Broadband Policy in India: What do We Know? What do We Need to Know?

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Abstract

In some technology sectors in India, particularly in software services, public policies and private initiative have yielded rapid growth and good private and social returns. But this has not been true for the case of the Internet, more so for broadband. There is strong belief among technologists and policymakers that broadband stimulates economic growth. That being so, it is puzzling as to why broadband adoption in India is and remains low, even falling short of modest official projections by half. This paper makes the case for information-driven policymaking by summarizing the current state of knowledge in this area and arguing that (a) we do not have a good understanding of the drivers and economic effects of broadband in India, and (b) this lack of understanding is largely due to the absence of a systematic way of monitoring the technological pulse of the nation.

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1 Introduction

On June 10, 2010, the Telecom Regulatory Authority of India (TRAI) released a *Consultation Paper on National Broadband Plan* (TRAI, 2010a). The document was in reference to a circular from the Department of Telecommunications (DoT) seeking recommendations on broadband connectivity. In keeping with TRAI's usual admirable openness, the initiative solicited feedback from all interested parties. This, however, was not the first attempt at increasing broadband penetration in the country. The *Broadband Policy 2004* of the Ministry of Communications and Information Technology (MCIT) had taken up the issue and made projections of 20 million broadband subscribers by 2010 (MCIT, 2004 p.2). Even these modest aspirations have fallen short by 50 percent (TRAI, 2010a. p. 4).

The recent and earlier documents make for an interesting comparative reading. The preamble to MCIT (2004) states: "Recognising the potential of ubiquitous Broadband service in growth of GDP and enhancement in quality of life through societal applications including tele-education, tele-medicine, e-governance, entertainment as well as employment generation by way of high speed access to information and web-based communication, Government have finalised a policy to accelerate the growth of Broadband services." The preface to 2010 reads: "In order to ensure continued economic growth of the country, rapid spread of broadband both in the urban and rural areas is an imperative. The need of the hour is to evolve a National Broadband Plan, covering various aspects right from the definition of broadband to spread of infrastructure and various regulatory and other issues." In other words, both profess a faith in the economic potential of broadband. But there is a puzzled recognition that adoption has been below expectations.

Do information and communication technologies (ICTs) raise national income? Evidence from around the world has been decidedly mixed. For decades, the net impact of ICTs on macroeconomic output could not be pinpointed or even identified accurately. This strange productivity paradox was highlighted by a comment from Solow (1987), who famously quipped that computers were "everywhere except in the productivity statistics." Evidence of the positive impact of semiconductor-related technologies has begun to trickle in only very recently, and has so far been limited to the richer countries of the world.[1] No corroborative research exists for developing countries, many of which appear to be putting a lot of faith in economically leapfrogging ahead with these shiny new technologies.

A recent working paper (Chaudhuri, 2010) discusses why this lack of evidence is not surprising. Most developing countries generate very little revenue from information technologies, simply because the levels of production and consumption of information are much lower as compared to the richer nations, and hence net valued-additions to their national income accounts are minuscule. The low levels of adoption also imply that they are not general purpose technologies (GPTs), which imply that they cannot have high total factor productivity.[2]

There would appear to be some necessary conditions which can make possible economic expansion using ICTs such as a skilled workforce, large domestic market to generate scale, good infrastructure and close meshing with world trade. Most poor countries clearly do not satisfy these criteria. However, a handful of countries, including India, have been reaping the benefits of being blessed with most or all of these conditions. For India, strategic investments in ICTs are an important policy question, since information technologies constitute a big component of national economic planning and aspirations.

Unlike China, which has cornered the world market for the manufacture of information hardware, India's strength lies in software services. What it lacks in ports, distribution centres and shipping lanes, it must make up for in high-speed hubs, server farms and bandwidth. An excellent broadband network should logically be a prerequisite not only for advancing its relative position in software services, but perhaps even to simply maintain it against competition from aspirants such as Malaysia, Mexico, South Africa and Ireland. Highspeed channels should raise productivity at least for the thriving services sector if not for the macro-economy. There is no reason to assume that home-users would not be interested in having high bandwidth at a reasonable price (which in theory should not be problem, since scale economies should exert a downward pressure on cost). It is thus puzzling that broadband service

[1] See OECD (2004) and Murakami (1997).

[2] See Jovanovic (2005) for the classic exposition on the topic.

providers do not appear to be keen to expand coverage, though there is potentially a huge untapped market for business and home users. Nor is there much evidence of concrete and thoughtful plans any time in the near future from the government.

That is not to say the government is not taking any initiative. On the contrary, it appears to be spending substantial amounts on schemes like *Bharat Nirman* for increasing rural teledensity.[3] The problem is that it is difficult to understand the policy process or the logic behind schematic actions, let alone financial disbursements. Governments quite obviously have maximal impact on encouraging young, cutting-edge sectors and consequently countries' developmental patterns. Examples range from the fantastic but infamous technological developments in Nazi Germany to the more benign development of the Internet itself (see next section).

