Report for GSMA

Assessment of the economic impact of wireless broadband in Taiwan

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analysys mason

Contents

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1 Introduction

Analysys Mason has prepared this report for GSMA to assess the direct and indirect economic impact of wireless broadband in Taiwan. The content of this report is based entirely on the sources and data presented in an earlier report by Analysys Mason. The primary focus of the assessment was to:

- evaluate the direct impact of wireless broadband services
- estimate the impact of wireless broadband services on related economic sectors within the ecosystem
- and estimate the second-order impact of wireless broadband services in terms of productivity gain

As shown in Figure 1.1, while Taiwan ranked highly in terms of digital economy, it cannot afford to rest on its laurels and is still behind Singapore and Hong Kong overall.

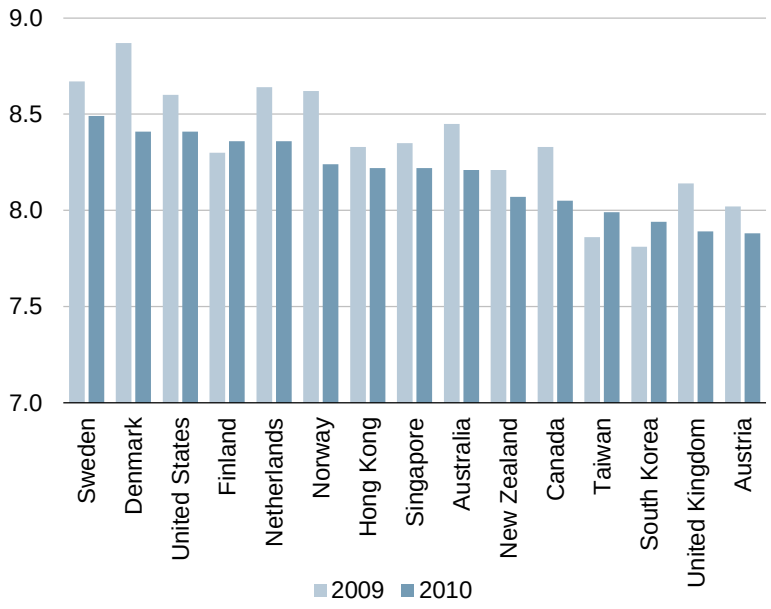


Figure 1.1: EIU score of e-readiness (2009) and digital economy (2010) [Source: EIU]

Specifically, Taiwan scores relatively low in terms of connectivity, scoring only 7 compared to other indicators, most of which score more than 8 (e.g. government policy/vision) as shown in Figure 1.2.

Indicator	*Score*
Government policy/vision	8.55
Social/cultural environment	8.40
Legal environment	8.15
Consumer/business adoption	8.15
Business environment	7.95
Connectivity	7.00
Overall	7.99

Figure 1.2: Breakdown of digital economy score for Taiwan [Source: EIU]

Based on these statistics, the Taiwanese government should push forward its digital initiatives, particularly with regard to connectivity, in order to drive its competitive advantage and sustain or improve its digital ranking.

Analysys Mason finds that an increase in wireless broadband penetration of 10% will contribute TWD 5 billion (USD 0.2 billion) or 0.27% to Taiwan's GDP (see Figure 1.3).

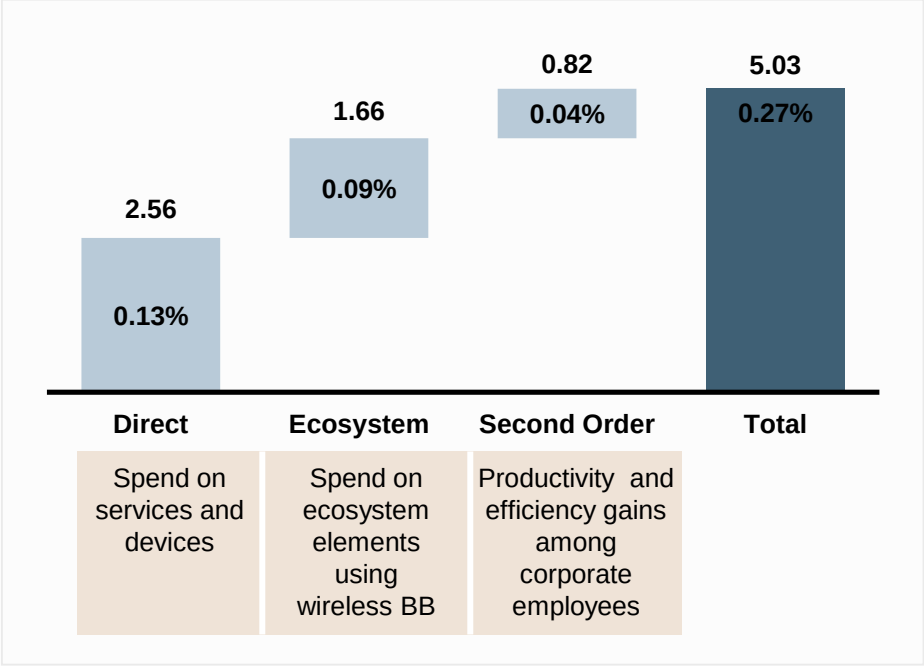


Figure 1.3: Impact on GDP by 10% increase in wireless broadband penetration (TWD billion, 2010-2015) [Source: Analysys Mason]

In addition, Analysys Mason finds that wireless broadband will contribute a total of TWD 333 billion in 2015, representing 1.76% of Taiwan's GDP. Specifically, we estimate TWD 161 billion to be generated from the direct impact from service delivery, TWD103 billion from the related

wireless broadband ecosystem and TWD69 billion from second order productivity gains (see Figure 1.4 below).

