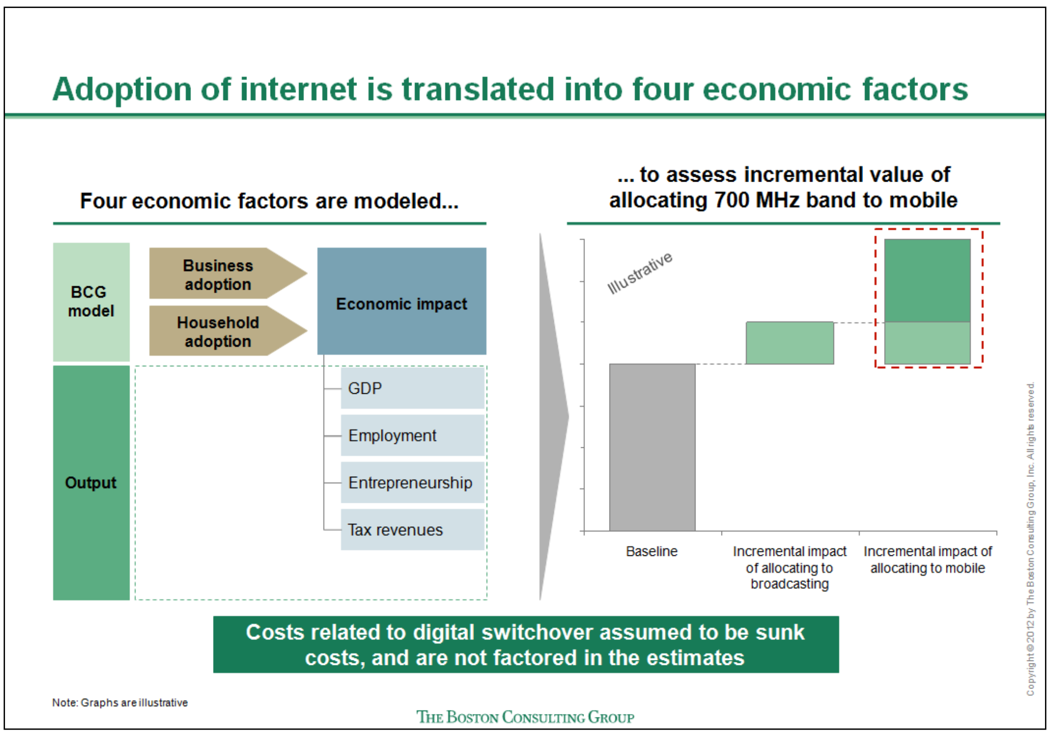

Exhibit 2.1 Methodology

[1] This is due to the spectrum characteristics of the 700 MHz band. See Appendix for more details

By 2020, the allocation of 700 MHz band to mobile could have a positive economic impact on Thailand, generating a GDP increase of US$18.9 billion (US$15.2 billion NPV) and tax revenue growth of US$3.5 billion, along with 30 thousand additional new businesses (including new departments or business units within existing firms) and 58 thousand extra new jobs.

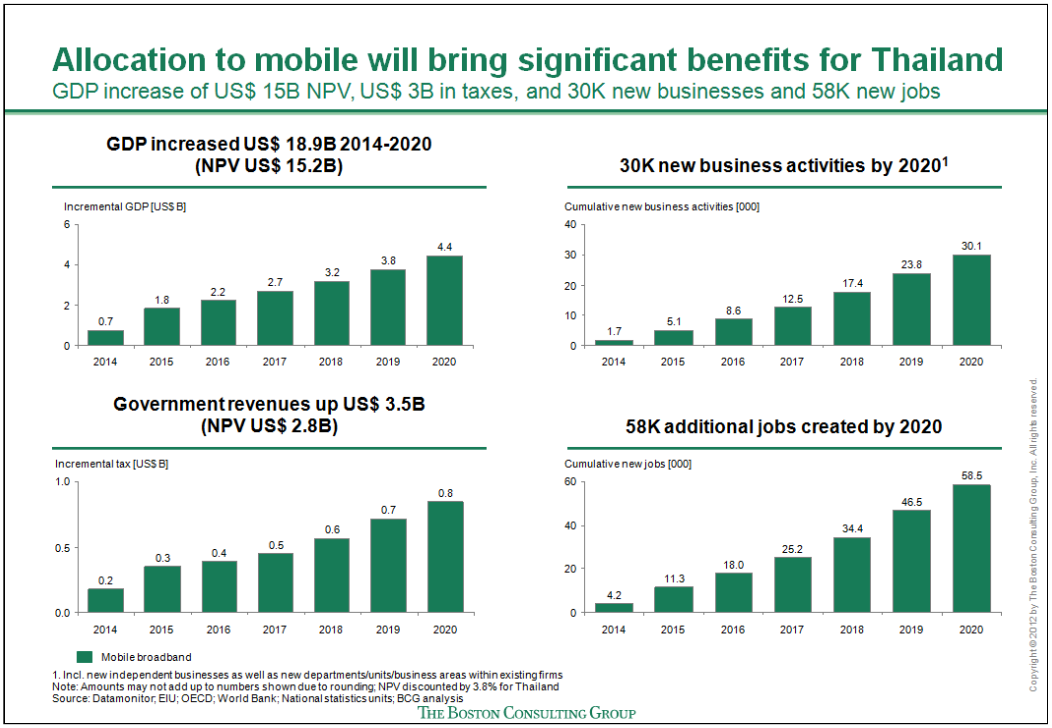

Exhibit 2.2 Impact of mobile allocation of 700 MHz band

On the other hand, if the band was allocated to broadcasting, it will accommodate more TV channels. This would generate additional broadcast revenue across the television supply chain. However, the overall effect on the industry might be less evident, since additional channels could cannibalize existing offerings and marginal channels only cater to limited audiences. The broader economy would see fewer spin-off effects since existing public service channels already provide a wide range of educational programmes and special interest groups are well served by cable and satellite TV.

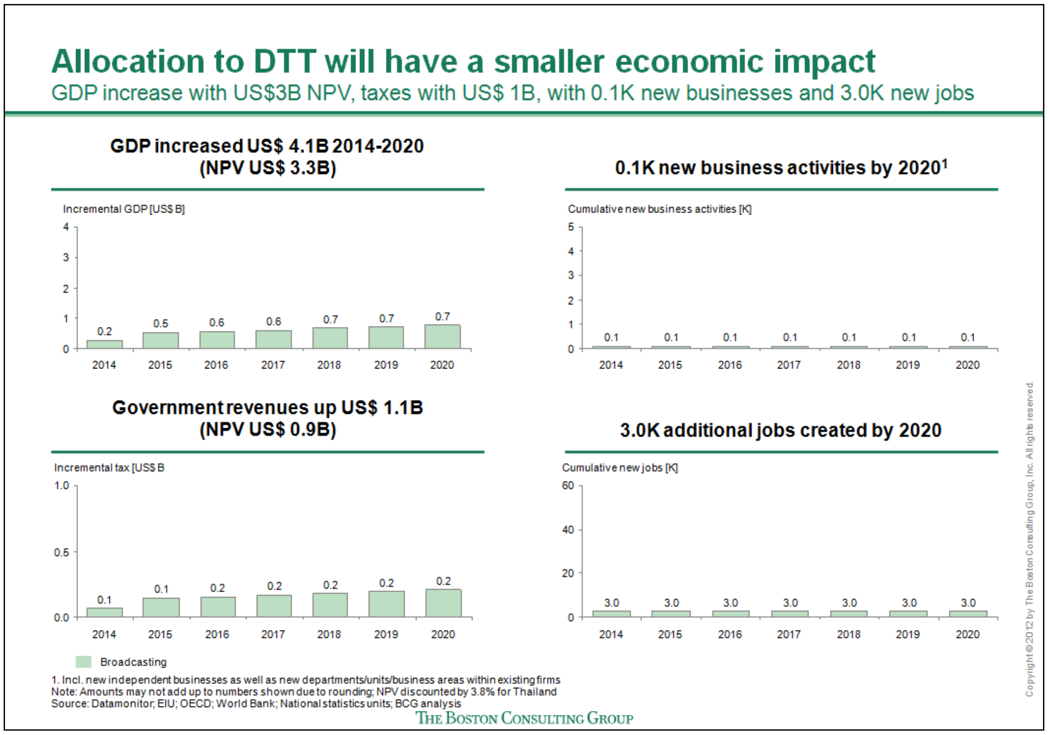

Exhibit 2.3 Impact of broadcasting allocation of 700 MHz band

Taking the best case scenario for broadcasting, by 2020, allocating the 700 MHz band to broadcasting services could have a very limited impact on the economy in Thailand, with a possible GDP increase of US$4.1 billion (NPV US$3.3 billion), increased tax revenues of US$1.1 billion, as well as around 100 new businesses or business units and 3 thousand new jobs.

These benefits represent a much smaller economic impact than would be generated by allocation to mobile. Furthermore, one could argue that the additional content could be delivered over the internet, for example, in the form of IPTV streamed over broadband, and hence the allocation to broadcasting does not in itself generate additional economic or social benefits.

2.2 Incremental benefit of mobile over broadcasting

Comparing the two scenarios, the allocation of the 700 MHz band to mobile services would bring Thailand significant incremental economic benefits over the allocation to broadcasting services – namely an extra US$14.8 billion (NPV US$11.9 billion) in GDP, by 2020, as well as additional tax revenues of US$2.4 billion (NPV US$1.9 billion), 30 thousand more business activities, and 55 thousand additional jobs.

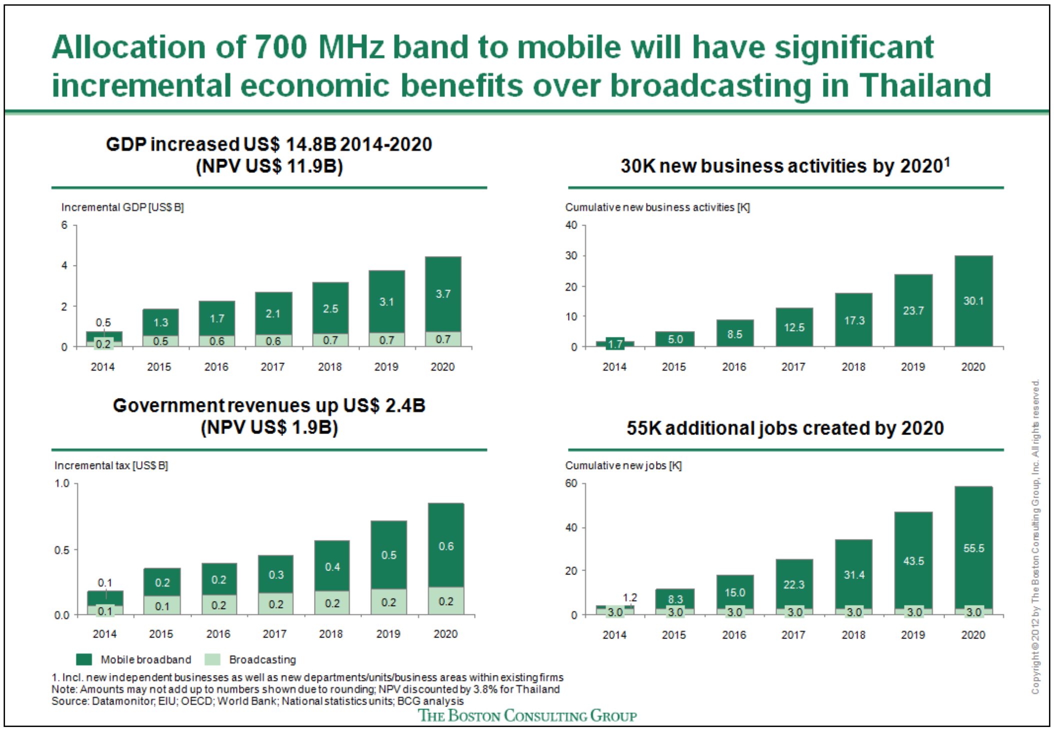

Exhibit 2.4 Impact of alternative allocations of 700 MHz band

2.3 Social benefits of mobile

In addition, allocation of the 700 MHz band to mobile services could bring about significant social benefits for Thailand, with social justice dividends including improved wealth distribution and cultural diversity, developmental benefits such as access to education and healthcare and improved food security, as well as increase innovation and infrastructure, leading to an improved business environment. Most elements of the Eleventh National Economic and Social Development Plan (2012-2016) would benefit from greater mobile broadband penetration.