An outstanding country success-story is Korea, where the government played a leadership rule in developing the IT sector. The aggressive and long term vision of the government can be traced back to 1976, when it decided to indigenously develop new and locally appropriate digital switching systems (Hwang, 2009). A hugely ambitious *National Basic Information System Project* was initiated as early as 1987 (Hwang, 2009). It made impressive investments in network infrastructure in close collaboration with the private sector service providers and hardware manufacturers such as SK Telecom and Samsung.[4] By 1999, 25% of the investment in IT infrastructure in Korea was directly from the public sector. To put it in perspective, the corresponding figures for the US, UK and Japan were 0, 2 and 0 percent respectively.[5] A presidentially mandated and coordinated policy was spelt out in the landmark 1999 white paper *Cyber Korea 21*.[6] The focus and speed of the initiatives can be gauged by the fact that within one year, an "information superhighway" with 94 nodes throughout the nation was ferrying data at a throughput of 2.5Gbps, a speed then unthinkable in most parts of the world.[7] Throughout the process, the government made financial, legal and regulatory interventions in order to deepen broadband penetration (Koh *et al.*, 2009). No less important was its careful analysis of the market structure, and its engagement with the private sector for resolving crucial issues such infrastructure support and price determination (Lee *et al.*, 2009). It is exactly this combination of vision, fortitude, understanding of market realities and concord with private players which are missing in India.

2 Choice of Technique and Related Policy Questions

India is a relative latecomer to the Internet, and particularly in broadband. The Internet, like many other revolutionary technologies, was first developed in the USA, as a project under the famed Defense Advanced Research Projects Agency (DARPA).[8] The development process was tortuous and non-linear. With the maturation of the set of technologies which make possible the Internet, neither DARPA nor the US Government attempted to stake a monopoly claim and all protocols passed firmly into the public domain.[9] To give credit where it is due, this openness could not be expected from most government agencies of the world. The role played by the US government in the saga is a lesson in enlightened involvement - on when the public sector should actively encourage and support individual initiative, and when it should give up the reins of control.

Till quite recently, Internet access and dialup access used to be synonymous. Dialup technology is relatively simple and has reached the end of its evolutionary cycle. In the basic mechanism, the end-user dials a number given by his Internet service provider (ISP). The modem attached to his phone line uses this number to establish a connection with the server of the ISP and obtain an Internet protocol

[3] URL: `http://www.dot.gov.in/bharatnirman.htm`

[4] For an excellent early narrative of the Korean case, see World Bank (2000).

[5] *Ibid*, p. 66.

[6] URL: `http://www.ipc.go.kr/ipckor/etc/cyberkorea21.html`. Accessed on July 11, 2010.

[7] *Ibid*, p.65.

[8] See `http://www.darpa.mil/50thanniversary.html` for a quick overview of DARPA's contributions in scientific and technological development. Accessed on July 07, 2010.

[9] A very nice concise history of the Internet is hosted by the Internet Society at `http://www.isoc.org/internet/history/brief.shtml`. See Waldrop (2008) for an amusing take on the genesis of the Internet.

address (IP) so that other machines on the Internet can "see" it and vice versa. The server itself is always attached to the Internet in order to handle requests around the clock from multiple end-user machines. Since data packets are exchanged between the user's computer and the server at the end of the loop essentially over a local call, the usual local calling rates over and above the ISP service charges apply for the duration the connection remains closed.

Compared to this, broadband is a fairly new technology, or more precisely, a set of technologies which have very different channels and operational characteristics. These can range from digital overlays on copper phone lines (which again are actually a family of technologies collectively referred to as xDSL) to fibre optic cables to the newest wireless Worldwide Interoperability for Microwave Access (WiMAX). Thus, there is not even a single and universally accepted definition of broadband, as is apparent from the vague but accurate statement of the International Telecommunication Union (ITU) that broadband connections are those that operate at speeds faster by a factor of 5 to 2000 times to dialup ones.[10] The one common feature is the "always-on" nature of the connection, i.e. there is always a dedicated connection between the end-user modem and the ISP server connected to the Internet. Unlike for dialup, the IPs assigned to end-user machines do not always change on disconnecting and reconnecting, and can remain static over fairly long stretches of time.

Each of these different broadband technologies have their own strengths and weaknesses, which have a direct relevance to their applicability to different topographical settings and service requirements. For instance, because DSL establishes dedicated connections between end-user modems and exchange servers, the signal does not get shared by different users and throughput remains uniform for every connection. However, since the technology is an overlay on copper lines, signal attenuation dictates that a connection be practically unusable beyond a distance of 5km from the exchange. Coaxial cable connections, which are split between multiple users, have the opposite characteristics. Thus, areas of high housing density are more suited to DSL, while low density areas are better off with cable. WiMAX is considered by many to be ideal for countries without legacy wired networks (Puskar and Aanstoos, 2007), though uptake has been disappointing so far.[11]

All broadband technologies, without exception, are going to be expensive for a country like India with existing connectivity conditions being poor at best to non-existent mostly. Before pledging huge investments, policymakers should hence have a clear idea about:

(a) The economic areas in which broadband is currently having or can potentially have a positive impact, after factoring in cost-considerations for different kinds of broadband technologies in location-specific environments.[12]

(b) Drivers of broadband adoption, and ways and means of encouraging their effects.

These two questions neatly capture the effects and causes of broadband adoption. As the rest of this article will argue, answering these questions in the Indian context is a difficult if not impossible task. As a matter of fact, we do not even have a basic understanding of the *current* state of broadband adoption in the country, which should be a prerequisite for any policy decisions. This is because, ironically, we have such poor information on the state of information technologies, especially broadband.