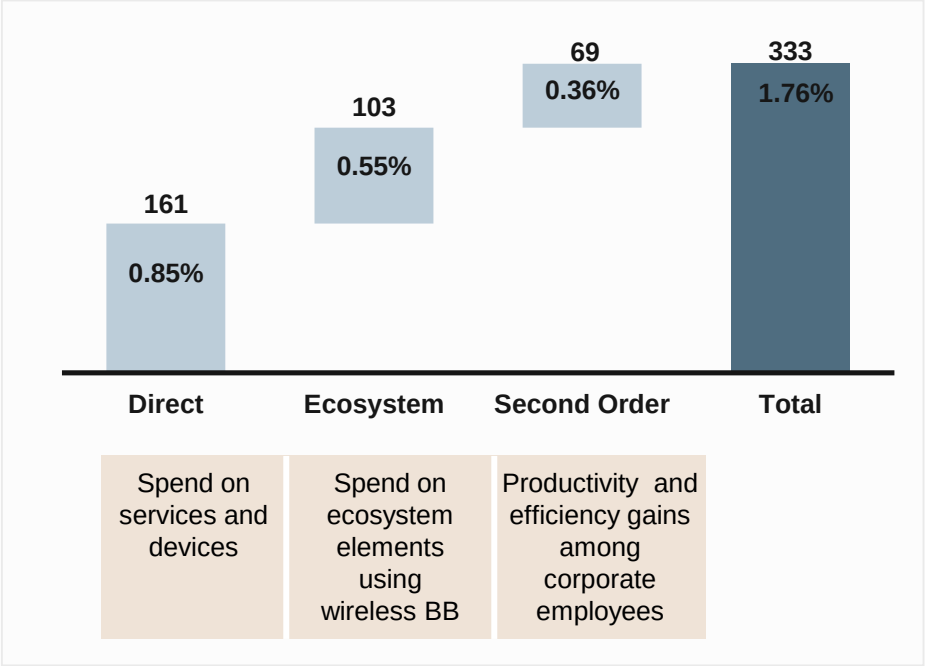


Figure 1.4: Total impact on GDP by wireless broadband in 2015 (TWD billion, 2015) [Source: Analysys Mason]

We believe that growth in wireless broadband penetration will largely be driven by a rise in smartphone penetration. Given the relatively low level of smartphone penetration in Taiwan compared to other countries, we believe penetration is likely to increase in future, driven by increased consumer demand to use smartphone features.

Apart from the direct effects of wireless broadband penetration on service providers, Taiwan will see benefits elsewhere in the ecosystem. Being one of the world's largest exporter of high-tech products, the manufacturing of ICT equipment and resulting export market will benefit from the increased adoption of wireless broadband services on a global scale.

The importance of 3G equipment and devices will be the main driver of such growth, with LTE representing an increasing role in later years as it develops its device ecosystem. In addition, due to the lack of global WiMAX demand and expected successful take-up of LTE, it is more likely that manufacturing revenues will be generated from LTE versus WiMAX technologies.

An increase in wireless broadband is also likely to see a significant benefit for the consumer/retail sector through more vibrant online commerce, entertainment and advertising. Moreover, social services and corporate sectors could also scale up with increasing wireless broadband adoption.

Although the adoption of wireless broadband will still contribute to second-order productivity gains, it is likely to be lower than those seen in developing countries.

In order for Taiwan to realise its true potential in terms of the wireless broadband market, the Taiwanese government should actively take initiatives to promote the development of HSPA as well as LTE, the latter of which the NCC should promote in the spectrum bands of 700MHz and 2600MHz.

2 Current situation in Taiwan

2.1 Demand-side

Broadband household penetration in Taiwan is at 114%, not far from levels in other developed Asian economies such as Hong Kong and Singapore (as shown in Figure 2.1 below). This high penetration is mainly driven by fixed broadband connections, accounting for over 68% of household penetration.

