

TO: M. H. Au,
Director General of Telecommunications
Office of Telecommunications Authority
Queens Road East
Hong Kong

FROM: Professor Janusz A. Ordover
Dr. William H. Lehr

RE: Response to Second Consultation Paper on Expiry of 2G Licenses

DATE: June 18, 2004

Dear Mr. Au:

At the request of Hutchison Telephone Company Limited and Hutchison 3G (HK) Limited (“HTCL”), we are submitting the attached report in response to the Office of Telecommunications Authority’s (“OFTA”) second consultation report in the matter of licensing mobile services on expiry of existing licenses for second generation (“2G”) mobile services.

The attached report provides an economic critique of OFTA’s recommendations for the treatment of 2G licenses. Specifically, we explain why we believe it is *not* appropriate for OFTA to treat these licenses asymmetrically, and to seek to promote entry by an additional 3G competitor using spectrum currently associated with HTCL’s 2G CDMA service. Contrary to the discussion in the *OFTA 2nd Report*, the recommended policy amounts to an ill-advised attempt at industrial engineering that is inconsistent with OFTA’s stated goals of promoting increased reliance on market forces, technically-neutral regulatory policy, and the growth of mobile data services in Hong Kong.

Economic theory and an analysis of conditions in Hong Kong’s mobile services market indicate that the slow pace of 3G evolution is *not* due to a lack of adequate 3G competition. Promoting entry by a new competitor using the cdma2000 technology will further fragment an already excessively rivalrous and fragmented market. This will increase market uncertainty and costs. OFTA’s recommended policy would discourage investment in mobile infrastructure and would be detrimental to the orderly development of 3G services in Hong Kong.

The best way to let market forces continue to work in Hong Kong is to treat all of the 2G licenses symmetrically by extending the “right of first refusal” to HTCL’s CDMA license.

Mobile Service Relicensing in Hong Kong: Economic Considerations

Submission by

Professor Janusz A. Ordover
New York University

and

Dr. William H. Lehr
MIT

on Behalf of

Hutchison Telephone Company, Ltd.

and

Hutchison 3G (HK) Ltd.

to be submitted to

Office of Telecommunications Authority

**** June 18, 2004 ****

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Submission by

Professor Janusz A. Ordovery
New York University

and

Dr. William H. Lehr
MIT

I. Introduction

1. This paper is being submitted on behalf of Hutchison Telephone Company Limited and Hutchison 3G Limited (HTCL) in response to the second consultation report issued by Office of the Telecommunications Authority (OFTA)¹ as part of its review of licensing policy for mobile services. In its report, OFTA is proposing to adopt an asymmetric regulatory policy for existing Second Generation (“2G”) mobile service licenses when the current licenses expire. Under the proposed plan, the licensees that are providing GSM and PCS services would be granted a “right of first refusal” to extend the lives of their existing licenses when those are due for renewal while the licenses that are being used to provide 2G CDMA (HTCL) and TDMA (CSL) services would expire and be re-auctioned.
2. OFTA’s policy goal is ostensibly to initially facilitate entry by an additional mobile service provider that would be licensed to offer Third Generation (“3G”) services using the frequencies currently occupied by HTCL’s CDMA service. It is likely that this new entrant would offer the 3G services by

¹ See Office of the Telecommunications Authority, “Licensing of Mobile Services on Expiry of Existing Licenses for Second Generation Mobile Services: Analysis of Comments Received, Preliminary Conclusions and Further Consultation,” Second Consultation Report, Hong Kong, 19 March 2004 (hereafter, *OFTA 2nd Report*).

utilizing cdma2000 technology similar to that currently deployed in Japan and Korea. Moreover, OFTA has foreshadowed that its general approach to spectrum licensing is that as other wireless technologies emerge and stabilize, the relevant spectrum will be made available. This may result in the entry of further mobile service providers in addition to the fifth 3G operator that would be licensed in the 800MHz band if OFTA implements its proposed policy (e.g. using TDD-based technologies).