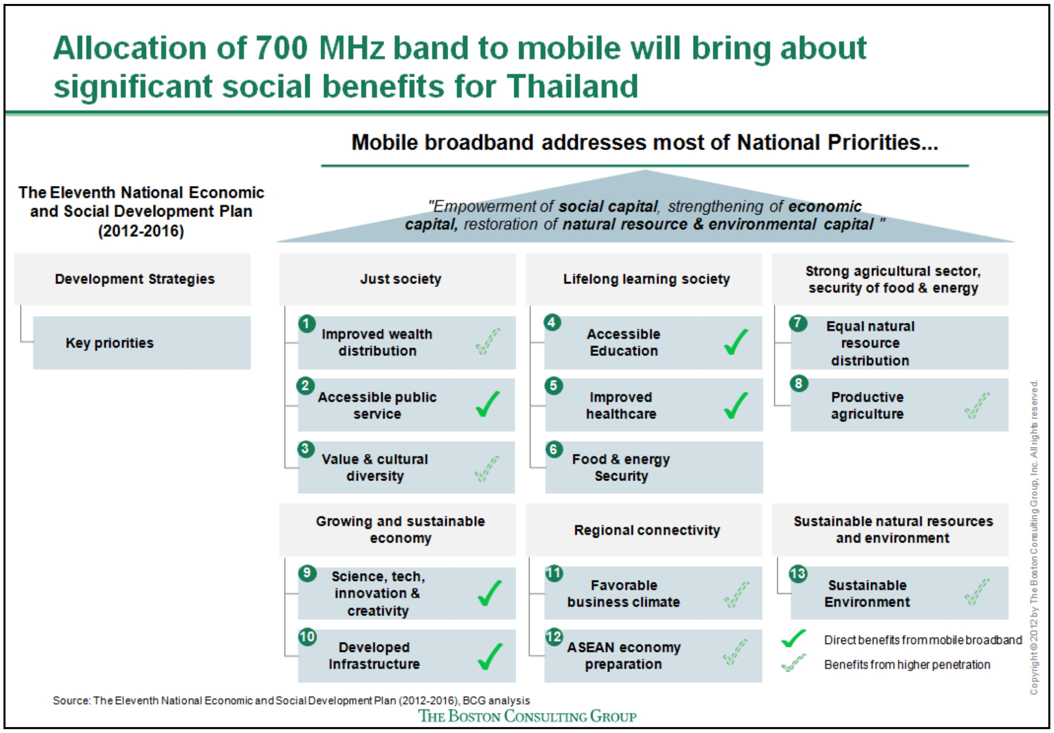

Exhibit 2.5 Social benefits of allocation to mobile

Low cost high-speed internet access—which is ideal for rural areas with poor infrastructure—could pave the way for substantial improvements in education and healthcare. When it comes to education, mobile broadband enables a rich and dynamic classroom experience with virtual classrooms that can be accessed via webcams, tablets and electronic whiteboards. As well as expanding access to education, this also increases interaction and collaboration among schools across the world. Moreover, mobile broadband allows children access to information anytime, anywhere.

Healthcare services can also be enhanced using mobile broadband since the technology facilitates remote diagnostics, increasing healthcare coverage in rural areas. Use of remote monitoring and video-consultations with specialists in hospitals both cuts costs and expands the reach of healthcare services, including emergency responses. Using mobile apps, healthcare workers could, for example, record patient data and transmit it wirelessly to medical specialists, improving the access to healthcare nationwide.

The 700 MHz band would also boost other aspects of Thai life and economy, such as agriculture, by making a host of services available to increase yields and quality. These services include agricultural information, data collection, trading, financing and even education and training. Collectively they can make a significant contribution to the income and welfare of the farmers.

3 THE IMPLICATIONS OF ALLOCATION TO BROADCASTING ON NEIGHBOURS

Mobile and terrestrial broadcasting signals, whether digital or analogue, are transmitted over radio waves from transmitters to receivers. This means signals using the same frequency directly interfere with each other, resulting in a reduction of the quality of service or in many cases a complete loss of service in affected areas, with direct interference potentially extending up to 200km. Fragmentation of different 700 MHz band allocations could therefore lead to cross-border interference.

If the 700 MHz band in Thailand is allocated to broadcasting, direct cross-border interference is likely to occur, since neighbouring countries, such as Malaysia, have committed to allocating the whole spectrum to mobile. Interference means the quality of service would be reduced or service becomes unavailable in the affected areas. We model the implications of this for Thailand's neighbours: Myanmar, Cambodia, Laos and Malaysia.

3.1 Implications for Cambodia, Laos, Malaysia and Myanmar

If Thailand chooses a non-harmonised solution it would have severe implications for its neighbours. Myanmar, Cambodia and Laos will be unable to use the 700 MHz band for LTE due to interference, and it is expected that these three countries will lose most or all of their potential benefits from mobile given that the majority of their populations will be affected by interference. Meanwhile, Malaysia will experience interference in the northern part of the country, along the border with Thailand. This could affect an estimated 10% of the rural population.

The results of these problems for neighbouring countries could be a collective loss of US$3.4 billion in incremental GDP, along with a cut of US$400 million in additional tax revenues, a loss of almost 96 thousand extra jobs and 41 thousand new businesses and business units.

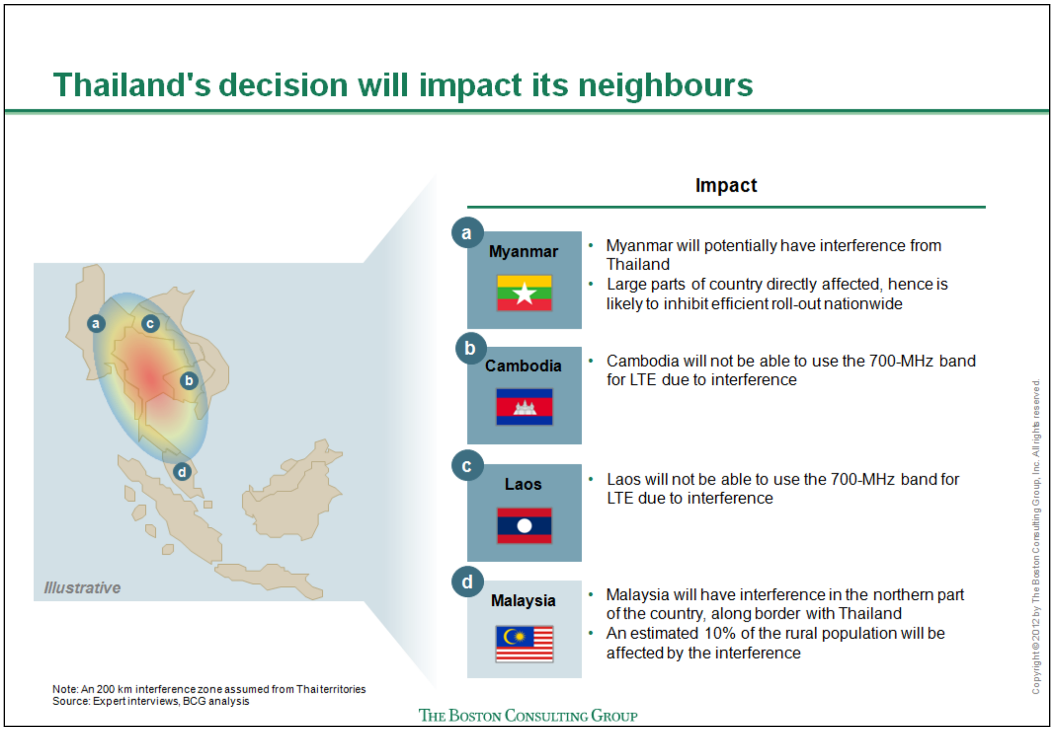

Exhibit 3.1 Thailand's decision will impact its neighbours

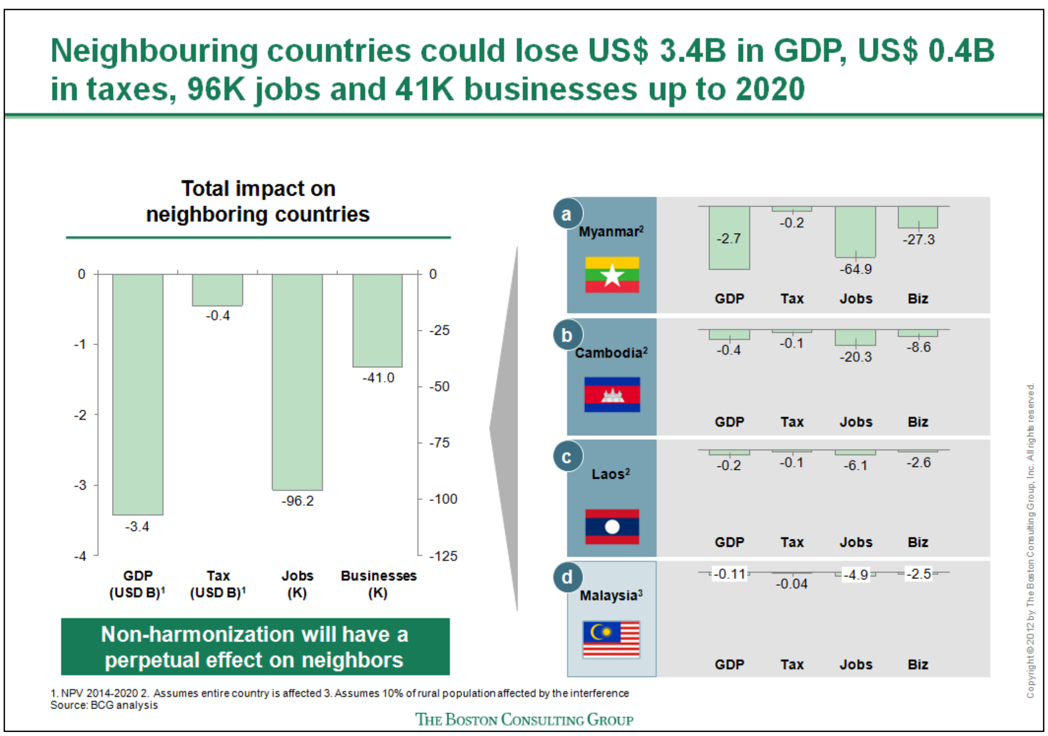

Exhibit 3.2 Implications of fragmentation for neighbouring countries

4 BENEFITS OF EARLY ALLOCATION

For countries that delay the decision to allocate the 700 MHz band, rollout would be affected and this could have an impact on the total socio-economic benefits that would have accrued to the country. We assessed the potential opportunity cost for Thailand of delaying allocation to mobile by one or more years relative to an early allocation baseline.

When we looked at the potential impact of delaying the decision on GDP and job creation, we found that delays could have a major impact on short-term GDP growth and employment opportunities when compared with the 2014 baseline.

Delaying by one year, to 2015, could lead to a loss in Thailand's incremental GDP growth of US$1.9 billion, with the loss of up to 13 thousand extra jobs. Delaying by two years, to 2016 could have an even bigger negative impact for the country, with a loss of US$3.9 billion in incremental GDP growth, along with the loss of up to 24 thousand extra jobs per year. The same logic applies to Thailand's taxes and business creation, which would also be correspondingly lower.