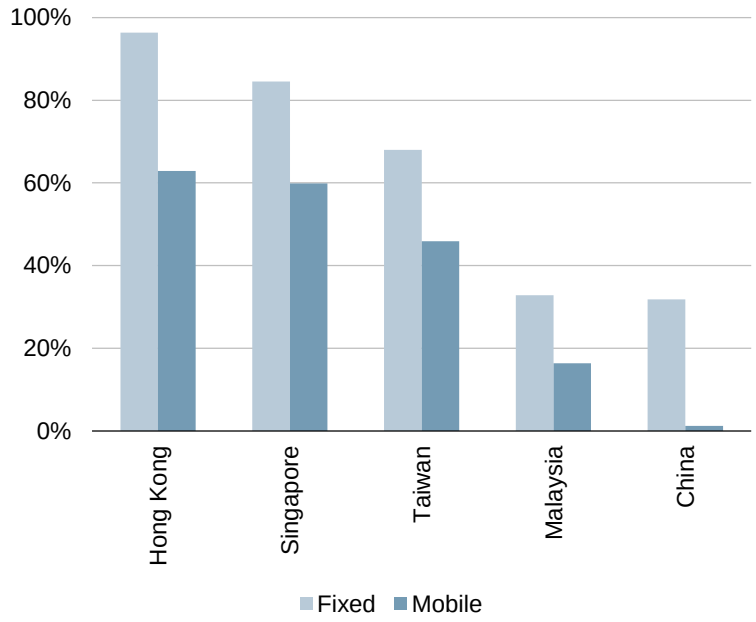


Figure 2.1: Broadband household penetration by access technology (2010) [Source: Telegeography, NCC, Analysys Mason, GSMA, regulator websites]

However, with fixed broadband growth showing stagnation in recent years, wireless broadband is becoming increasingly important (see Figure 2.2 below). Recent growth in wireless broadband penetration can be explained by the extensive roll-out of 3G networks, the developed ecosystem of 3G devices and consumer preferences. While wireless broadband is generally considered a complement to fixed broadband in urban areas and can be expected to see more growth with increased consumer spending power, in remote rural areas, where there is unlikely to be good fixed line infrastructure, wireless broadband is likely to be the main avenue for Internet access.

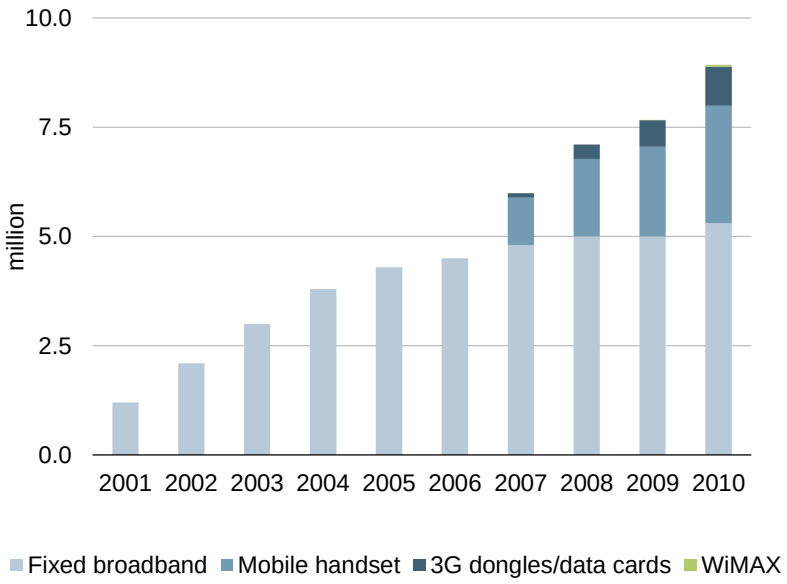


Figure 2.2: Evolution of broadband subscriptions in Taiwan [Source: NCC]

As shown in Figure 2.3, flexibility and mobility are the key reasons for wireless Internet usage in Taiwan, with 56% of the population indicating this as the main reason for wireless Internet usage. In addition to this, the affordability of mobile Internet equipment is an important driver for wireless broadband usage.

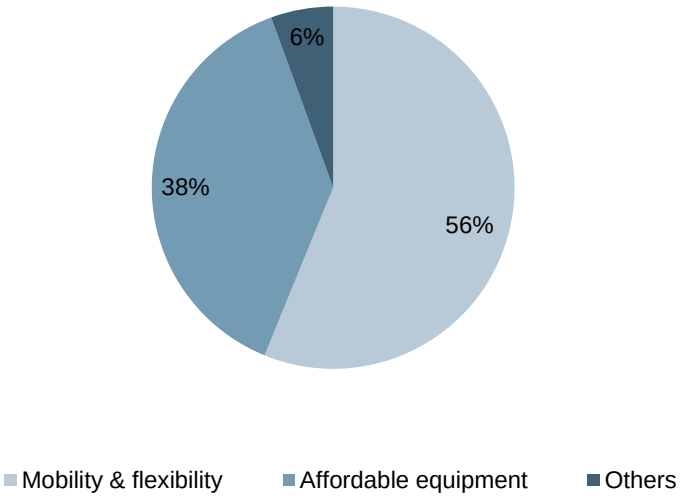


Figure 2.3: Reasons for using wireless Internet access in Taiwan (2010) [Source: Taiwan Network Information Centre]

In particular, wireless broadband access via mobile handsets is likely to be the main driver of growth. As shown in Figure 2.4 below, mobile handsets provide the most affordable option in the market, and are likely to be a popular means of wireless broadband adoption. Growth of smartphones is also likely to drive usage further as consumers begin to use the features and functionalities of their devices. Recent growth in smartphone usage is evident; in Q1 2011, 44% of total handset sales in Taiwan were smartphones, a quarterly and annual increase of 18% and 150% respectively.