3. OFTA's purpose in adopting this policy is to:

- Promote accelerated development of broadband wireless data or 3G services.
- Promote more efficient spectrum utilization by retrieving the CDMA and TDMA spectrum which OFTA regards as under-utilized and re-auctioning the spectrum currently utilized by HTCL's 2G (IS-95B) CDMA system.²
- Support increased reliance on market forces to determine the optimal number of competitors and the choice of technologies.

4. Moreover, OFTA intends that the proposed policy remain consistent with the following considerations with respect to its licensing policies:

- ◆ *To ensure choice of services*
- ◆ *To provide stable investment environment*
- ◆ *To ensure efficient use of spectrum*
- ◆ *To ensure continuity of customer service*

² OFTA is not currently planning to re-auction the reclaimed spectrum being used by CSL to support its 2G TDMA services, but is planning to reserve this for future use by current licensees. As we explain further below, this asymmetric treatment further highlights the sense in which OFTA's proposed policy is not "technically neutral."

- ◆ *To maintain technology neutrality*³

5. The goal of this paper is to provide an economic analysis of OFTA's policy. This analysis demonstrates that the proposed policy is inconsistent with OFTA's stated purpose and goals. Indeed, if adopted, OFTA's policy is more likely to slow adoption of 3G services, will fail to promote more efficient utilization of spectrum, and likely would harm competition and incentives to invest in the development of broadband wireless services in Hong Kong. Moreover, the paper will explain why in our view OFTA's policy reflects an inappropriate effort at industrial engineering that seeks to bias the market's choice by forcing introduction of a new competitor using an incompatible technology.⁴ This directly conflicts with OFTA's stated – and appropriate – goals to “provide [a] stable investment environment,” “ensure efficient use of spectrum,” and “maintain technology neutrality.”⁵
6. Although OFTA's policy is claimed to give effect to market forces, OFTA's band plan⁶ and its strategy of encumbering the license with additional

³ See *OFTA 2nd Report*, paragraph 9.

⁴ If both cdma2000 and W-CDMA are deployed in the Hong Kong market there will be incompatibility issues at multiple levels. Although telephone calls between callers on the two networks will be supported (as is the case already across the multiple 2G networks), supporting other advanced services such as mobile video conferencing may not be viable. In either case, additional costs will be incurred to implement the requisite “gateway” capabilities to support cross platform interoperability.

⁵ See *OFTA 2nd Report*, paragraph 9, and paragraph 32, where OFTA argues: “the TA will maintain a technology-neutral approach in the licensing of mobile services and the TA has all along been relying on market force to decide on the technology to be adopted.”

⁶ See *OFTA 2nd Report*, paragraphs 33-38, wherein OFTA explains band plan and its suitability for cdma2000 deployment, the unlikelihood that this might be used for another technology like GSM 850, and the expectation that licensing this spectrum will make available services like those “supported by the cdma2000 standard, which is currently not adopted by mobile operators in Hong Kong.”

requirements⁷ demonstrate that the real effect of the proposed policy will be to force the introduction of what is *hoped* to be a data-centric operator using the cdma2000 technology in Hong Kong.

7. Because there are already four licensed 3G competitors and three of them have yet to commit to deploying services, it is simply not credible that OFTA's intent is to remove impediments to entry by another 3G service provider or to address inefficiency in spectrum utilization. There is no spectrum scarcity or other entry barriers that would inhibit 3G competition in Hong Kong: the problem is not too little competition in mobile services, but too much competition for the current level of demand.
8. The entry of a fifth 3G licensee would further fragment the market which is already significantly more fragmented than appears likely to be sustainable. It is noteworthy that mobile services in Hong Kong are more fragmented and competitive than in either Japan or Korea which have been held forth as examples of successful 3G progress. The intense rivalry and fragmented Hong Kong markets limit current and potential competitors' ability and incentives to investment in new broadband infrastructure and content. Indeed, service providers with substantial assured demand for the content are often in a better position to solve the coordination problems of simultaneous provisioning of content and services that are compatible with and optimized for the content.
9. The slower pace of development of 3G in Hong Kong reflects the impact of market forces and the intense rivalry in the mobile sector that is due in part to

⁷ See *OFTA 2nd Report*, paragraphs 41-43, wherein OFTA explains its intention to impose stringent license requirements which, again, will increase the likelihood that the licensee will use the spectrum for cdma2000.

past regulatory policies. Hong Kong can catch up rapidly, however, once it achieves ‘critical mass.’ Public policies that encourage the growth of investment in Hong Kong-specific content and applications would help increase demand for mobile data network services which would motivate 2G carriers to accelerate their 3G upgrade plans.