3 Broadband Adoption - Reading the Global Tea Leaves

What lessons can be learnt from around the world regarding the outcomes and drivers of broadband technologies? The World Bank (2009a), cited by TRAI (2010a) asserts that broadband has a statistically significant and substantial impact on economic growth for developing countries. This is a bold

[10] URL: http://www.itu.int/osg/spu/publications/birthofbroadband/faq.html. Accessed on June 14, 2010. Interestingly the page appears to have been uploaded or last updated in 2003.

[11] WiMAX has been consistently ignored for another technology standard called Long Term Evolution (LTE) by mobile operators. It appears to be under attack even in the area where its strength is purportedly highest, viz. in heavy data transfers. See `http://www.reuters.com/article/idUSTRE62T32Z20100330`. Accessed on July 06, 2010.

[12] The importance of geographical factors in network infrastructure should not be underestimated, and even rich countries can have blind spots in harsh terrain or the difficulty of providing service in areas which are remote or has harsh climatic conditions. India, with its huge territorial expanse ranging from desert to alpine terrain has a particularly challenging task confronting it.

claim, and the analysis presented in the report should be viewed with healthy skepticism. The central thesis of a ten percentage point in broadband penetration raising 1.38 percentage points in economic growth in low and middle income countries presents an estimate that is suspiciously high, and one wonders if changing the analytical strategy, including some variables omitted in the econometric model or excluding a select handful of overachievers such as China would not change the findings substantially. Broadband adoption in most poor countries are so abysmally low (Fig.1) that making the case that it can have substantial macro-economic effects must be defended as occurring through some mysterious homeopathic mechanism.

[Figure 1]

There is obviously a sharp difference between the adoption patterns of broadband between the rich and poor countries. Adoption in lower- and middle-income countries remain stubbornly low. TRAI (2010a) correctly mentions demand, supply and regulatory issues which could influence the uptake path. Even discounting amorphous and politically contentious regulatory factors, sorting out the basic causalities is not an easy task. The common and generally simplistic method is to run a cross-country regression with the usual suspects as independent variables and broadband penetration as the outcome.[13]

[Table 1]

Table 1 presents a bare-bones structure in which broadband penetration is postulated to depend on income and education levels as well as mobile penetration proxying for a general information demand. Note that the model reasons the causality to run from income to adoption and not vice-versa as in World Bank (2009a).[14] As may be expected, income appears to have a positive and statistically significant effect. However, cross-country analyses can be especially deceptive for the dissection of the broadband question for three reasons. Adoption levels in developing countries are too low for such comparisons to be meaningful in any sense. Such a model assumes homogeneity of effects across countries, which common sense would dictate to be highly implausible. At a deeper level, it must be kept in mind that an entire country cannot be considered to be a conscious entity as is implicitly assumed in a decision theoretic framework. Because of these shaky theoretical foundations, cross-country models are highly prone to specification errors. For example, simply assuming the latent structure to be quadratic instead of linear can produce very different results for the education indicator (Table 2).

[Table 2]

Such parametric modeling ignores country-specific "soft" factors which have a powerful impact on the consumption patterns of information goods and services. The importance of these socio-cultural factors cannot be overemphasized and they are a frequent source of despair for the marketing divisions of technology vendors. It is very difficult to make predictions about adoption of technologies, and unexpected demand or persistent apathy can be equally probable. For instance, Flip Video changed the world market for handheld video recorders almost overnight in a completely unforeseen manner.[15]

[13] See, for example, Lee and Brown (2007). A more sophisticated treatment is Cava-Ferreruela and Alabau-Muñoz (2006).

[14] This is very clearly a highly simplified model and should not regarded with undue seriousness. One obvious shortcoming is that it does not take into account a feedback "learning effect" from broadband usage. There is evidence that Internet usage is a positive function of speed. See OECD (2007), fig.16.

[15] http://www.theflip.com/en-us/

In the US, Hispanics consistently lag behind Whites, Asians and Africans in Internet use, without any coherent explanation having been offered for it.[16] Among countries, South Korea famously rode the broadband wave on the wild and inexplicable popularity of Internet cafés or "PC-Bangs" (which literally translates to "computer rooms") (Park, 2007).

Analyzing these socio-economic and cultural factors can provide us with valuable insight about the general trajectories of technology adoption and deviations from them.[17] However, the variables themselves are largely irrelevant for policy purposes, since they cannot be influenced or manipulated to meet desired outcomes. The knowledge that people in higher income brackets tend to use broadband more is not important it itself, since a policy of increasing broadband penetration by first increasing domestic income levels would have to travel a long and circuitous path indeed. Of much greater worth would be a study of strategic, regulatory and institutional practices around the world which, controlling for given socio-economic realities, can reasonably be expected to encourage the use of Internet technologies.