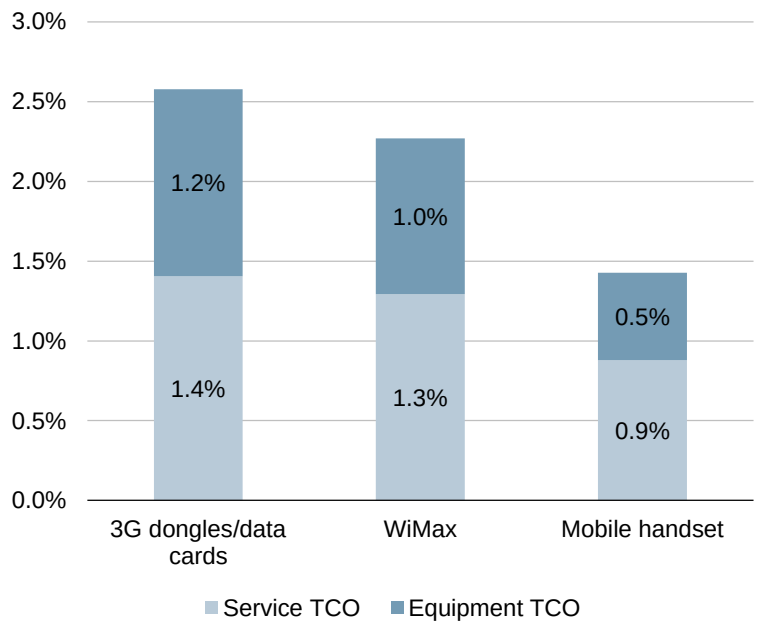


Figure 2.4: Entry-level total cost of ownership (TCO) as a percentage of private consumption[1] (2010) [Source: operators' websites, Yahoo Taiwan]

As indicated by recent trials, Taiwanese operators are interested in deploying LTE. WiMAX operator Global Mobile (technology-neutral licence holder) has made plans to switch to LTE and First International (a WiMAX-specific licence holder) has included LTE migration in its network development plans[2] and is expected to co-operate with China Mobile in the trial of TD-LTE in Northern Taiwan, with plans to migrate to FD-LTE in future. WiMAX operators in Taiwan are keen to deploy LTE due to the growing global LTE subscriber base and operator investment in the technology which will see LTE achieve greater support and a more robust ecosystem vis-à-vis WiMAX. In addition, the compatibility of LTE devices with existing technologies and the fact that operating TD-LTE in the 2.6GHz will enable interoperability and roaming, reliable vendor support and economies of scale are also likely to drive WiMAX operators to deploy LTE.

Mobile operators are considering launching LTE as well. Chungwha Telecom, together with Nokia Siemens Networks, is conducting live FD-LTE trials where Nokia Siemens Networks provides all FD-LTE equipment (core network and base stations) and related technical support for the operator's pilot platform. However, mobile operators' incentives are different to those of WiMAX operators. First of all, growing demand for data may cause spectrum constraints. Therefore, the

[1] Private consumption expenditure consists of the expenditure, including imputed expenditure, incurred by resident households on individual consumption goods and services

[2] First International's migration and trials are contingent upon the appropriate licence changes

allocation of additional spectrum and subsequent deployment of LTE allows operators to complement existing networks, reducing any future capacity constraints. Secondly, the launch of LTE by other players means that mobile operators are expected to deploy LTE in order to retain their competitive advantage.

Given their current spectrum allocation in the standard 2.6 GHz LTE band, lack of WiMAX take up around the world, and the imminent launch of TD-LTE, we believe that WiMAX operators are likely to deploy TD-LTE technology going into the future. On the contrary, mobile operators are expected to continue offering HSPA+ 3G services in the short-term, moving to FD-LTE in later years. This strategy is driven by the backward compatibility of HSPA+ and LTE devices, the delayed reallocation of 700MHz spectrum which is currently utilised by the military, and the comparability of HSPA+ and LTE technologies in terms of supporting short-run data demand. Although there may be delays in gaining NCC approval for changing WiMAX operator's licence conditions to allow LTE deployment, WiMAX operators are still considered more likely to deploy commercial LTE networks faster than existing mobile operators.

2.2 Supply-side

As shown in Figure 2.5 below, Taiwan has a very well-developed fixed-line infrastructure, with almost all fixed voice lines being ADSL-enabled. Chunghwa Telecom stated that, at the end of 2010, more than 97% of its 12 million installed telephone lines were capable of delivering ADSL services and network coverage. While DSL still dominates the fixed-line market, FTTH is becoming increasingly important, with over 90% of new fibre additions switching from the ADSL service. As at the end of 2010, the operator had constructed ~3.36 million FTTx ports, and the FTTx network (with speeds of 30Mbit/s) was reported to cover ~79.3% of the total population. Although cable has seen a significant rise in subscribers in recent years after slow growth between 2005 and 2007, it is still a small market, representing almost 18% of total fixed-line subscribers.