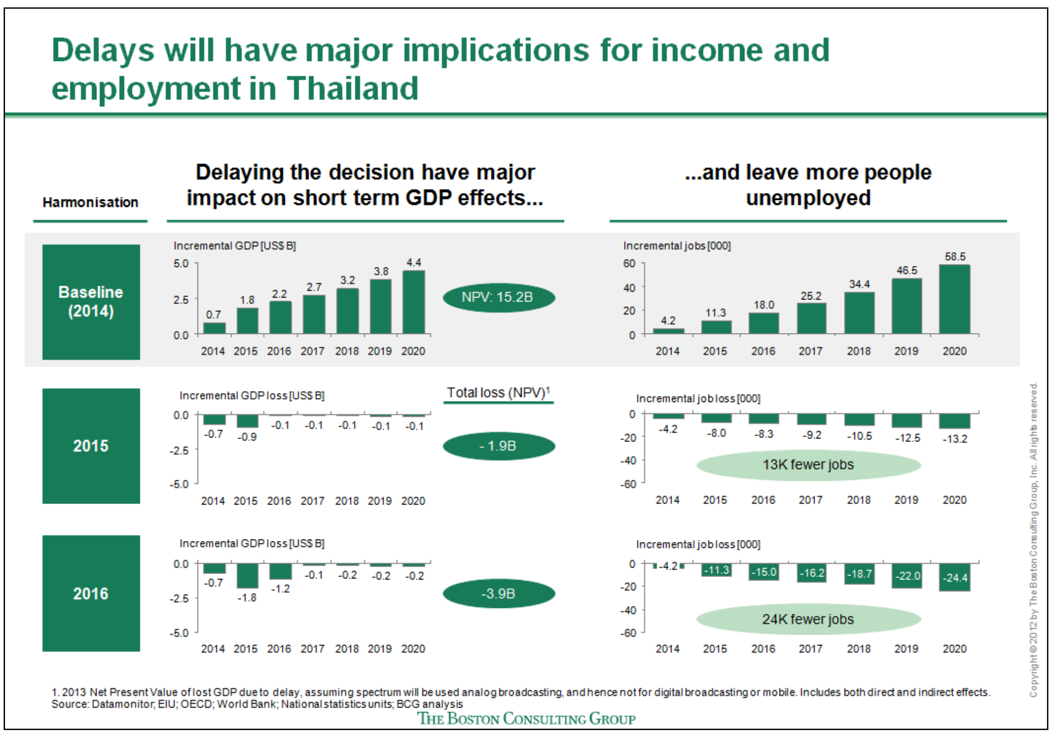

Exhibit 4.1 Impact of delayed allocation

5 CALL TO ACTION

The switchover to digital is an once-in-a-lifetime opportunity for Thailand.

It will allow the country to allocate spectrum to its most productive use, since mobile broadband has the potential to generate significantly greater economic and social benefits than alternative uses such as broadcasting.

Regional harmonisation in line with the APT band plan is critical to reap the full benefits of the Digital Dividend for Thailand and its neighbours.

Non-harmonization would impose additional costs in terms of both infrastructure and end-user devices, increasing the barriers to adoption and reducing the upside.

Prompt action is needed to maximize the benefits.

APPENDIX - METHODOLOGY

The core methodology for estimating the socioeconomic impact of broadband penetration comprises four key components, as depicted below in Exhibit A.1.

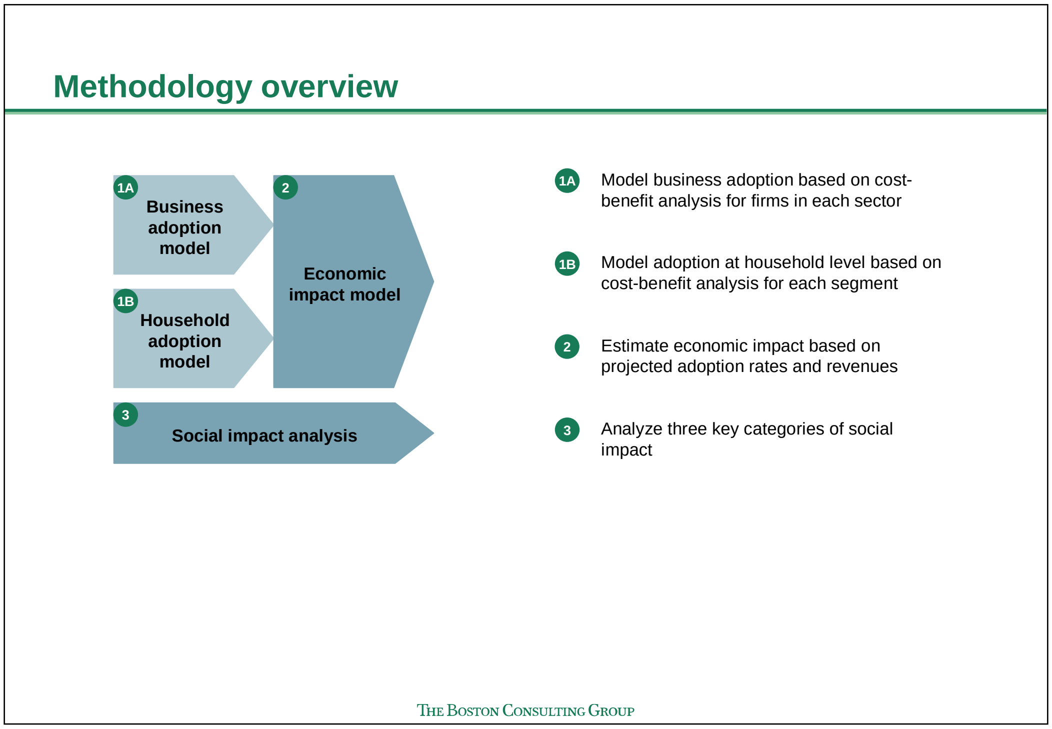

Exhibit A.1 Methodology overview

The general approach to modeling adoption is to do a bottom-up cost-benefit analysis to estimate of the number of subscribers in each segment for each year. Adoption is modeled separately for businesses and households. The methodology for business adoption, household adoption and economic impact are described in more detail below, as outlined in Exhibit A.2

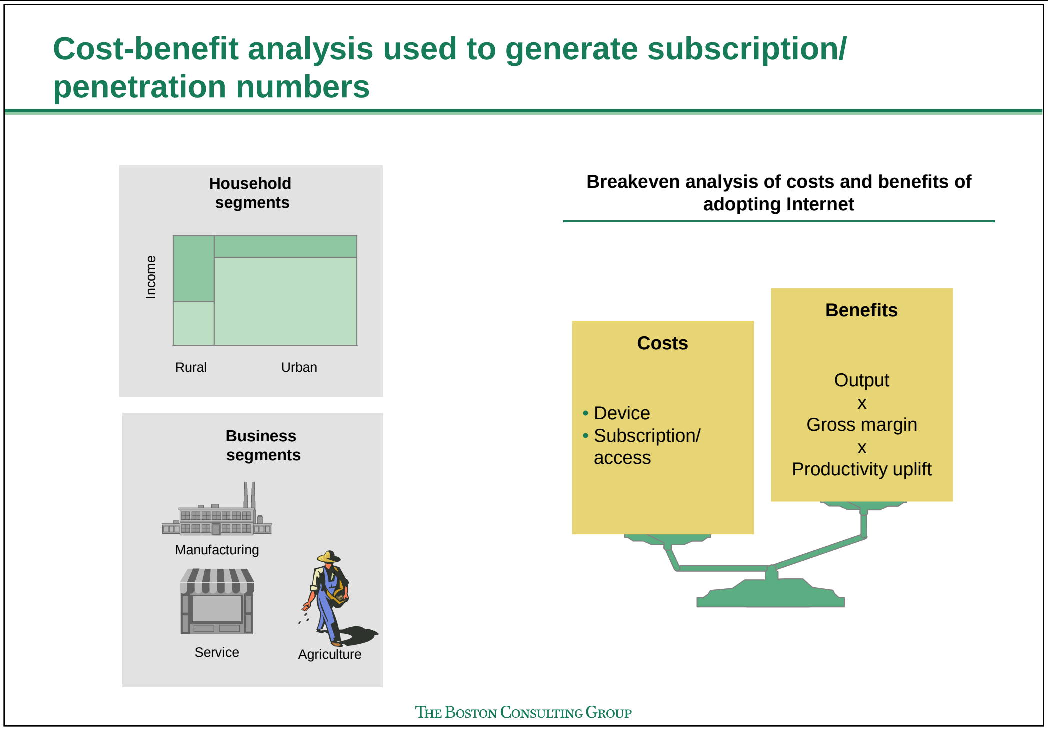

Exhibit A.2 Cost-benefit analysis

In addition, three extensions to the core model will be discussed:

- Impact of assigning the 700 MHz band to mobile broadband and the consequences of non-harmonisation of the 700 MHz band
- Impact of assigning the 700 MHz band to digital broadcasting (an alternative use)
- Extrapolation of results from study countries to the Asia-Pacific region

A.1.A Business adoption model

Estimating business adoption involves three steps:

- Segmentation of firms by size and industry
- Defining the addressable market
- Estimating adoption based on a cost-benefit analysis.

Segmentation Business adoption analysis begins by segmenting firms into agriculture, services and manufacturing sectors as each have distinct drivers of benefit from broadband adoption.

Firms in each sector are further divided into large and small firms based on number of employees, as firm size is observed to drive penetration as well as the type of package required.

Defining addressable market In some markets, some businesses are not computer-capable, and these have been excluded from the addressable market. This is done based on data from the local statistical office.

Estimating adoption Adoption is estimated by analyzing the costs and benefits of Internet adoption for firms within each segment. Firms will adopt if the increased gross profit from Internet usage exceed the total costs of ownership.

The primary driver of benefit is the increased productivity that accrues to the firm because of the Internet. Productivity in this case is defined as gross value added per worker, or in accounting terms, gross profit per employee. We have leveraged existing research to estimate the productivity impact of the Internet on industry, both services and manufacturing, and, in line with those studies, have assumed an increase in labour productivity of up to 10% for services, and 5% for manufacturing.

Within that range, the exact benefit depends on e-business intensity, that is, the extent to which the Internet is integrated into processes within the company. For example, a firm could initially use the Internet for internal emails, then for third party services such as e-banking or e-government, all the way up to a website with an online store. The model assumes that productivity increases linearly as e-business intensity increases, reaching 10% in service and 5% in manufacturing when intensity reaches 100%.

We have cross-referenced a number of studies to estimate the starting level and rate of change of e-business intensity in the study countries.

Starting e-business intensity An EU study from 2008 measured the level of e-business intensity in European countries in 2006, providing a benchmark for determining productivity uplift. To extend this measure to the study countries, which were not covered in the original EU report, an independent e-business adoption measure (the Economist Intelligence Unit e-Readiness ranking), which did cover both Europe and the Asia-Pacific, was used. A relation between the two measures was found through linear regression, yielding e-business intensities for the study countries in the year 2006.

Rate of change of e-business intensity The EU report found that countries differed in growth rate of e-business intensity depending on their categories (such as “large industrial countries” or “less developed knowledge societies”). The study countries were assigned to these categories, and their associated growth rates, based on measures such as their demographic and economic structures.

We have assumed that these growth rates will remain linear over the timeframe of the study. It is possible that in reality, intensity growth will accelerate due to increasing network externalities as more companies in the economy adopt the Internet. However, we have chosen not to make additional assumptions around the rate of change in intensity, and prefer linear growth rates as they are more conservative.

From these e-business intensities, we derived the projected productivity increases for the study countries as shown in Exhibit A.3.

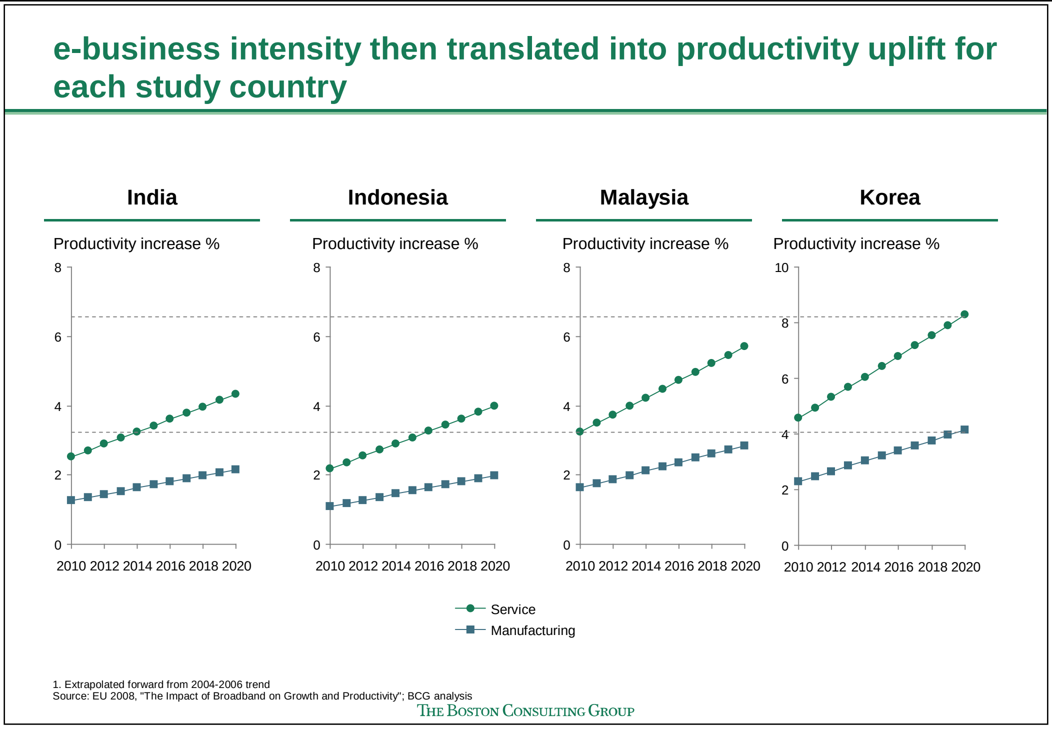

Exhibit A.3 Productivity impact

Agriculture The productivity uplift accruing to agriculture from ICT has been more difficult to estimate, with anecdotal reports varying widely in estimated impact. For example, in Senegal, the Internet was reported to have helped farmers to make better decisions about the choice of priority crops, optimal use of fertilizers and product diversification, leading to a productivity increase of 5%. In contrast, the Bangladeshi "e-krishak" scheme was reported to have increased yields by 65% for some farmers by providing online information solutions. To be conservative, BCG has assumed a 5% productivity uplift for small agricultural companies as a result of Internet adoption.