A simple case in point would be the development of the Internet market in the US vis-à-vis other comparably rich countries. In the early days of the Internet, pricing was an an uncertain issue, and ISPs typically offered a block of unlimited usage time beyond which usage was metered. In 1996, AOL, the largest ISP, moved to a completely flat rate after much trepidation. This was a straightforward strategic move on the part of AOL, keeping in mind a probable preference for simplicity of consumers, even at higher prices. However, the effects of this prosaic business decision were compounded by a regulatory and institutional peculiarity of the US telecommunications market, viz. in having unlimited local calling for a fixed monthly rent as the norm. The combined effect from the perspective of the consumers was a net flat price, and Internet penetration tripled in one year. Levinson and Odlyzko (2007) offer an excellent discussion of this preference for simplicity ultimately boosting the adoption of many different kinds of communication services, from the British Penny Post to the Internet. The Indian Internet market, with its nightmare tangle of rules, regulations and pricing regimes would do well to pick up some pointers from other parts of the world which have already climbed the learning curve.

4 Broadband Adoption in India: What do We Know?

Broadband, defined as minimum 256kbps downstream in MCIT (2004), currently stands at less than one percent penetration in India, which is poor even by the standards of developing countries. The market is very much fragmented, having 104 service providers. Though on the face of it this appears to point towards a high degree of competition, Internet service provision is clearly an oligopolistic game at the national level. The erstwhile state monopoly, BSNL, has 56% of the market, and 95% of the market is cornered by just the top 10 players.[18]

In terms of technology, 86.54% of all broadband connections are DSL.[19] This is surprising as India has a low wireline penetration, and troubling because that is actually shrinking rapidly.[20] A more worrying fact is that the shrinkage is quicker in rural areas than in urban ones. Since the country is so overwhelmingly dependent on DSL for providing broadband access, the diminishing reach of wireline is a serious blow to plans of broadband expansion in the country, especially in the rural parts.

[16] This gap has been apparent since the first surveys on Internet penetration. The latest numbers point towards its continued existence. See "Demographics of Internet Users", December 2009, of the Pew Internet and American Life Project. Available at http://www.pewinternet.org/Reports/2010/Internet-broadband-and-cell-phone-statistics.aspx?r=1. Accessed on June 15, 2010.

[17] The interactions between these socio-cultural factors and ICTs are highly complex, little understood, and hence difficult to quantify in neat structural models. As an example, consider the long-standing conundrum of why, if ICT usage increases human capital, no effect shows up in something even as simple as student learning outcomes (Trucano, 2005). In a fascinating recent paper, Spiezia (2009) shows that perhaps the missing link could be what he describes as "capital" - which includes social and cultural capital - which students imbibe from social and domestic environments.

[18] TRAI (2010b) p.24.

[19] *Ibid*, p.26

[20] *Ibid*, p. ix

The question of appropriate technology becomes important in this context. The concept of appropriateness should be considered along the dimensions of both technical and economic efficiency, which raises a question mark for what technology to promote for raising broadband penetration. For instance, WiMAX, which is often discussed as being technically appropriate for a country like India, is clearly too expensive to make substantial inroad in the near future. Apart from additional hardware costs, even tariffs at present are several times that of DSL packages.[21]

In international perception, Indian consumers are thought to enjoy cheap, high-quality ICTs. This is particularly misleading for broadband. Tariffs adjusted for national income are still forbiddingly high.[22] TRAI (2010a) quotes statistics from the ITU ranking India 77^{th}in real tariffs, i.e. in proportion to national income. The picture becomes worse when further adjusted for speed, in which case the rank slips to 84 (See Appendix). To put it in perspective, quality-adjusted real tariffs in the UK are cheaper than in India by a factor of nearly 270. In any case, trying to gauge price and speed in India is a heroic task because of the confusing spread of plans every ISP appears to offer. A characteristic tradeoff is that unlimited plans throttle throughput while speedier plans are metered. The consumer looses out on the broadband experience either way. Reiterating the lessons of Levinson and Odlyzko (2007), the chances of a boom in broadband usage would appear to be slim till the market offers decent speeds at a reasonable price and without the uncertainty of paying by the minute and the byte.

5 Broadband Adoption in India: What do We *Not* Know?

Chapter 5 of TRAI (2010a) collates all the 35 questions listed at the ends of the preceding chapters. Some of them are more assertion than query. It would be difficult, for instance, to argue in the negative with the sentiments of "5.6: Do you agree that existing telecom infrastructure is inadequate to support broadband demand?" or "5.1: Is non-availability of optical fibre from districts/cities to villages one of the bottlenecks for effective backhaul connectivity and impacts roll out of broadband services in rural areas?" A few suffer from circular logic. For example, Q. 5.22 ("Should broadband tariff be regulated in view of low competition in this sector?") appears to answer Q.5.19 two questions before ("Does the broadband sector lack competition?"). Some of the regulatory questions probably do not need a reinventing of the wheel as they have been extensively discussed and dissected by subject matter experts in other parts of the world. Questions relating to tariff regulation (5.22) or Right of Way (5.18) are established topics in telecommunications literature. Since the basic technologies - whether they be DSL or cable or optical fibre - are standard, there is no reason to presume their functional characteristics would be different enough in India to merit a whole new line of investigation.

But it is the bulk of the questions, which can roughly be described as pertaining to structural characteristics of the Indian market, which deserves special scrutiny. Quoted below are a prominent few:

5.1: What should be done to increase broadband demand?

5.3: What measures should be taken to improve the perceived utility of broadband among the masses?

5.17: Is present broadband definition too conservative to support bandwidth intensive applications? If so, what should be the minimum speed of broadband connections?