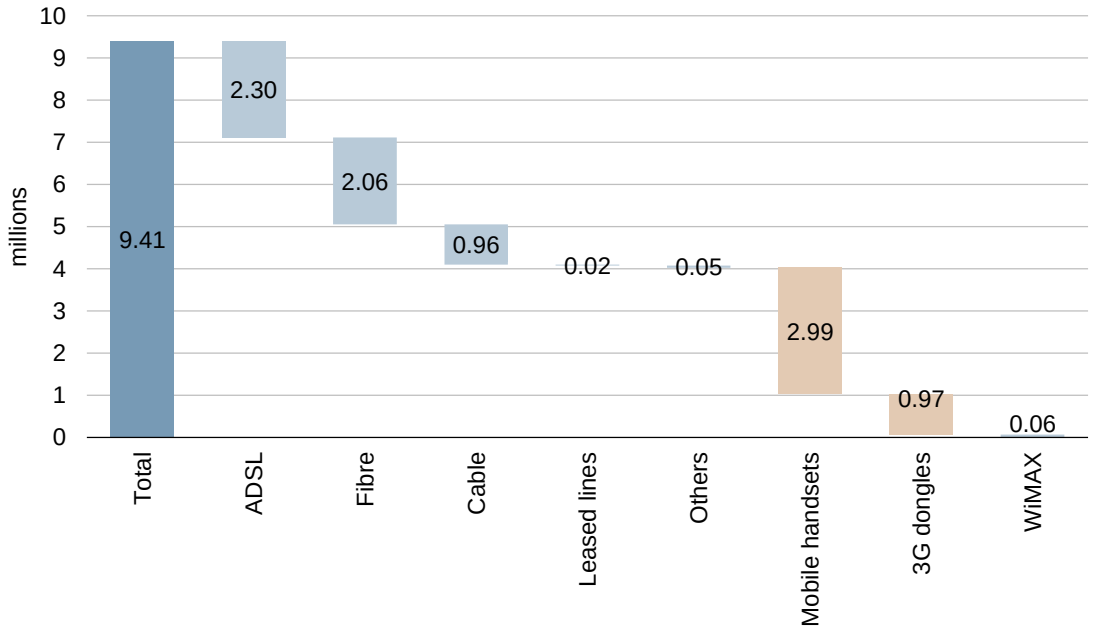


Figure 2.5: Broadband lines split by technology (April 2011) [Source: NCC]

Both 3G mobile handsets and dongles have seen rapid take-up in recent years, operators rolling out extensive 3G networks to meet increasing demand. In 2009 Chunghwa Telecom upgraded more than 2250 3G base stations with HSDPA capabilities. FET has also signed a TWD4 million deal with Ericsson in order to upgrade FET's core 3G network, increasing peak download speeds to up to 21Mbit/s. Other smaller operators have expanded their 3G networks as well. For example, Vibo has purchased 3500 3G base stations from Chinese equipment vendor ZTE and is planning to invest TWD3 billion (USD104 million) in order to upgrade its 3G base stations by the end of 2011. Aside from the roll-out of networks, a developed device ecosystem from the global take-up of HSPA services is also another main driver of growth for 3G mobile handsets and dongles. The developed ecosystem for such devices/equipment allows both operators and consumers to benefit from economies of scale and enjoy the subsequent competitive prices for devices/equipment.

Despite government efforts such as the M-Taiwan project (a national programme to implement the Taiwan WiMAX blueprint), WiMAX has seen limited success, with only approximately 0.06 million customers by April 2011. The limited success of WiMAX is mainly driven by operators' restricted addressable market resulting from limited network coverage. All six licences operate on a regional basis where each licence can only be used in one of the three (North, Central, or South) regions of Taiwan. In addition, given most operators are start-up companies, these operators lack the ability to raise enough capital to extend their networks and deploy base stations. An additional factor limiting the growth of the WiMAX market is the lack of a developed device ecosystem which means both consumers and operators cannot benefit from economies of scale.

3 Impact on the ecosystem

Apart from service delivery, as shown in Figure 3.1, the 'ecosystem' relating to the wireless broadband value chain includes a variety of stakeholders including manufacturers, and both international and domestic companies involved in the provision of a range of online portals and specific m-applications.