For large commercial farms, the value added from these holdings is assumed to be 20% of the manufacturing gain for that country at that time. This is based on relative benchmarks[2], and fits well with expected outcomes. The majority of the increase in value added in family farms is attributable to moving them towards the efficient production frontier, through better information

[2] *See ICT and productivity – an economic analysis of Australian industry* (Department of Broadband, Communications and Digital Economy, Australia) 2008

on seed varieties, planting times, fertilizer, disease treatment, as well as through better prices. Large farms should already have access to these, and be operating close to the efficient frontier, benefiting from their larger scale. Therefore, it should not be surprising that the benefit of Internet adoption is relatively low for such farms.

To estimate the breakeven percentile for adoption, we need to estimate the costs as well as the benefits. We determine the cost by defining the type of package that firms in each segment (large vs small firms) are likely to adopt, and estimate the price of such packages at each point in time. We then estimate the distribution of firm revenues within each segment, starting from the lowest. The applicable productivity increase is multiplied against the estimated revenues of the firms within each segment[3] for each year to derive the benefit of Internet adoption. The lowest level of firm revenues for which the benefits equal the cost is the breakeven percentile, and all firms with revenues above that are assumed to adopt. This process is illustrated in Exhibit A.4.

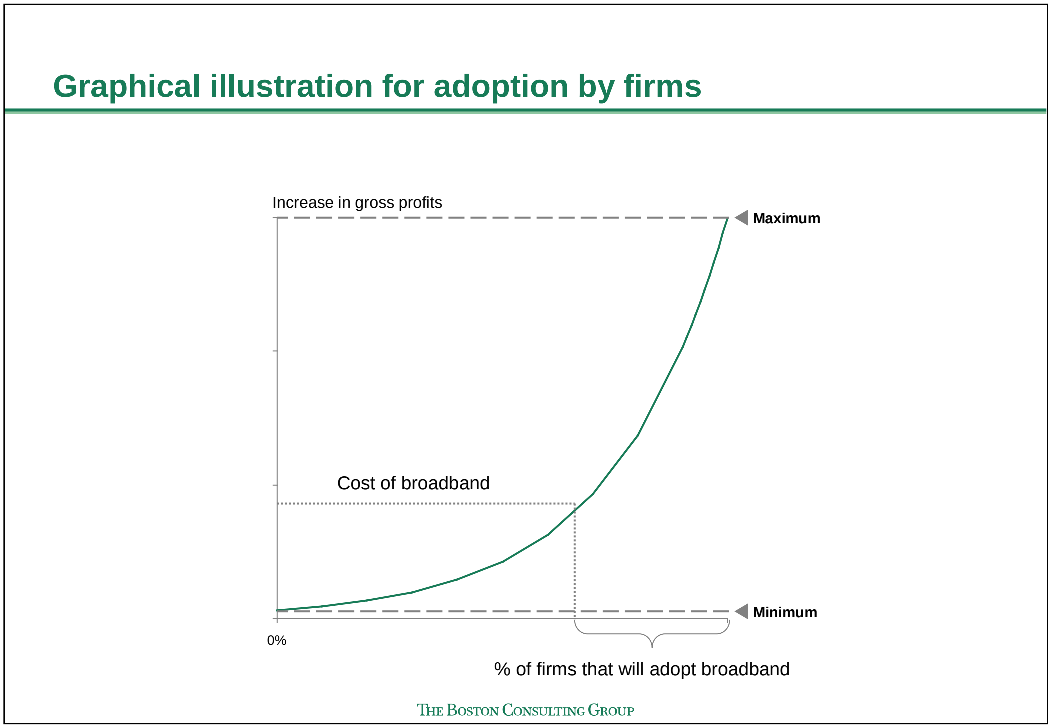

Exhibit A.4 Adoption by firms

[3] Revenues of firms within each segment are assumed to be distributed exponentially, with a small number of high revenue firms and a large tail of low revenue firms. This assumption is supported by the available data

Additional assumptions

Device costs have been excluded from the total cost of ownership for large firms, which typically already have a 100% computer penetration rates in the study countries.

The number of firms and the revenue of firms are assumed to each constitute 50% of real GDP growth. From a value added perspective, GDP is equal to the sum of value add for all firms, and hence, in aggregate, the number of firms and their revenue should track real GDP over time.

A.1.B Household adoption

The methodology for household adoption is broadly similar to business adoption.

Defining addressable market Households which are below the poverty line, or whose communities do not have adequate physical infrastructure for Internet access, are excluded from the addressable market.

Segmentation Households are segmented according to location and income. Consumer research suggests that location (urban vs rural) is a primary driver of likely adoption behavior as IT literacy, availability of services and awareness are driven by the rural/urban environment. For each location, the population is divided into "high" and "low" income based on their potential to be early adopters. A household is defined as "high" income if its expenditure on communications/IT, as reported in the local household expenditure survey, is higher than the average for that population.

Estimating adoption Adoption is estimated by analyzing the costs and benefits of Internet adoption for households within each segment. Households for whom the benefits from Internet usage exceed the total costs of ownership are assumed to adopt.

Estimation of benefits for households

Benefits for households are divided into two categories: "Needs", which are expressed as a percentage of household income, and "wants", which have a fixed dollar value for each segment.

"Needs" comprise the following

- Productivity gains from household businesses, calculated by multiplying the applicable productivity gain for the country against the proportion of household income derived from entrepreneurship and self-employment
- Productivity gains from agriculture. Studies suggest that households can increase their income by ~15% from better information and better prices, and this is multiplied against the proportion of income from agriculture for rural households

- Cost savings from online procurement/shopping are estimated based on an analysis of household expenditure. Elements of expenditure which could be spent online are identified, and multiplied against the possible savings based on available benchmarks.
- Time savings for urban segments are also factored in. Time savings can be generated through email access on-the-go, search functions to locate destinations, etc. Studies support the view that leisure time is valued at more than or equal to the hourly wage rate, and this 'perceived' value of time is included in the needs estimate

"Wants" benefits capture the perceived benefits of Internet use, e.g.,

- Information search, e.g., news, websites of interest
- Entertainment, e.g., games, sports scores
- Social networking, e.g., instant messaging, online communities
- "Sophistication", keeping up with global trends

Recognizing that these elements are inherently difficult to quantify, the approach taken in this report is to express consumer's willingness to pay as a multiple of Average Revenue Per User (ARPU) for mobile voice. The argument is that mobile voice can provide many similar functions, and provides us with a starting point for estimating what consumers *might* be willing to pay. Each consumer segment is assessed based on the value they are likely to place on each of the elements. In general, urban high income segments are assumed to have the highest want benefits, and rural low income segments the lowest. The "wants" estimates are also cross-checked against expenditure on relevant categories (e.g., entertainment and recreation) as a further sanity check.

Estimation of costs for households

The total cost of ownership for households comprises the cost of access device and the cost of subscription.

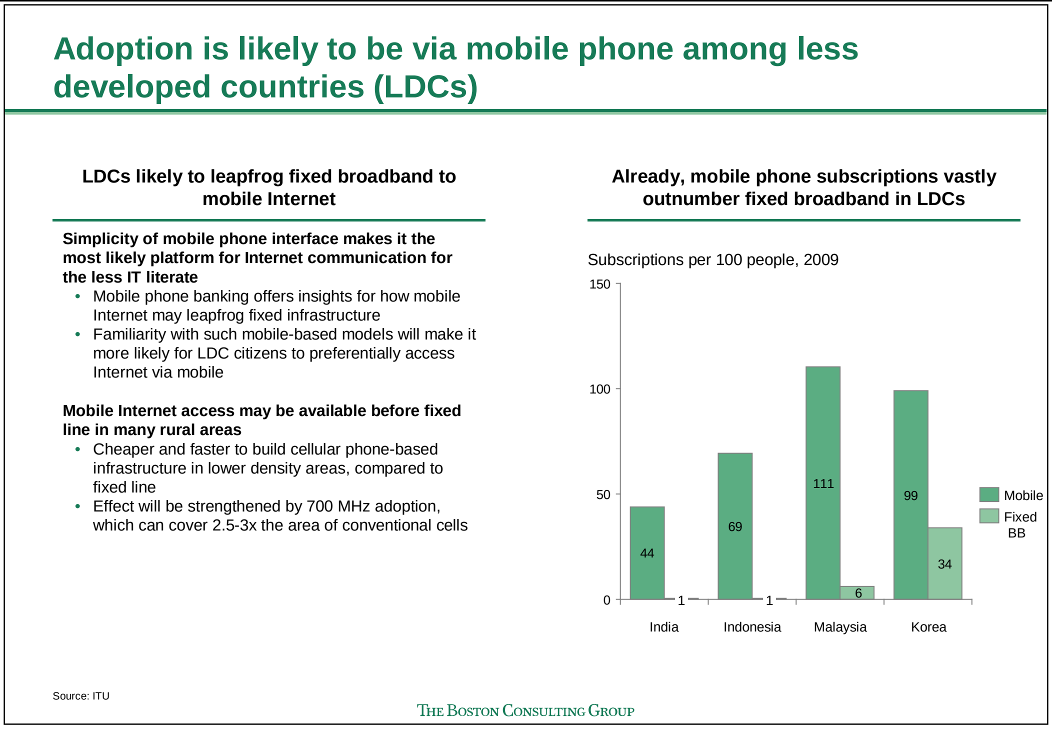

Exhibit A.5 Adoption platform for study countries

Choice of access platform varied between countries. In countries such as India or Indonesia, where fixed broadband penetration was <1% but mobile penetration was high and still rapidly growing, phones with basic Internet connections were assumed to be the primary device for potential Internet connections (see Exhibit A.5). In contrast, Korea and Malaysia have higher PC and fixed broadband penetrations. Thus, in these countries, the PC was assumed to be the primary access device for high income households.

Subscription and device costs were then estimated for these assumed access platforms, based on market data and expert interviews. The costs were typically of the lowest category of device and subscription that could fulfil the associated "needs" and "wants" benefits. Projections were also made on the rate of decline in costs over time, in line with experiences in developed countries.

Estimation of adoption

With the above information, the breakeven percentile for household adoption can now be calculated. The distribution of households by income can be estimated from data from the national statistics offices[4]. The breakeven percentile is defined as the percentile for which the total benefits ("needs" as % of income, plus "wants") equals the total cost of ownership. Households at or above that level of income are assumed to adopt.

Additional subscriptions within the household

The possibility that households could adopt more than one connection is also addressed within the model. This could represent a family supplementing the main fixed household connection with a Blackberry subscription for the businessman father, or perhaps a mobile broadband subscription for an undergraduate child. Households are assumed to adopt subsequent subscriptions if the total "need" and "want" benefit is sufficient to cover the total cost of ownership (service and device) of multiple subscriptions. To be conservative, no incremental benefit has been assumed from the fact that the subsequent subscription is mobile. The number of subscriptions has also been capped to 3 subscriptions for urban high-income households, to reflect the average household size in these segments.