5.20: Do you think high broadband usage charge is hindrance in growth of broadband? If yes, what steps do suggest to make it more affordable?

5.30: Do you think that bad quality of broadband connection is impacting the performance of bandwidth hungry applications and hence crippling the broadband growth?

An attempt to answer these questions based on current knowledge of the Indian broadband market would be an exercise in futility. It is not possible, for example, to comment on whether existing

[21] Depending on the speed of connection, annual consumer tariff ranges from Rs. 10,000 to Rs. 18,000. Business rates vary from a steep Rs. 44,000 to an outrageous Rs. 200,000. See http://www.bsnl.co.in/service/bbtariff/wimaxtariff.htm. Accessed on July 07, 2010.

[22] TRAI (2010b), p. 66.

broadband tariffs are too high without having a relatively good understanding of consumers' reservation prices and the price-elasticity of demand. Neither is it possible to make a pronouncement on how to increase broadband demand without first having a clear idea about the determinants of demand and the mechanism through which they operate.

In order to predict policy outcomes with a reasonable degree of certainty, we need a much better appreciation of market dynamics than what we have at present. What is required is a body of research providing documentary evidence, at the very minimum, on the following:

1. Penetration: In which parts of the country is broadband [not] available? State-level data published by TRAI is not granular enough for creating a detailed picture. Current and regularly updated "to-the-curb" information in the form of mappable GIS data is needed to identify and assess broadband availability over time.

2. Customer profiles: Who are online? What are their identifying characteristics including, but not limited to, age, income levels and educational attainments. Are their any systematic differences across regional, social and cultural identifiers?

3. Usage patterns: What are people using Internet connections for? What are the current and expected bandwidth requirements? Do these online activities require high throughput (which can be expensive)? For example, checking email does not need a broadband connectivity, but working with cloud servers does.

4. Supply considerations and constraints: Why are service providers not expanding operations rapidly? Do they perceive low returns on investment? Is it because they face excessive bureaucratic meddling? Do they consider some areas, such as the the North East, not worth the effort because of political stability issues?

5. Determinants of demand, which would have to consider:

   (a) Market parameters such as estimates of sensitivity to price and quality.

   (b) Individual level characteristics identified in (1) which can be used to model purchase of service and usage decisions.

   (c) Regional and local differences, if they exist. Given the huge territorial expanse of the country, topographical and climatic variations, and social and cultural spectra which are wider than anywhere else in the world, care must be taken in any national expansionary policy to ensure a reasonable level of equity.

6 Information-driven Policymaking - Why and How

The questions listed above outline the basic minimum premises needed to get a pulse of this sector. It is ironic that India, widely considered to be a superpower in information technologies, has such fundamentally poor information about the information channels in the country.[23] Research focusing on these aspects is standard practice in developed nations. The most high profile amongst these are periodic reports published by the National Telecommunications and Information Administration (NTIA) in the US.[24] In the UK, Ofcom, the regulatory and competition authority for communication industries, regularly publishes research reports online.[25] The Australian Communication and Media

[23] As a matter of fact, despite the intense journalistic glorification of ICTs for development, precise figures on economic or financial returns are virtually non-existent. One of the few exceptions is OECD (2010), which also brings to attention this deficiency.

[24] www.ntia.doc.gov. *The latest report is DIGITAL NATION: 21st Century America's Progress Towards Universal Broadband Internet Access.* URL: http://www.ntia.doc.gov/reports/2010/NTIA_internet_use_report_Feb2010.pdf. Accessed on June 17, 2010.

[25] URL: http://www.ofcom.org.uk/research/

Authority (ACMA) goes so far as to fine tune its research and publication for consumers and industry separately.[26]

Apart from the generally bureaucratic reports published by government agencies, the most important insights are invariably either from researchers affiliated to universities or thinktanks, or those emerging from international research organizations. The foci of the research cover the whole spectrum of topics. Researchers typically do not sit in academic ivory towers, instead appearing commonly in the public space as experts on government panels and as strategic consultants for companies. Very often they are called upon to appear as expert witnesses in contentious legal cases. Thus, there is a constant circular flow of knowledge between the government, industry and academia. Research serves as guidelines for policymakers. In India, in comparison, the number of papers published on a topic as important as the sensitivity of Internet demand to tariff levels is precisely zero. In other words, the generous call to comment by TRAI notwithstanding, whatever policies would be formulated regarding tariffs would be based on conjectures and opinions. This is true for all the areas listed in the preceding section.

It is worthwhile to trace the sources and flow of knowledge in open economies. Market research firms frequently run small scale surveys, parse the data and sell the reports to either contracting clients or to whomever may be interested in the product. These are generally not considered to have high intellectual worth because they almost never adhere to strict research methodological standards. However, they provide the important service of broadly tracing and highlighting major economic trends. Some thinktanks or research organizations periodically conduct their own surveys. Some, such as the Pew Internet and American Life Project (PIALP), are highly respected because of the quality of their work.[27] But the most important of sources of data are the government agencies themselves, and different agencies often work in close collaboration to cover different aspects of a particular report. For instance, the NTIA reports are generated from the annual Current Population Survey (CPS) conducted jointly by the Bureau of Labor Statistics and the Census Bureau.[28] It should be noted that without this cross-jurisdictional collaboration, it would not be possible for American lawmakers to get informed about complex, overlapping issues such as how broadband is affecting the labour market in some remote parts of the country.