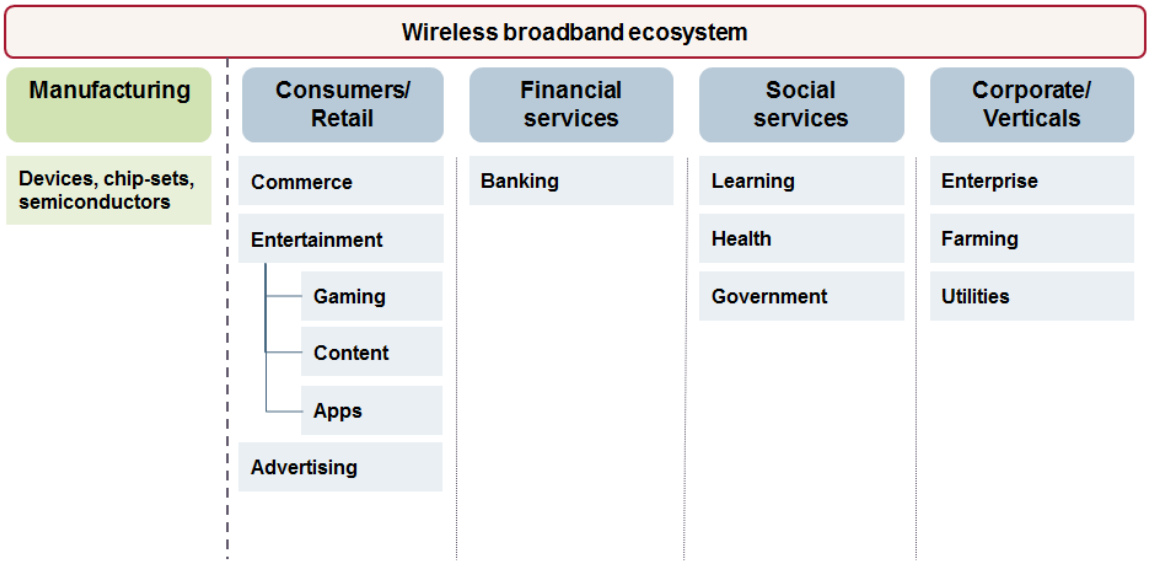


Figure 3.1: Wireless broadband ecosystem in Taiwan [Source: Analysys Mason]

3.1 Manufacturing

ICT manufacturing and the consequent exports of high-tech products are significant elements of the Taiwanese economy. Taiwan ranks third in the world in terms of high-tech products as a percentage of total exports and is ranked as the world's leading producer of notebook computers. Notebook shipments from Taiwan were estimated to reach 85 million units in the first half of 2011, representing approximately 87% of the forecast global market of notebook shipments.

While previously focused on the production of computers, the future of Taiwan's device manufacturing will be driven by the demand for smartphones and tablet computers. For example, shipments of app-enabled smartphones and tablets are expected to reach 377 million in 2011 and 462 million in 2012, thus overtaking traditional PCs.

Taiwanese manufacturing companies could also benefit from the standardisation of technologies and spectrum bands by achieving economies of scale. Once technologies are harmonised, device manufacturers will be able to achieve economies of scale by manufacturing increasingly popular

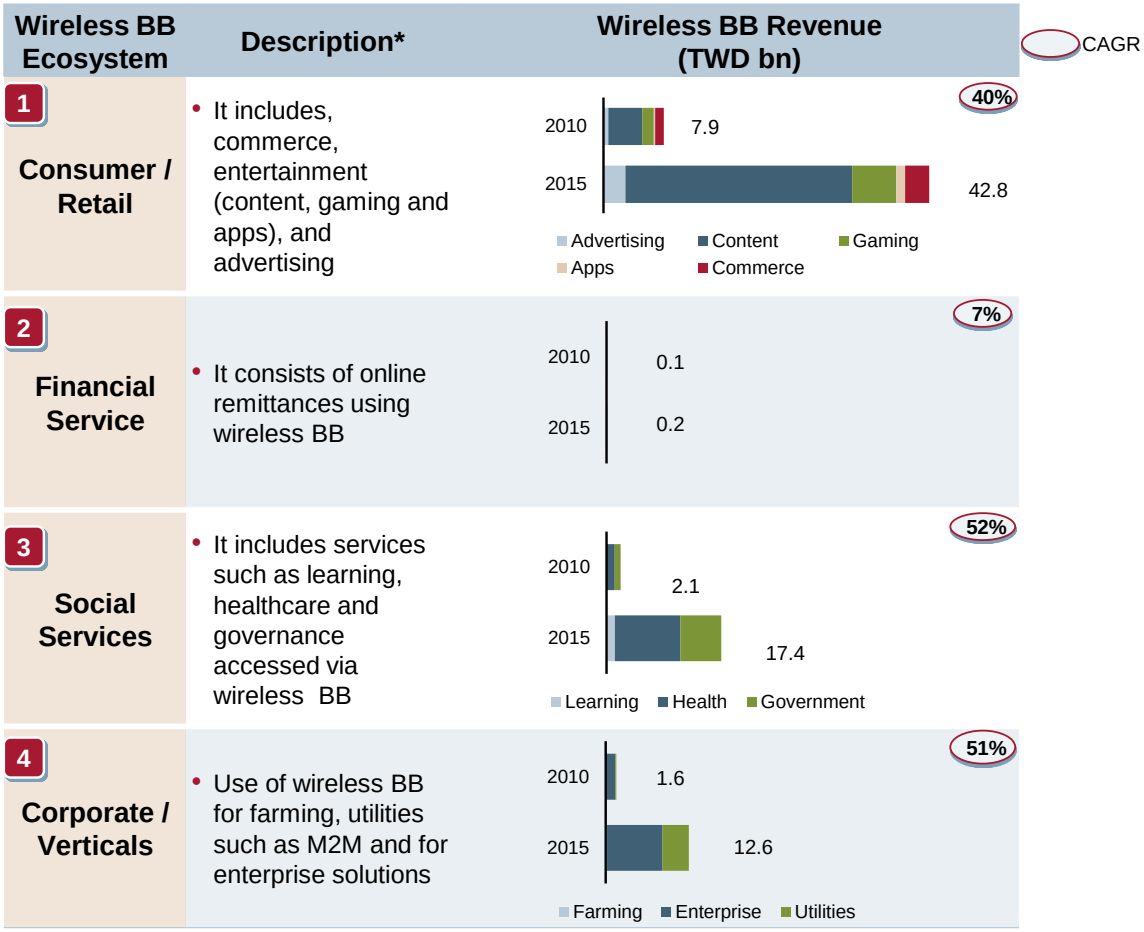
multi-band devices. Taiwan should then harmonise spectrum in the relevant bands according to the economies of scale achieved in the device market.