A.2 Economic impact model

The economic impact model uses the Internet adoption figures from the adoption models to calculate their effect on 5 key economic parameters: productivity improvement, new business activity, jobs created, GDP impact and tax revenues. These are accounted for with respect to the telco supply chain, as well as the economy at large. The productivity impact and new business activity parameters , in particular, are more applicable to the general economy than to the telco industry specifically.

[4] . This is typically reported in deciles, but was converted into percentiles through interpolation

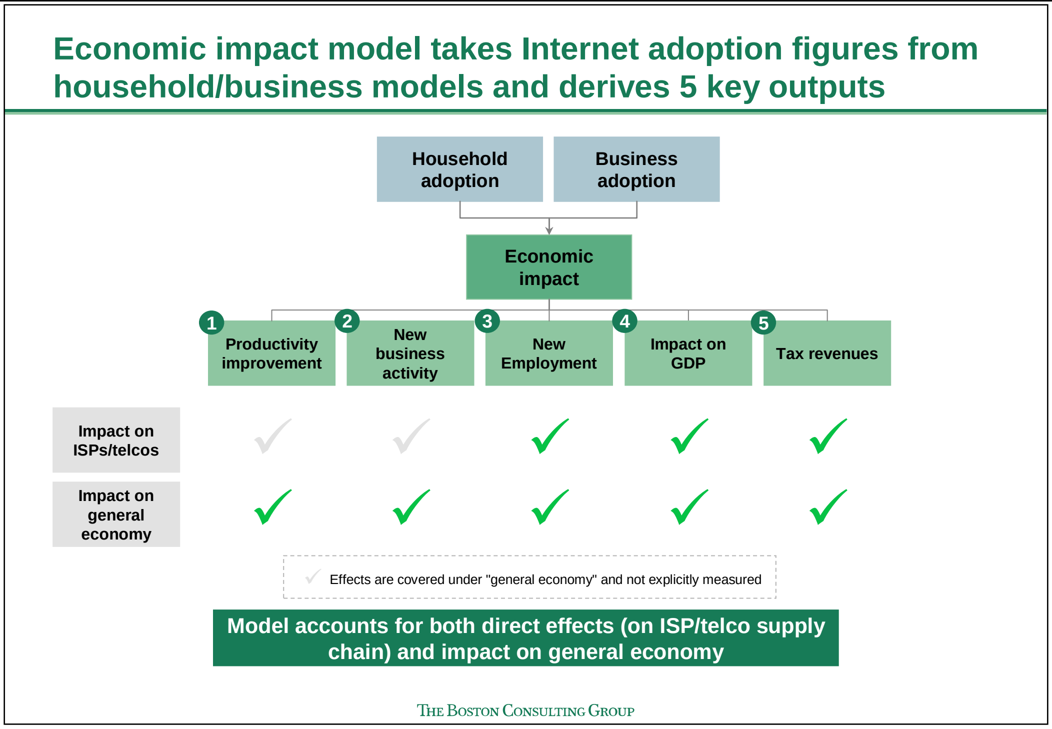

Exhibit A.6 Parameters of economic impact model

Productivity impact

We have already argued that Internet adoption will improve the productivity (gross value added per employee, or gross profit per employee) of firms that integrate it into their operations. Exhibit A.7 shows how productivity gains at the individual firm level are ultimately translated into GDP impact at the economy level. This is done by multiplying the productivity gain at the firm level by the Internet adoption rate and the total GDP contribution for each of the 6 segments in the business adoption model. The productivity impact by sector is then summed to arrive at an economy-wide productivity uplift figure.

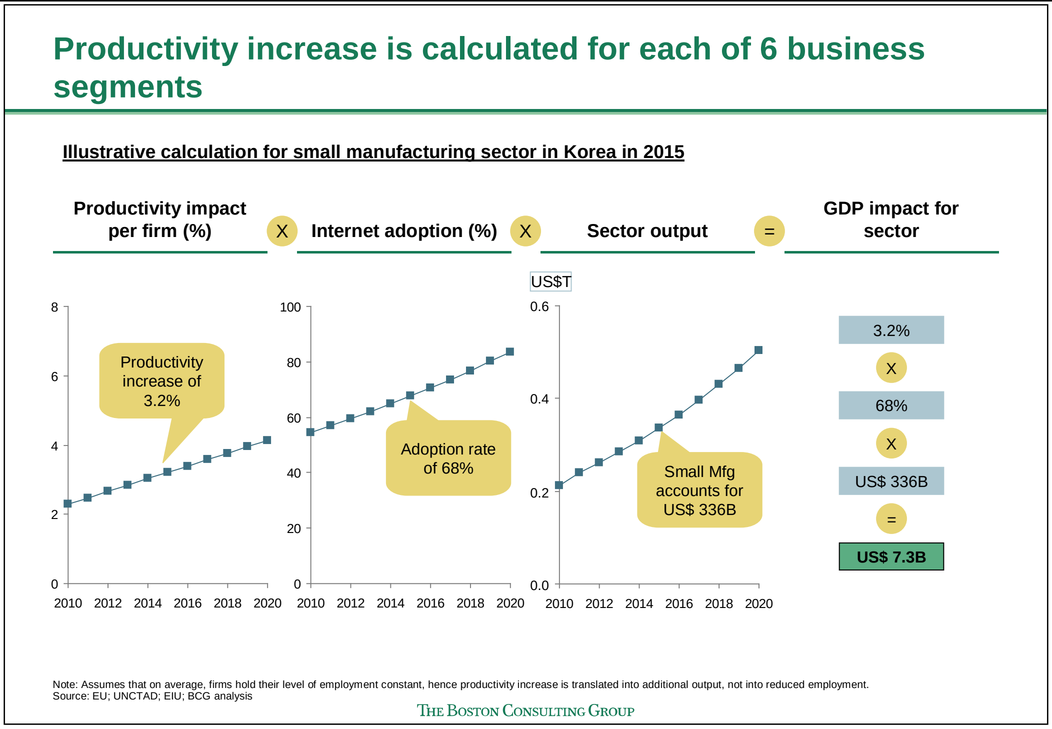

Exhibit A.7 Productivity impact calculations

New business activity

The Internet creates multiple opportunities for entrepreneurs to exploit. These include, but are not limited to:

- Businesses based on offering Internet access and its benefits to first-time or low-income users, such as Internet cafes, digital studios
- Leveraging the Internet as a sales channel for goods or services
- Using the Internet as an information aggregator to bring together buyers and sellers, such as with an online auction site or job search services
- Providing services to other Internet businesses, such as website design, e-commerce platforms, server and storage

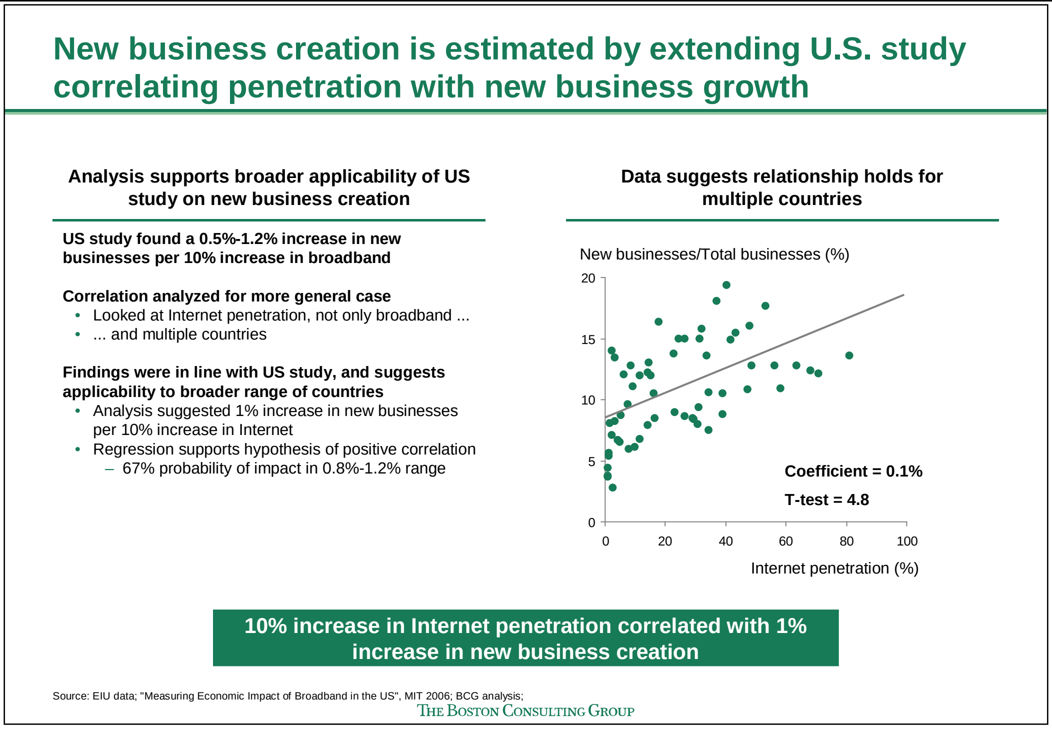

Exhibit A.8 New business creation

The study assumes that a 10 percentage point (pp) increase in overall Internet penetration will increase the rate of new business formation by 1%. This means that, if there are 1 million companies in the economy, ten thousand additional new businesses will be formed each year for every 10 pp of penetration. This relationship was reported in a study in the US, and supported by an analysis of a broader dataset of countries, as can be seen in Exhibit A.8.

These additional business activities are assumed to have the average revenues, profits and number of employees as the average small firm in the economy, thereby contributing to GDP as well as job creation.

GDP impact, employment and tax revenues

The last 3 parameters can be estimated by combining new business/productivity results with the direct impact of increased broadband adoption on the ISP supply chain.

- Incremental employment is estimated as the sum of employment resulting from additional jobs in the ISP supply chain, and new business employment. The latter is derived by multiplying new business creation with employment per new firm, from historical statistics. The former is estimated using the ISP job/profit ratio – that is, the number of employees the ISP needs to hire in order to generate $1 of value add. When multiplied by ISP broadband revenues (which is the sum of value adds across its supply chain), this ratio yields the total number of jobs created within the industry.

- GDP impact is calculated for the ISP supply chain as the sum of the following components: infrastructure spending as a result of 700 MHz band rollout; regulatory fees; additional wages paid to employees; and profits. In keeping with the principle of conservative estimation, care is taken to account for payments that may be made to foreign entities and thus have no GDP impact in the study country. Specifically, infrastructure spending and profit have been multiplied by their "% domestic share" in order to account for foreign outflows and avoid overestimating GDP impact.
- Although not a component of GDP, contribution to government revenues, in the form of taxes and regulatory fees, is an area of keen interest, and is therefore reported alongside the other economic metrics. The main components are: Value Added Taxes and corporate taxes accruing from new businesses, productivity increase as well as the ISP incremental revenues; income taxes from incremental employment; and regulatory fees and other industry-specific taxation.

A.3 Impact of the 700 MHz band and technical harmonisation

Having built up a core model that translates price, income and industry data into broadband adoption and economic impact figures, we are now in a position to model the impact of the 700 MHz band by considering the different scenarios.

As statistics on Internet adoption frequently use different terms and definitions, the BCG methodology refers to Active Subscriptions, being the number of fixed and mobile Internet subscriptions actually being used, and taking part in the estimated socio-economic benefits, as shown in Exhibit A.9. For fixed line Internet, typically the number of users reported is higher than number of subscriptions, as people may use the Internet at cafés, or several share one household connection. For mobile Internet on the other hand, typically the number of subscriptions is higher than the number of actual users, as subscriptions are counted as Internet enabled devices – including dongles – in areas with 2.5G or better coverage, regardless of whether they are used.