The strength of the system rests on the two pillars of the collection of high-quality data and their free sharing amongst researchers in industry, academia and regulatory agencies. For example, the Federal Communications Commission (FCC), the US equivalent of TRAI, has a dedicated subdomain for disseminating data.[29] The data are downloadable and analyzable in standard statistical packages, and undergo internal and external scrutiny for quality. In comparison, TRAI publishes no tariff data, nullifying any attempt to gauge the sensitivity of broadband demand to price. Neither does it provide any supporting contextual socio-economic information, though it almost certainly can have access to information from other governmental agencies such as the Census, Central Statistical Office (CSO) or the National Council of Applied Economic Research (NCAER). The lowest level of aggregation in the data is the state, rendering toothless any estimates of individual-level purchase decisions. TRAI may possibly be the only major regulator in the the world which uses secondary data from market research firms such has IMRB to justify national plans.[30] Adding to the incovenience, all data posted on the TRAI website are in portable document format (PDF), making statistical analysis a prohibitive enterprise.

There is a deeper, more fundamental deterrent to drawing conclusions from the information provided. The TRAI website hosts one whole page of defensive statements such as: "The Telecom Regulatory Authority of India specifically does not make any warranties or representations as to the accuracy,

[26] URL: http://www.acma.gov.au/WEB/STANDARD/pc=ACMA_PUBS_DIR

[27] URL: www.pewinternet.org

[28] The CPS data is available at http://www.census.gov/cps/. For the Internet and Computer Use files from the CPS used in the NTIA reports, see http://www.ntia.doc.gov/data/index.html. Accessed on June 17, 2010.

[29] URL: `http://reboot.fcc.gov/data/`

[30] The Quality of Service (QoS) Indicators which TRAI posts on its website, for instance, are conducted by IMRB. See: `http://www.trai.gov.in/AuditSurvey.asp`. Accessed on July 07, 2010.

completeness or adequacy of any such material or the same being up-to-date."[31] Is this conceivably because TRAI posts unaudited data self-reported by the service providers? If the regulatory authority of a country does not guarantee the quality of the data it publishes, what robust insight can researchers hope to come up with?[32] On the basis of our current state on knowledge, it is not possible to deduce even macro-estimates of the effects of broadband on the economy, let alone fine-tune pricing structures for increasing penetration.

7 Conclusion

There are signs of growing awareness of this information deficiency. Just the fact that TRAI, a bureaucracy, is soliciting feedback from all and sundry is a hopeful indicator. DoT and TRAI are more active than most in encouraging the flow of information amongst stakeholders. Much to their credit, they are also unusually open to ideas from outside of Indian shores, and regularly host seminars inviting specialists from across the globe. A topical example would be the *Seminar on ICT Measurement and Indicators*, held between the the 12th and 14th of May, 2009, including among the participants representatives of ITU, OECD, UNESCO, UNCTAD as well as of domestic state ICT initiatives.

The problem appears to be in following the conversations up through to concrete outcomes. Though a great deal of expertise was traded on the floor in the above mentioned seminar, no change in either the collection or sharing of data has been discernible since in the operations of TRAI. This is very unfortunate, since policy processes, in order to be effective, have to be information-driven. TRAI, as the ultimate arbiter of telecom issues, must ensure that an extensive knowledge-base exists from which to draw upon in order to answer policy questions. In theory, this is very possible, since service providers have to report all subscription information to the government. Given the human and technical capacity constraints of TRAI, this may not be feasible. One alternative model would be to encourage and assist institutions of higher learning in hosting the data.[33] Complete and open access must then be allowed too interested researchers, after safeguarding legal and confidentiality concerns.

Over the last one and a half decades, monitoring the information economy has become an established discipline. The gathering and analysis of information regarding access to and usage of ICTs are now well-understood and routine procedures, and India does not have to start from scratch methodologically. It would be easy enough to use the set questionnaires used by different country agencies as templates for designing one tailored to the Indian context. Most international organizations also have considerable expertise in this area which they share readily.[34] There is perhaps no good justification as to why Indian statistical agencies cannot do periodic surveys on the breadth and depth of information services in the nation.

Uninformed decisions can have serious financial and social repercussions, and India has been particularly prone to this. Unless needs and gaps in services are rigorously identified and analyzed, policies will invariably cause leakages and distortions. It is thus in the direct interests - or even the social responsibility - of TRAI to allow the maintenance, analysis and free exchange of information on matters in its jurisdiction. An added benefit would accrue to the service providers, who would profit from directly from insight gained from the insight gained, and from interactions with researchers and regulators.