Given China Mobile's likely future deployment of LTE in the 700MHz band[3], economies of scale are likely to be achieved in Taiwan through spectrum harmonisation in this band. However, this spectrum is currently used by military/police organisations and it may take up to three years to be allocated for LTE and a further four years to finalise the licensing process and deploy commercial LTE networks. Therefore, operators may be forced to look at less desirable alternatives for LTE deployment in other bands.

3.2 Other aspects of the ecosystem

An increasing adoption of wireless broadband could benefit supporting platform services and content, as shown in Figure 3.2 below. Analysys Mason forecasts that, in 2015, TWD 42.8 billion of GDP will be generated from the consumer and retail areas and TWD 0.2 billion from financial services. Social services are expected to contribute TWD 17.4 billion to total GDP and corporate/verticals sector to make a contribution of TWD 12.6 billion in 2015.

[3] Source: People's Daily Online, http://english.peopledaily.com.cn/90001/90776/90881/7312152.html. Industry Canada, http://www.ic.gc.ca/eic/site/smt-gst.nsf/vwapj/smse018e.pdf/$file/smse018e.pdf



Note: *all refer to wireless broadband access including access from wireless devices and mobile specific applications on smartphones and tablets

Figure 3.2: Impact of wireless broadband on other parts of ecosystem [Source: Analysys Mason]

A number of measures have also been identified in order to enable players within the ecosystem to benefit from the increasing penetration of wireless broadband:

For the consumers/ retail segment:

- Commerce: focus on the development of near field communication (NFC) payment applications
- Entertainment: focus on trying to leverage the large-scale Chinese VAS market by entering partnerships with Chinese operators
- Advertising: adopt strategies such as those seen in Japan to develop rich mobile Internet advertising and use NFC as a way to better target consumers in the mobile internet advertising space

For financial services:

- Banking: although we do not expect a lot of revenue to be created, operators and financial institutions should look to enter partnerships to provide non-traditional banking services such as chore-management applications which can create social benefits instead

For social services:

- Learning: focus on language learning as a way to develop m-learning
- Health: if higher bandwidth is made available to operators, operators have the opportunity to further develop m-health applications, and particularly time-critical applications which rely on high speed data services
- Government: the government should focus on extending the variety of its m-applications for governance purposes

For corporates/verticals:

- Enterprise: profit from growth of the private enterprise cloud computing market, particularly with regard to mobility apps arising from the increase in wireless broadband penetration
- Farming: focus on the development of e-agriculture and m-agriculture
- Utilities: continue the development of the M2M market in terms of CCTV and smart meters

4 Stakeholder engagements

The Taiwanese government's WiMAX development plan aimed to leverage local Taiwanese production in order to become the world's largest exporter of WiMAX products. However, low levels of worldwide WiMAX demand has meant that no global WiMAX hub was developed. Despite government bodies still pushing for the adoption of WiMAX for various applications in Taiwan, the lack of scale means WiMAX devices are likely to cost more than LTE devices in the medium term.

Recommendations

- Given the similar functionality of the two technologies, the government should consider the development of HSPA+ and LTE instead of WiMAX

Although the Taiwanese government has been keen on pushing WiMAX as the main driver of wireless broadband, hoping to both increase local demand and give Taiwan the opportunity to be the world's WiMAX hub, the lack of global demand for WiMAX services meant that this was not as successful as initially envisaged. In fact, we find that HSPA equipment will continue to be the main driver of Taiwan's export market of equipment/devices for the foreseeable future. In addition, although the launch of LTE is in not expected until at least 2014, Taiwan's LTE export market is likely to be more significant than that for WiMAX. Despite a lower market share for the exports of LTE vis-à-vis WiMAX equipment, the potential scale of global LTE take-up and lack of WiMAX standardisation means the value of Taiwanese LTE exports is expected to be driven by demand for LTE equipment/devices. Furthermore, the future deployment of LTE in Taiwan could further enhance the competitiveness of local manufacturers.