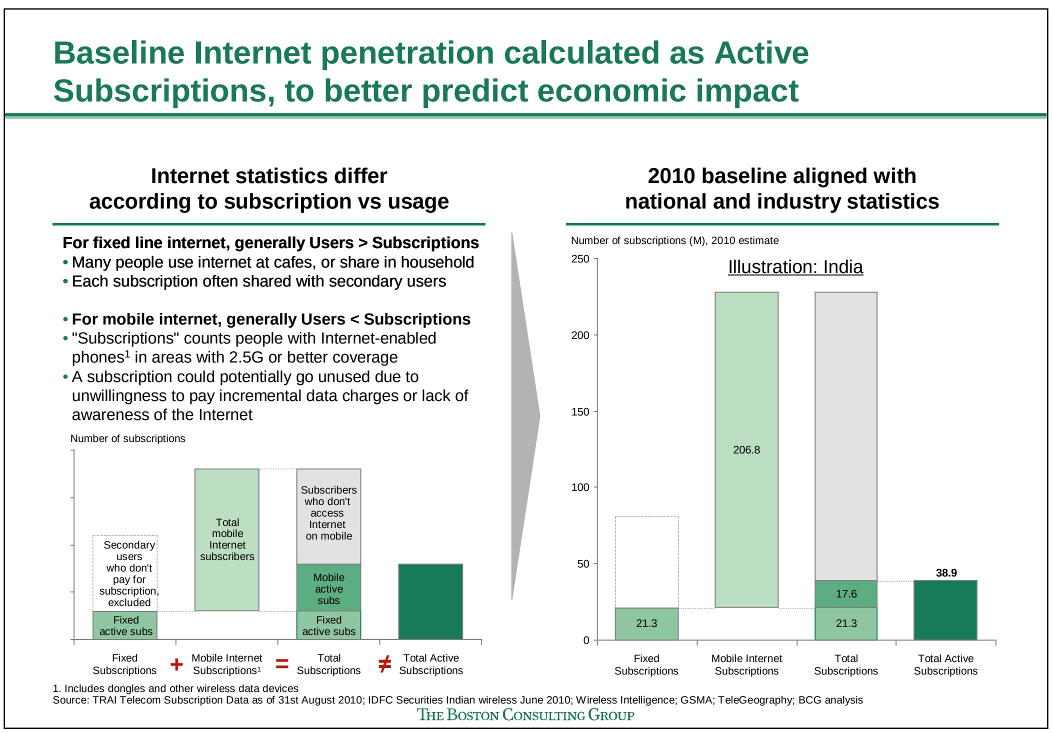

Exhibit A.9 Active Subscriptions

Scenario 1: Allocation of harmonised 700 MHz band to mobile broadband

We assume that the 700 MHz band based mobile broadband is rolled out 2014-2015, and measure the effect to 2020. The key changes in the scenario are:

- **Subscription price decrease of 6-10% to consumers as a result of service cost reduction**

  The 700 MHz band will primarily impact infrastructure roll-out costs in rural areas, as it has a much greater range than the 1800 MHz band, 2100 MHz band or 2600 MHz band based transmissions. Differences in propagation characteristics of the various frequency bands implies that utilizing the 700 MHz band in comparison will require fewer towers to serve a particular area. We assume that these savings, as a percentage of overall ISP costs, are passed on to the consumers, with the caveat that this may require a competitive telco market or government regulations on the use of the 700 MHz band to drive adoption through lower prices. With a conservative infrastructure cost reduction of 50% (dependent on network topology and degree of pre-existing infrastructure in rural areas), the most conservative estimate for savings is 6% based on BCG's benchmarks on telco cost structures, although experts believe the number could be significantly higher. Based on discussions with industry experts, a 10% cost decrease is applied for Malaysia, Indonesia and India, while 6% is applied to account for Korea's more mature network.

- **Increase in rural household benefits by 10-20%**

  This assumption accounts for the network externalities created by the projected increase in mobile broadband penetration in the rural areas. As rural penetration increases, more applications and services will be developed to service the rural areas, in turn increasing the benefit of mobile broadband subscription. Therefore, "needs" benefits are assumed to increase by 10%, and "wants" by 20%, which is typically sufficient to close the existing gap between rural and urban benefits.

- **Increase in rate of productivity growth**

  As productivity gain from Internet adoption is modeled on e-business intensity in the business adoption model, allocating the 700 MHz band to mobile broadband is expected to increase the rate of e-business intensity growth. This reflects both a network externality as more rural firms come online, and also the increasing value of the Internet to all firms as Internet penetration increases.

Additionally, to simulate the lag time required for the economy to build awareness and fully realize the potential of deploying mobile broadband in the 700 MHz band, the above assumptions are phased in over two years.

Scenario 2: Allocation of 700 MHz band to mobile broadband, but non-harmonised bandplan

- **Increase in device cost by $1.5 - $15**

  Non-harmonised bandplan forces handset manufacturers to customize handsets specifically for the non-harmonised countries. This raises the R&D and production cost of the handset, due to the need for circuit board redesign and additional RF components. A study by RTT on the cost effects of non-harmonisation further argues that such a niche market would benefit less from product development efforts due to its lack of scale, leading to cost as well as value inefficiency compared to harmonised country. As shown in Exhibit A.10, this implies a per-handset price increase of US$1.5 in a market like China with 80M sold handsets per year, up to US$15 for markets with 8M handsets.

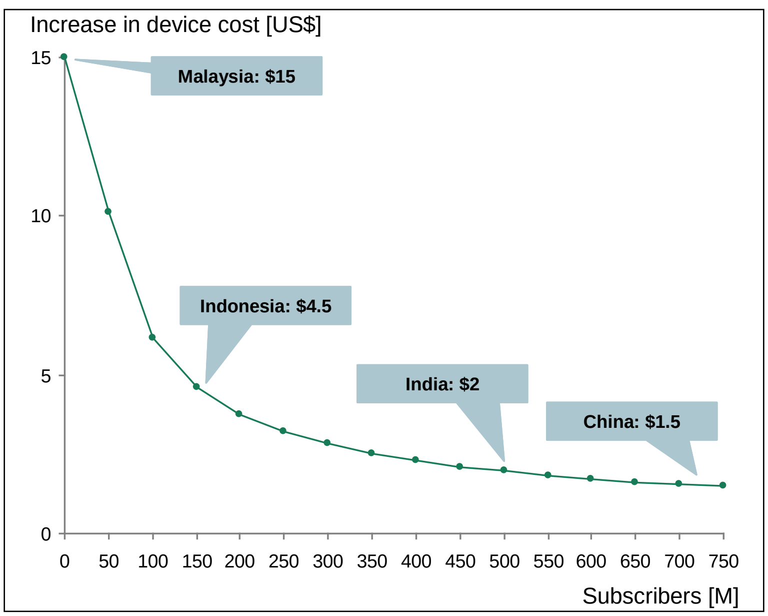

Exhibit A.10 Device cost increase due to non-harmonisation

A.4 Impact of allocating 700 MHz band to broadcasting

As digital broadcasting has been identified as the most likely alternative use for the 700 MHz band, it is necessary to compare the effect of allocating the band to Digital Terrestrial Television (DTT) rather than to mobile broadband. These effects are calculated by considering the effects of incremental DTT channels on GDP impact, new jobs, new businesses and taxes – thus allowing comparability with the core model.

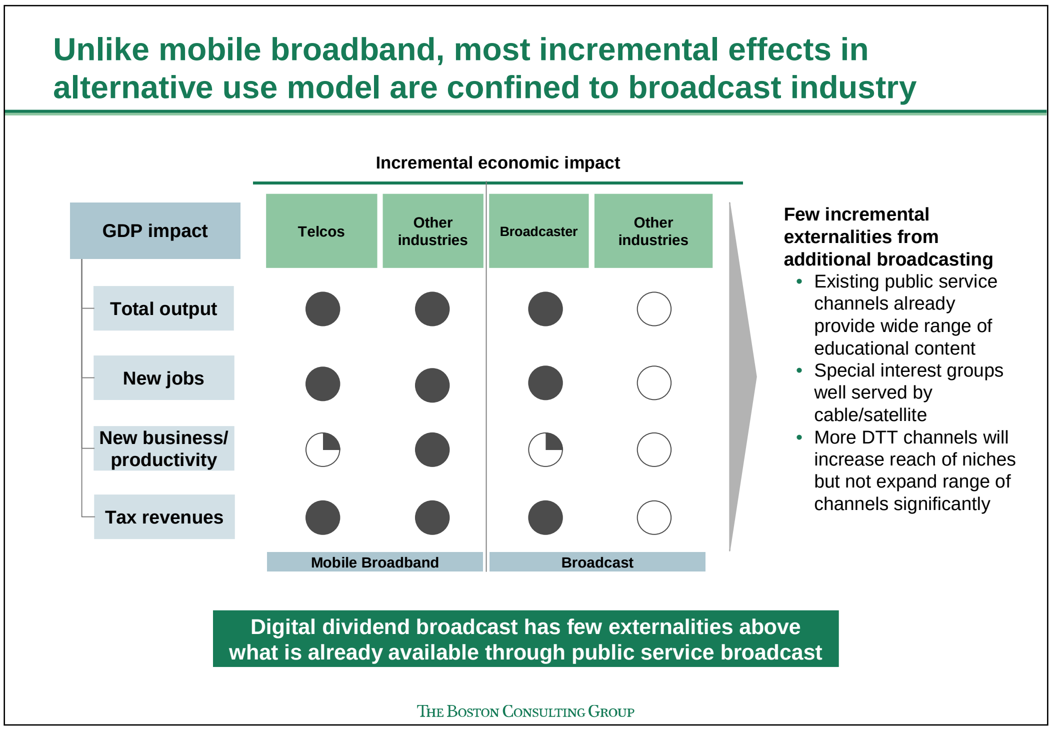

Exhibit A.11 Economic impact of broadcast vs. broadband

However, unlike mobile broadband, 700 MHz band based broadcast is not likely to have many incremental externalities on the general economy (see Exhibit A.11). While it is true that broadcast plays a crucial role in disseminating of social messages and educational material, most of these externalities can be captured by existing public service TV channels. Special interest groups are also well served by cable, satellite or IPTV in most markets, especially since the number of channels can be increased from the current baseline even without the 108 MHz bandwidth of the 700 MHz band being allocated to broadcasting. Therefore, the broadcast model focuses on the economic effects of the broadcast industry rather than the general economy.

Estimation of socioeconomic impact of incremental DTT channels

The broadcast model estimates the number of additional DTT channels that 700 MHz band can hold, and combines that with per-channel revenue and employment in order to arrive at GDP output and job creation. Government taxes are then derived from these figures.

The key assumptions in the broadcast model were:

- **Incremental number of TV channels**

  We assumed that the maximum technically feasible number of TV channels will be added to the study countries' broadcast offerings. This was determined by estimating the number of multiplexes that could fit in the 698-806 MHz band, and assuming 10 digital TV channels to each multiplex. The 10:1 compression is based on DVB-T/MPEG4 standards, which is optimistic as the MPEG2 to MPEG4 upgrade has not been applied yet in most countries. DVB-T2 compression, which further offers 30-50% spectrum savings, was not assumed as it has been used in most countries to implement High Definition TV, which would not result in more TV channels overall.

- **Revenue per incremental TV channel**

  Additional TV channels create incremental value add across the broadcast supply chain, from production houses to content aggregation and distribution. To measure this incremental effect, we consider the additional revenue earned by broadcasters as a result of the additional TV channels, which is the sum of these value add components. In theory, the revenue of each marginal TV channel should be approximately equal to the lowest-revenue TV channel in each study country, since a popular TV channel would tend to replace less popular offerings. However, in the interest of conservativeness, BCG has estimated incremental TV channel revenue as the average TV channel revenue within the broadcast industry.

- **Employment per incremental TV channel**

From interviews with experts in the broadcast industry, BCG estimates that each additional syndicated TV channel creates only a small number of jobs since they only need to package and distribute local content, while TV channels which produce content will have more employees. The TV channel mix was assumed to be 50-75% local, depending on the nature of the film and broadcast industry in each industry. Channels subsidized with public funds were excluded from the analysis because they utilize government funds which could have been used in other job creation/economic stimulus measures.

In general, the broadcast model was calculated based on best-case estimates in order to deliberately overstate the effect of allocating 700 MHz band to broadcast. However, evidence from countries that have made the DTT transition suggests that incremental revenues and number of TV channels may be lower than expected due to issues of commercial (rather than technical) feasibility. In Exhibit A.12, the average number of digital terrestrial TV channels in Europe is 32, compared to the 25-35 incremental TV channels used in the broadcast model. Also, in a market with hundreds of TV channels, each incremental TV channel is unlikely to gain significant market share without cannibalizing existing TV offerings, reducing the overall value add to the industry. Therefore, the total economic impact of allocating 700 MHz band to broadcast is likely to be lower than the results reported in this study.