- 10.** This paper complements the reports by PA Consulting in two respects:
 - First, it provides general economic theory and analysis in support of the Hong Kong-specific assumptions underlying PA Consulting’s model of mobile competition in Hong Kong.
 - Second, the results of the PA Consulting’s model provide quantitative support specific to the Hong Kong market for the economic analysis included herein that demonstrates that the progress of 3G services and competition for broadband wireless in Hong Kong is *not* constrained because of a lack of adequate competition or spectrum availability (either to facilitate the entry of additional competitors or of alternative technologies such as cdma2000).⁸
- 11.** Therefore, the activist policy adopted by OFTA that seeks to promote entry by a fifth 3G licensee will likely harm rather than benefit the development of a robust market for wireless broadband services in Hong Kong.
- 12.** The balance of this paper is divided into four sections:
 - Section II reviews the current status of competition in the provision of wireless services in Hong Kong. This analysis shows that mobile

⁸ A comparison of the GSM/WCDMA versus cdmaOne/cdma2000 trajectories to 3G wireless services does not suggest any material basis for preferring one technology or the other (see PA Consulting Japan/Korea Report, Appendix C, Hutchison Submission in Response to the Second Consultation Paper, 19 June, 2004).

services are extremely competitive in Hong Kong, and that market forces are directing an appropriate pace for the evolution of 3G services.

- Section III explains why seeking to introduce a fifth facilities-based 3G competitor is likely to harm the healthy development of the market.
- Section IV critiques the proposed OFTA plan for being inconsistent with the desire to rely on market forces and eschew technology-biased policy.
- Section V explains why we believe that the best policy would be to extend HTCL's CDMA license under comparable terms to the other 2G licenses, or at a minimum, treat the CDMA spectrum analogously to the spectrum associated with CSL's TDMA license. In any case, we do not think it is consistent with sound spectrum policy reform to reactivate the CDMA license at this time while encumbering it with special restrictions.
- Section VI concludes.

II. Mobile Services in Hong Kong

- 13.** The global growth in mobile telephony services from a niche, high-cost service for a few wealthy consumers to a low-cost, mass communication service used by everyone has been one of the most important trends in telecommunications in the past decade. Now, with the introduction of broadband wireless data services in the form of third-generation or 3G services, mobile communications are poised to merge with the world of the Internet and e-Commerce. The transition to mobile data services for the mass market will bring a host of new applications and services. Consumers and

businesses will benefit from lower (quality-adjusted) prices,⁹ expanded services, and increased choice.

A. Challenges Confronting the Mobile Operators

- 14.** While the promise of the broadband wireless future is great, there are also significant challenges that need to be addressed. Billions of dollars in new investment are needed to put in place the network infrastructure, and to create the broadband content and applications that will be delivered via the new 3G networks.
- 15.** This poses a difficult challenge for mobile service providers. First, the global telecommunications sector is just now emerging from the telecom meltdown that followed the dot.com crash in 2000. In the new environment, investors are more reticent to commit capital in advance of a proven market need. In the global competition for multinational telecom investment, smaller markets face an added challenge, given the greater risks posed to fixed investments.
- 16.** Second, the rapid pace of technical innovation in wireless technology has continued, forcing the industry to continuously revise its plans for next generation mobile services. With the recent progress in the development of wireless LAN technologies like WiFi (802.11) and broadband fixed wireless access technologies like WiMax (802.16), the future landscape for broadband wireless remains unclear and is characterized by considerable risks. These

⁹ With the addition of new data and voice services, the Average Revenue Per Unit (ARPU) is expected to stabilize or even increase. Although subscribers will not pay more for making traditional voice calls, it is expected that they will pay more for the bundle of services they purchase. On a quality-adjusted basis, however, prices ought to be lower.

increasing risks further exacerbate the difficulties in access to the needed capital.