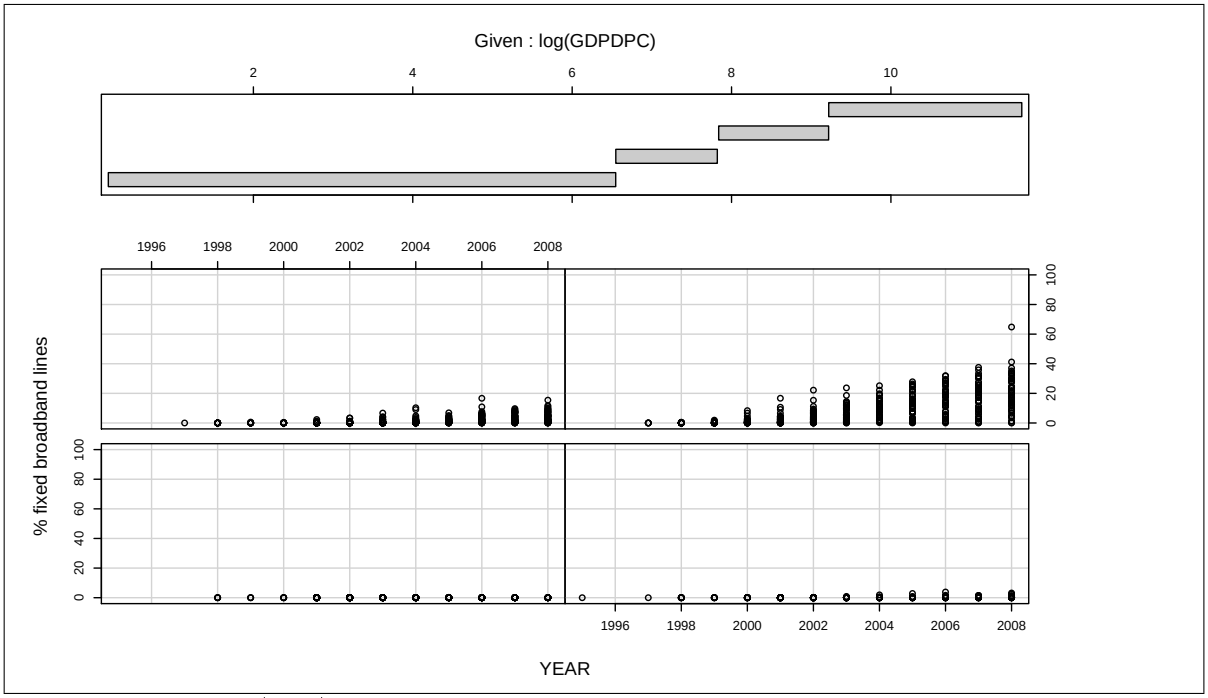
[31] URL: http://www.trai.gov.in/Disclaimer.asp

[32] In all fairness, TRAI does suffer from grossly inadequate qualified manpower. The Annual Report of 2008-2009 laments this issue (TRAI, 2009, p.169). This is a problem which is endemic in all policy areas in India, as is at least a major reason behind the astonishingly poor quality of the documents produced from various bureaucratic quarters. A recent "mission document" (MHRD, 2009) even misspells "information" as "infofrmation" on the cover page.

[33] There are again existing models which could be followed, such as the Inter-University Consortium for Political and Social Research (ICPSR), hosted at the University of Michigan. It is a crying shame that nothing like this exists in India. URL: `http://www.icpsr.umich.edu/icpsrweb/ICPSR/`. Accessed on July 07, 2010.

[34] See, for example, the excellent OECD *Guide to Measuring the Information Society* (OECD, 2009).

Figure 1: Worldwide Adoption of Broadband, by Income Quartile



Data Source: ITU(2009). Lowest income quartile on bottom left, highest on top right. Income (gdppcd) defined as per capita GDP in US$.

Table 1: Determinants of Broadband Adoption

Variable	Description	Estimate	Std. Error	t value	Pr(>|t|)
(Intercept)		-3.9755	0.8526	-4.66	0.0000
GDPDPC	*Per capita GDP in US$*	0.0002	0.0000	11.22	0.0000
ENROLL	*Gross school enrollment*	0.0082	0.0087	0.94	0.3467
MOBILE	*Mobile penetration*	0.0302	0.0068	4.44	0.0000
YEAR2000	*Base year: 1999*	0.5339	0.7324	0.73	0.4662
YEAR2001		2.1552	0.6583	3.27	0.0011
YEAR2002		2.5754	0.6566	3.92	0.0001
YEAR2003		2.7961	0.6647	4.21	0.0000
YEAR2004		3.6150	0.6712	5.39	0.0000
YEAR2005		4.5993	0.6955	6.61	0.0000
YEAR2006		26.9668	3.2657	8.26	0.0000

Data Sources: ITU (2009) and World Bank (2009b)

Table 2: Determinants of Broadband Adoption - Alternative Model

Variable	Description	Estimate	Std. Error	t value	Pr(>|t|)
(Intercept)		0.5957	1.2931	0.46	0.6451
GDPDPC	*Per capita GDP in US$*	0.0001	0.0000	2.75	0.0061
$(GDPDPC)^2$	*Per capita GDP in US$: squared*	0.0000	0.0000	1.36	0.1754
ENROLL	*Gross school enrollment*	-0.1416	0.0336	-4.21	0.0000
$(ENROLL)^2$	*Gross school enrollment: squared*	0.0012	0.0003	4.64	0.0000
MOBILE	*Mobile penetration*	0.0318	0.0075	4.26	0.0000
YEAR2000	*Base year: 1999*	0.5216	0.7240	0.72	0.4715
YEAR2001		2.0176	0.6571	3.07	0.0022
YEAR2002		2.4289	0.6583	3.69	0.0002
YEAR2003		2.6511	0.6689	3.96	0.0001
YEAR2004		3.5238	0.6797	5.18	0.0000
YEAR2005		4.4945	0.7110	6.32	0.0000
YEAR2006		26.3772	3.2271	8.17	0.0000