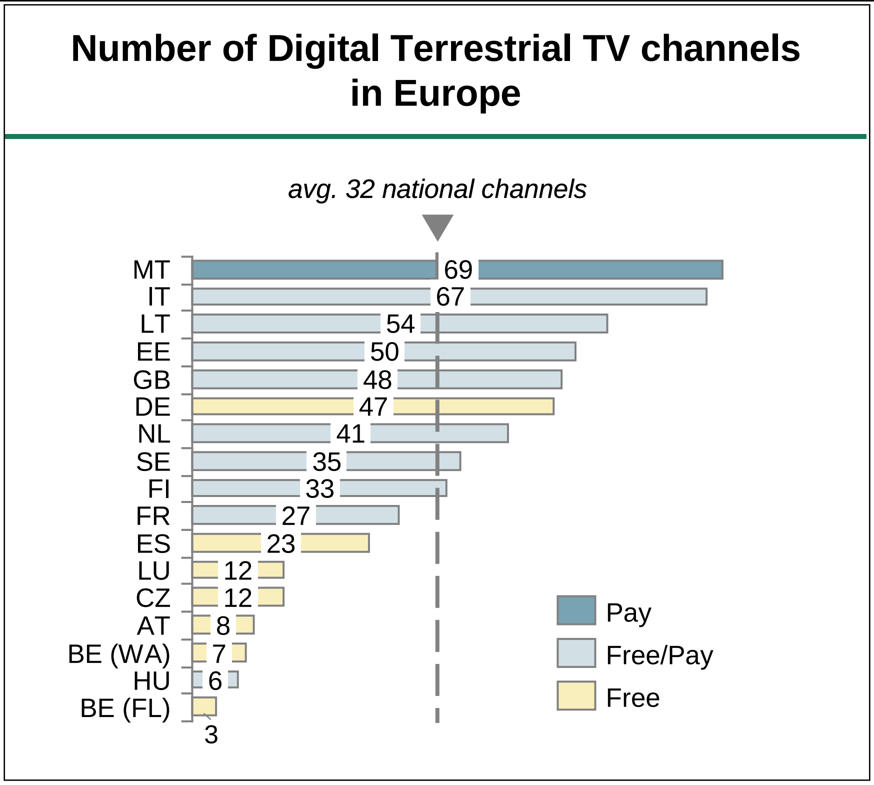

Exhibit A.12 Number of DTT channels in Europe

A.5 Extrapolation methodology

Having compared various scenarios for the study countries (mobile broadband, non-harmonisation, broadcast), we can now generalize the results to the region. In order to estimate the economic impact across Asia Pacific, the region[5] is divided into three clusters based on three key benefit drivers; UN's Human Development Index (HDI), level of urbanization and current mobile penetration. GDP per capita is also used as an underlying driver for extrapolation.

Given that the benefits of the 700 MHz based mobile broadband will be primarily rural, countries with lower levels of urbanization would expect to see greater uplift in overall adoption, all things being equal. Mobile penetration is used as a proxy of the technological and Internet sophistication in the country, and countries with lower penetrations would expect to see a bigger impact from the lower cost of infrastructure rollout and ability to target current non-adopters. Finally, countries with lower levels of overall human development would also expect to see a

[5] Due to lack of reliable public data, the countries of Kiribati, Marshall Islands, Micronesia, Tuvalu and North Korea are omitted from this study

bigger social benefit as mobile broadband solutions can be tailored to address their most pressing needs.

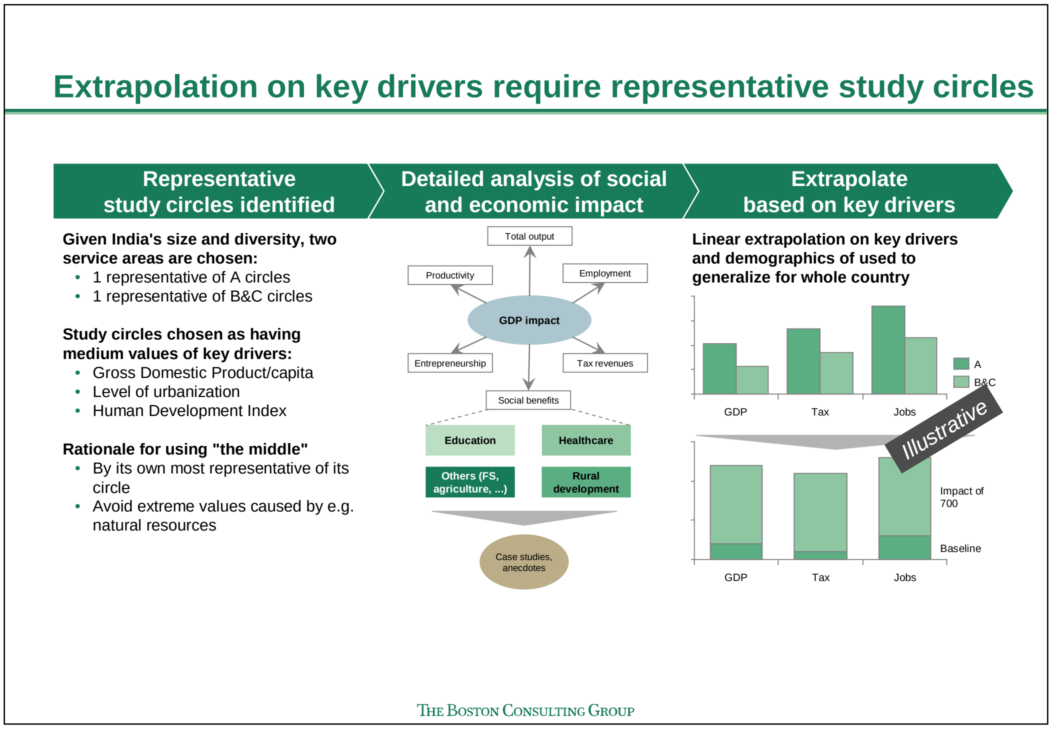

Exhibit A.13 Extrapolation methodology

Cluster A – study country Korea

Consists of countries high on HDI and level of urbanization; Australia, Brunei, Japan, New Zealand and Singapore. These have all currently more than 90 mobile subscriptions per 100 inhabitants, HDI above 0.9 and fairly high level of urbanization, with the exception of Japan at 66 per cent urban population.

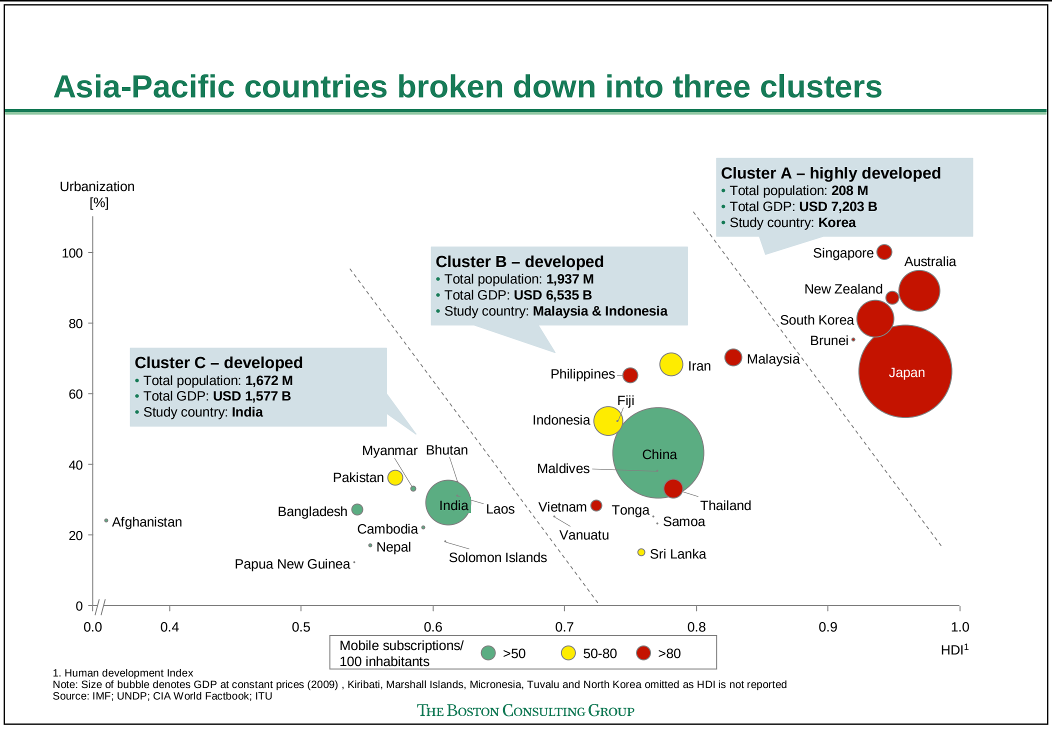

Exhibit A.14 Clustering of Asia-Pacific countries

Cluster B – study countries Malaysia and Indonesia

Two study countries are chosen in order to represent the diversity of this cluster, with HDI varying from 0.73 (Vietnam) to 0.83 (Malaysia), 56 to 148 mobile subscriptions per 100 inhabitants (China and Maldives, respectively) and level of urbanization from 15 per cent (Sri Lanka) to 68 per cent (Iran). The cluster consists of China, Fiji, Indonesia, Iran, Malaysia, Maldives, Philippines, Samoa, Sri Lanka, Thailand and Tonga.

Cluster C – study country India

Being the largest market among the least developed countries in Asia Pacific, India itself is modeled through deep-dives into two states representing the regulatory authorities “Metro & A” and “B&C” circles, namely Maharashtra and Rajasthan, respectively. The study circles are themselves selected to be representative of the other states/regions in the same circle classification, based on HDI and urbanization, as shown in Exhibit A.13.

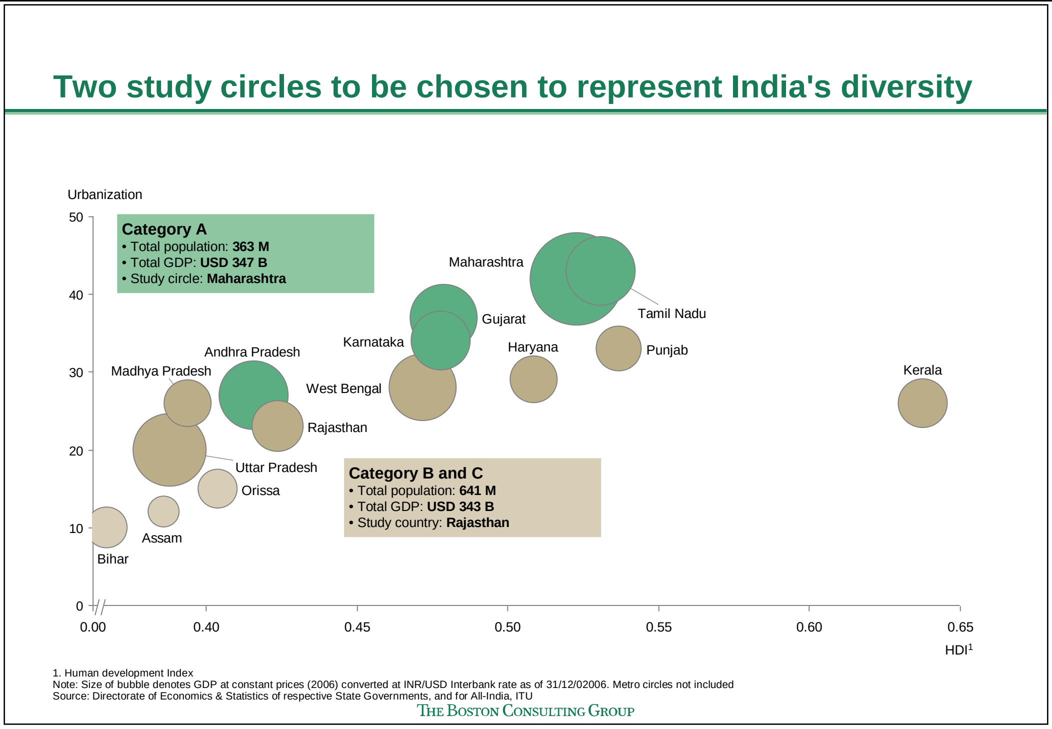

Exhibit A.15 India study circles

Countries in Cluster C are Afghanistan, Bangladesh, Bhutan, Cambodia, India, Laos, Myanmar, Nepal, Pakistan, Papua New Guinea and Solomon Islands.