Recommendations

- Given the smaller market size of WiMAX in terms of demand, Taiwan should focus on the manufacturing of HSPA/LTE versus WiMAX devices and equipment

LTE is supported by many bands around the world, resulting in quite a fragmented market. As shown in Figure 4.1 below, there is a clear distinction between the use of different bands, with Asian and European countries harmonising in the 700MHz and 800MHz bands respectively. Harmonisation within these prevailing LTE bands will enable operators to gain many benefits including interoperability and roaming, fast and reliable vendor support and economies of scale in the production of handsets and network equipment.

In Taiwan, WiMAX operators are likely to use 2.6 GHz spectrum because it is already allocated to them; with China Mobile's imminent launch of LTE in the 700MHz band, Taiwanese mobile operators are likely to follow suit, also deploying LTE in the same spectrum band.

Bands	*Deployments and plans*
700 MHz	Verizon (USA), with growing momentum in Asia (inc. China, Indonesia, Vietnam, Australia) for harmonisation on this band
800 MHz	Vodafone (Germany), with plans in the EU for harmonisation on this band, T-Mobile (Germany), Telefonica (Germany)
850 MHz	No deployments; potential trial by SK Telecom
1.5 GHz	NTT DoCoMo (Japan)
1.8 GHz	CSL (HK), Elisa (Finland), CenterNet (Poland), MobileOne (Singapore), Omnitel (Lithuania), TeliaSonera (Latvia)
2.1 GHz	Glo (Nigeria), Metro PCS (USA)
2.6 GHz	TeliaSonera (Denmark, Finland, Norway, Sweden, Uzbekistan), CSL (HK), Net4Mobility (Sweden), Telekom Austria (Austria), T-Mobile (Austria), VivaCell (Armenia), EMT (Estonia), Elisa (Finland)

Figure 4.1: LTE deployments worldwide by spectrum band [Source: Analysys Mason Research, Informa Telecoms & Media, 4G Americas, GSA]

Recommendations

- Taiwan should significantly focus on the deployment of LTE in the 700MHz and 2.6GHz bands
- The NCC's most important task is to ensure that the reallocation of spectrum in the 700MHz band is as efficient as possible. The regulator must also facilitate changes in WiMAX operators' licence conditions to deploy LTE

As shown in Figure 4.2 below, there are a number of frequencies that could be used for either HSPA or LTE.

Frequency	*Status*	*Rationale for wireless broadband*
2600 MHz	Existing allocation to WiMAX operators	Lack of global WiMAX standardisation
2100 MHz	Likely future capacity constraint for 3G data from ~2013 onwards	-
1800 MHz	Spare capacity/ frequency bands that will be released in 2012 after the expiry of 2G licences	2100MHz: capacity constrained in future; 1800MHz: spare capacity
900 MHz	Likely capacity constraint for 2G voice and data	-
850 MHz	Existing allocation to APT-CDMA	To retain competitiveness
700-800MHz	no existing allocation for commercial usage that can be used for offering wireless broadband services	Better propagation characteristics for rural coverage

Figure 4.2: Frequencies status and rationale for wireless broadband [Source: Analysys Mason]

The NCC will need to define a clear roadmap to allow wireless broadband to realise its true potential.

Recommendations

- 2600MHz: issue technology-neutral licences for operators with current WiMAX-specific concessions; ensure less stringent approval of applications to move to LTE and consider competition effects in mobile market
- 2100MHz: Release and allocate spectrum in other bands in order to make up for future data capacity constraints
- 1800MHz: Issue technology-neutral licences for spectrum in this band to allow refarming and consequent use of this band for LTE and HSPA data services
- 900MHz: Issue technology-neutral licences for spectrum in this band to allow refarming and consequent use of this spectrum for HSPA data services
- 850MHz: Facilitate move for APT-CDMA to launch faster wireless broadband services by issuing technology-neutral licences according to market demand
- 700-800MHz: Reallocate the 700MHz for LTE and realise the digital switchover as efficiently as possible

Annex A Glossary of terms

Term	*Glossary*
3G	Third Generation mobile access technology
ARPU	Average Revenue Per User
ADSL	Asymmetric Digital Subscriber Line
BB	Broadband
CDMA	Code Division Multiple Access
DSL	Digital Subscriber Line
EIU	Economist Intelligence Unit
FD-LTE	Frequency Division Duplex - Long Term Evolution
FTTB	Fibre to the Building
FTTH	Fibre to the Home
FTTN	Fibre to the Node
GDP	Gross Domestic Product
GHz	Gigahertz
GSM	Global System for Mobile Communications
HSPA	High-speed Packet Access
HSPA+	High-speed Packet Access Evolved
ICT	Information and Communication Technology
LTE	Long Term Evolution
MHz	Megahertz
NCC	National Communications Commission
NFC	Near Field Communication
PC	Personal Computer
TD-LTE	Time Division - Long-Term Evolution
TD-SCDMA	Time Division – Synchronous Code Division Multiple Access
TWD	New Taiwan Dollar
USD	United States Dollars
WCDMA	Wideband Code Division Multiple Access
WiMAX	Worldwide interoperability for microwave access