Data Sources: ITU (2009) and World Bank (2009b)

APPENDIX

Monthly Tariff, Adjusted for Speed and GDP

Rank	Country	Adj. Tariff	Rank	Country	Adj. Tariff
1	United Kingdom	0.00008	71	Lebanon	0.01251
2	Italy	0.00009	72	Algeria	0.01321
3	Japan	0.00011	73	Mauritius	0.01466
4	Czech Republic	0.00016	74	Dominican Rep.	0.01493
5	Luxembourg	0.00019	75	Egypt	0.01573
6	Denmark	0.00023	76	Georgia	0.01580
7	Netherlands	0.00023	77	Seychelles	0.01623
8	Macao, China	0.00025	78	Thailand	0.01680
9	Portugal	0.00031	79	Jordan	0.01750
10	Korea (Rep. of)	0.00031	80	Ukraine	0.01861
11	Hong Kong, China	0.00034	81	El Salvador	0.01920
12	Norway	0.00037	82	Sri Lanka	0.02007
13	Germany	0.00040	83	Peru	0.02029
14	Russia	0.00042	84	**India**	**0.02136**
15	United States	0.00043	85	Fiji	0.02241
16	Switzerland	0.00048	86	Morocco	0.02732
17	Singapore	0.00054	87	Albania	0.02782
18	Sweden	0.00058	88	Botswana	0.03297
19	Austria	0.00059	89	Dominica	0.03436
20	Belgium	0.00060	90	Iran (Islamic Rep. of)	0.03443
21	Finland	0.00071	91	Saint Lucia	0.03528
22	T.F.Y.R. Macedonia	0.00074	92	Jamaica	0.03583
23	Greece	0.00074	93	St. Vincent and the Grenadines	0.03856
24	Hungary	0.00075	94	Armenia	0.03895
25	Bulgaria	0.00076	95	Pakistan	0.03970
26	Spain	0.00077	96	Namibia	0.04104
27	Slovak Republic	0.00077	97	Samoa	0.04250
28	Ireland	0.00077	98	Cape Verde	0.04272
29	France	0.00078	99	Bhutan	0.04658
30	Latvia	0.00083	100	Papua New Guinea	0.05686
31	Canada	0.00083	101	Azerbaijan	0.06185
32	Iceland	0.00090	102	Angola	0.06913
33	Lithuania	0.00107	103	Senegal	0.07244
34	Romania	0.00113	104	Belize	0.07494
35	Malta	0.00116	105	Bolivia	0.07569
36	Croatia	0.00128	106	Sudan	0.07882
37	Paraguay	0.00156	107	Nicaragua	0.10650
38	Argentina	0.00183	108	Guyana	0.12409
39	Australia	0.00206	109	Tonga	0.14381
40	Cyprus	0.00211	110	Zambia	0.14553
41	Estonia	0.00214	111	Lesotho	0.14949
42	Trinidad and Tobago	0.00260	112	Cote d'Ivoire	0.15106
43	Montenegro	0.00265	113	Nepal	0.20248
44	United Arab Emirates	0.00269	114	Tanzania	0.26852

Rank	Country	Adj. Tariff	Rank	Country	Adj. Tariff
45	Bosnia and Herzegovina	0.00286	115	Mali	0.31211
46	Serbia	0.00323	116	Vanuatu	0.34738
47	Oman	0.00324	117	Bangladesh	0.41493
48	Kuwait	0.00350	118	Cambodia	0.45169
49	Poland	0.00353	119	Madagascar	0.45531
50	Bahrain	0.00362	120	Benin	0.50116
51	Slovenia	0.00376	121	Cameroon	0.55716
52	Maldives	0.00446	122	Yemen	0.73128
53	Moldova	0.00462	123	Rwanda	0.76698
54	Malaysia	0.00473	124	Kenya	0.78034
55	Chile	0.00474	125	Togo	0.87722
56	Grenada	0.00474	126	Mozambique	0.88207
57	Costa Rica	0.00490	127	Sao Tome and Principe	0.94692
58	Uruguay	0.00494	128	Niger	1.17941
59	Brazil	0.00524	129	Lao P.D.R.	1.24001
60	Viet Nam	0.00528	130	Uganda	1.94000
61	Barbados	0.00673	131	Nigeria	1.95124
62	Mexico	0.00684	132	Comoros	2.06969
63	Saudi Arabia	0.00821	133	Swaziland	2.72301
64	Panama	0.00849	134	Gambia	2.84443
65	Colombia	0.00882	135	Guinea	4.52540
66	Venezuela	0.01103	136	Ethiopia	7.91390
67	China	0.01134	137	Burkina Faso	13.00793
68	South Africa	0.01139			
69	Tunisia	0.01182			
70	Philippines	0.01204			

Data Source: ITU (2010). Adjusted tariff (US$) is defined as $[(\textit{Monthly Tariff})/(\textit{Speed in Mbps})]/(\textit{Per capita GDP})$. Data is for 2008.

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