Uplift factors

In order to scale up the effects from individual study countries to the cluster, all countries in the cluster are assigned an uplift value that is calculated based on the key drivers. The uplift factor adjusts the results for the study country to all other countries in the cluster based on their relative level of urbanization and mobile penetration, which, as noted above, are the key drivers of expected economic benefit.

As shown in Exhibit A.16, the uplift factor is calculated as the inverse of the average of urbanization and penetration. For countries in Cluster B, the countries’ urbanization and penetration numbers are indexed towards the average of study countries Malaysia and Indonesia. Similarly, Indian states are indexed towards the average of study circles Maharashtra and Rajasthan.

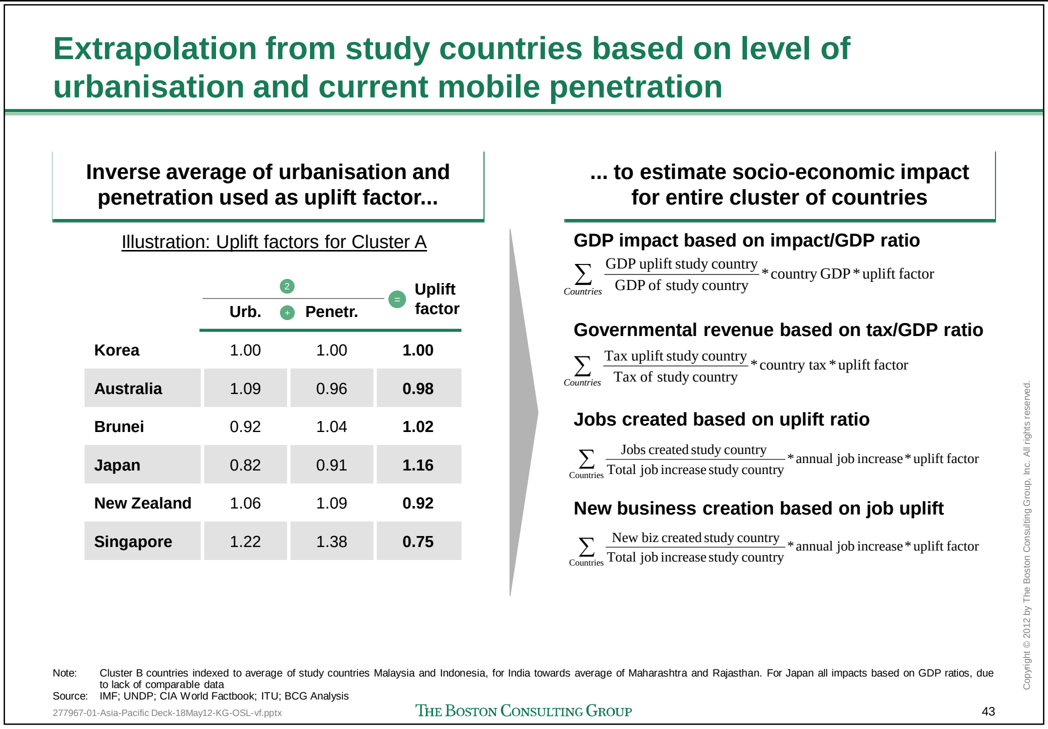

Exhibit A.16 Extrapolation calculations

As shown in Exhibit A.14, total impact across Asia Pacific is extrapolated along the four main socio-economic factors. Total GDP impact is calculated for each country as the country's GDP multiplied with the study country's GDP uplift, multiplied with the respective uplift factor. Total tax impact is calculated based on a tax/GDP ratio, while both jobs and new business creation are based on the relative uplift in job creation. The latter is due to lack of reliable, comparable multi-country statistics on business creation.

Uplift factors for all countries are shown in Exhibit A.17.

Uplift factors estimated for all countries relative to their cluster study country/countries

Cluster A	Cluster B[1]	Cluster C[1]
Australia: 0.89	China: 1.51	Afghanistan: 1.34
Brunei: 1.02	Fiji: 1.24	Bangladesh: 1.19
Japan: 1.16	Indonesia: 1.00 (study country)	Bhutan: 0.95
New Zealand: 0.93	Iran: 1.02	Cambodia: 1.18
Singapore: 0.77	Malaysia: 1.00 (study country)	India: 1.00 (study country)
Korea: 1.00 (study country)	Maldives: 0.94	Laos: 0.93
	Philippines: 1.07	Myanmar: 1.74
	Samoa: 1.61	Nepal: 1.81
	Sri Lanka: 1.94	Pakistan: 0.93
	Thailand: 1.31	Papua New Guinea: 2.30
	Tonga: 2.23	Solomon Islands: 2.82
	Vanuatu: 1.30	
	Vietnam: 0.94	

1. Uplift factors based on driver values indexed to the average of the study countries/circles
Note: Kiribati, Marshall Islands, Micronesia, Nauru, North Korea and Tuvalu not included due to lack of reliable data
Source: IMF; UNDP; CIA World Factbook; ITU; BCG Analysis

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Exhibit A.17 Uplift factors

BIBLIOGRAPHY

Key books and articles

Australian Communications and Media Authority, *Clearing the Digital Dividend* (2011)

Adekunle, Adewale, *Using ODL aided by ICT and Internet to increase agricultural productivity in rural Nigeria* (International Institute of Tropical Agriculture, 2006)

Aetha, *Case studies for the award of the 700 MHz/800MHz band: Australia* (2011)

AMI Partners, *2004-05 Indonesia Small Business Market Opportunity and Topline Assessment* (2005)

Analysys Mason and Hogan & Hartson, *Valuation of the Digital Dividend in France* (2008)

Asia Pacific Telecommunity, 9th meeting of the APT Wireless Forum, document AWF-9/OUT-13

Business Monitor International, *Korea Telecommunications Report* (2010)

Caldow, Janet, *Working Outside the Box: A Study of the Growing Momentum in Telework* (2009)

Census of India, *Census Results* (2001)

Census of India, *Census Results* (2011)

Cha, Eun Shil, *Prevalence and changes in chronic diseases among Korean farmers: 1998 to 2005* (Korea University 2009)

D'Costa, Valerie, and Kelly, Tim, *Broadband as a platform for economic, social and cultural development: Lessons from Asia* (Joint OECD-World Bank Conference, 2008)

East Asia Countries: Policies and Implementation (International Association of Agricultural Economists Conference 2006)

Economic Impact of Mobile Communications in Serbia, Ukraine, Malaysia, Thailand, Bangladesh and Pakistan (Deloitte 2008)

Economic Planning Unit of Malaysia, *Tenth Malaysia Plan* (2010)

Economou, Persephone, *Harnessing ICT for FDI and Development (*OECD 2008)

Econston, Broadcasters and radio spectrum: *The emergence of a European digital dividend in the United Kingdom and Spain* (2011)

El-Darwiche, Bahjat, *et al*, *Towards More Effective Regulation: Unlocking the Value of Telecoms Markets in the MENA region* (Booz Allen Hamilton 2007)

Entner, Roger, *The Increasingly Important Impact of Wireless Broadband Technology and Services on the US economy* (2008)

Fornefield, Martin, Delaunay, Gilles, and Elixmann, Dieter, *The Impact of Broadband on Growth and Productivity: A study on behalf of the European Commission* (2008)

Gillett, Sharon, *et al*, *Measuring Broadband's Economic Impact* (U.S. Department of Commerce, 2006)

Grameenphone, *Annual report*, 2009

GSMA, *Digital Dividend Toolkit* (2011)

Ha, Yeonseob, *Korea's Experience on Improving Rural Education (*Yonsei University 2009)

ICT and productivity – an economic analysis of Australian industry, (Department of Broadband, Communications and Digital Economy, Australia 2008)

Information Technology and Innovation Foundation, *Framing a National Broadband Policy* (2008)

Intven, Hank (editor), *Telecommunications Regulation Handbook* (World Bank InfoDev 2000)

Korea Internet and Security Agency, *Survey on the Internet Usage* (2009)

Malaysian Communications and Multimedia Commission, *Spectrum Plan 2011* (2011)

Ministry of Economic Development of New Zealand, *Digital Dividend: Opportunities for New Zealand* (2011)

Ministry of Human Resource Development of India, *Annual Report on Education 2007-08* (2007)

National Broadcasting and Telecommunications Commission (NBTC) of Thailand, *Spectrum Master Plan* (2012)

National Council of Applied Economic Research, *The Great Indian Middle Class*

Network Strategies, *Digital dividend spectrum: key issues for New Zealand* (2011)

Ninomiya, Seishi, *Successful Information Technology for Agriculture and Rural Development* (National Agricultural Research Center 2004)

Ofcom, *Digital dividend: clearing the 800 MHz band* (2009)

Ofcom, *Coexistence of new services in the 800 MHz band with digital terrestrial television* (2011)

Organisation for Economic Cooperation and Development, *OECD Communications Outlook* (2009)

Performance Management and Delivery Unit of Malaysia, *Economic Transformation Programme* (2010)

Planning Commission of India, *11th Five Year Plan* (2007)

RTT Online, *RF Cost Economics for Handsets* (2007)

SCF Associates Ltd, *The Mobile Provide: Economic Impacts of Alternative Uses of the Digital Dividend* (2007)

Statistics Malaysia, *General Report of the Population and Housing Census* (2000)
The Programme for International Student Assessment (OECD 2006)

Telecom Regulatory Authority of India, *The Indian Telecom Services Performance Indicators* (2011)

Primary websites and other resources

Alokito Bangladesh: http://www.alokito-bangladesh.com.bd
Badan Pusat Statistik: http://dds.bps.go.id
Bangkok Business News: http://www.bangkokbiznews.com/home/
Capitaline: http://www.capitaline.com
CIA World Factbook: https://www.cia.gov/library/publications/the-world-factbook/
Directorat Jenderal Pajak: http://www.pajak.go.id
Economic Planning Unit of Malaysia: http://www.epu.gov.my
Economist Intelligence Unit : http://www.eiu.com
Euromonitor : http://www.euromonitor.com
Eurostat database: http://epp.eurostat.ec.europa.eu/portal/page/portal/eurostat/home/
Gartner: http://www.gartner.com
GSM Association: http://www.gsmworld.com
Indiastat: http://www.indiastat.com
International Monetary Fund: http://www.imf.org
International Telecommunications Union: http://www.itu.int
Internet Math Tutoring: http://www.Internetmathtutoring.com
InternetWorldStats: http://www.Internetworldstats.com
ITC Limited: http://www.itcportal.com/sustainability/lets-put-india-first/echoupal.aspx
Korea Communications Commission: http://eng.kcc.go.kr
Korea Internet and Security Agency: http://isis.nida.or.kr/
Korea National Statistics Office: http://kostat.go.kr
Malaysia Communications and Multimedia Commission: http://www.skmm.gov.my/
Manager Online: http://www.manager.co.th/home/
Manobi Development Foundation: http://www.manobi.net
Ministry of Statistics and Programme Implementation (India): http://mospi.nic.in
MyHealth Malaysia: http://www.myhealth.gov.my
Myngle: http://www.myngle.com
National Statistics Office of Thailand: http://web.nso.go.th/
OECD Broadband portal: http://www.oecd.org/sti/ict/broadband
OECD Health database: www.oecd.org/health/healthdata
Office of the National Broadcasting and Telecommunication Commission:
http://www.nbtc.go.th/wps/portal/NTC/Home2
Office of the National Economic and Social Development Board: http://www.nesdb.go.th/
Service Canada: http://www.servicecanada.gc.ca/eng/home.shtml
Source for Change: http://www.sourceforchange.in
Statistics Malaysia: http://www.statistics.gov.my

Telecom Regulatory Authority of India: http://www.trai.gov.in
Telkomsel: http://www.telkomsel.com
TheCarrot website: http://thecarrot.com
UITP: http://www.uitp.org/publications/Mobility-in-Cities-Database.cfm
United Nations Development Program: http://www.undp.org/
Vault: http://www.vault.com/wps/portal/usa
World Bank Database: http://data.worldbank.org/
World Health Organisation: http://www.who.int