- 17.** Third, global regulatory reform is liberalizing telecommunications markets. While this is removing regulatory barriers that have heretofore hindered market development, liberalization has also resulted in increased competition and increased regulatory and market uncertainty. Wireless and wireline services are converging, serving simultaneously as potential complements and substitutes.¹⁰ In this environment, carriers are understandably proceeding cautiously to husband scarce investment and corporate resources. In this climate, access to external financing remains tight because outside investors remain highly cautious about investing in telecommunications operators. This accentuates the importance of internally-generated funding to finance infrastructure investment. Such enhanced internal funding may be needed to signal to the financial community the company's own assessment of the attendant investment risks and ensure external financing. In any case, when external finance may be difficult to secure – not necessarily because investments are unsound but because asymmetric information restricts the flow -- inability of incumbents to generate internal funds due to excessive competition (price and non-price) that threatens carrier margins makes investment in new infrastructure less likely.
- 18.** While competition can be a potent motivator for investment and technological progress, too much competition can have exactly the opposite effect. Prices

¹⁰ Mobile data services make it possible to use computing/communications services in more environments and therefore increases demand for broadband services of all kinds, thereby complementing fixed broadband data. Simultaneously, it can serve as a substitute for fixed broadband services for consumers who do not need the higher data rates usually associated with wired offerings.

can be too low to be consistent with adequate incentives to invest in infrastructure and new services, with the result that consumers suffer. Even in the theoretical ideal of perfect competition, the number of competitors is in determinant. In an industry such as telecommunication services where large fixed and sunk costs are common, excess competition can fragment the market raising industry costs for all and reducing overall efficiency and surplus. While the benefits of competition in a static market in the form of lower prices and enhanced incentives to minimize costs are easy to demonstrate, the relationship between market structure and dynamic efficiency is much more complex and the potential harm from excessive competition is more severe.¹¹

19. Before considering the current state of 3G service development in Hong Kong, it is important to assess the state of the market for 2G services, since this is the customer market and base on which 3G services will expand.

B. Current 2G Service Competition in Hong Kong is Excessive

20. Access to basic and advanced communication services is critical to sustaining Hong Kong's role as an international business center and as a fulcrum for economic growth in Asia. In response to this need, Hong Kong has been in the forefront of global communication trends. With six facilities-based providers offering service to over 7.35 million mobile subscribers (which implies a penetration rate of 108%)¹², Hong Kong has arguably the most competitive

¹¹ For more on this issue, see, e.g., William J. Baumol, The Free-Market Innovation Machine, Princeton University Press (2002).

¹² There were 7,349,202 mobile subscribers in Hong Kong as of March 2004 (see OFTA, "Key Statistics of Telecommunications in Hong Kong, Wireless Services," June 7, 2004). The population of Hong Kong is estimated to be 6,810,100 (see Census & Statistics Bureau). This implies a penetration rate of 108% (which is potentially over-stated because some subscribers are not Hong Kong residents and others may have multiple telephones).

mobile market in the world (see Figures 1 and 2) and one of the highest penetrations of (fixed-line) broadband services (see Figure 3).

21. With penetration at saturation point, carriers have been competing heavily on price, with the result that mobile telephone prices in Hong Kong are among the lowest in the world (See Figure 4). Only the United States, which offers a much larger market, is close to being as fragmented and rivalrous as the Hong Kong market. Unsurprisingly, as Figure 4 demonstrates, increased competition – as reflected by a fragmented market – translates into lower carrier profit margins.¹³
22. The six facilities-based competitors are operating eleven mobile network systems (see Figure 5). As will be discussed further below, it is noteworthy that Japan and South Korea, which are often cited as exemplars for wireless broadband, are much less fragmented and rivalrous. Available evidence indicates that mobile carriers in Japan and South Korea are able to earn higher profit margins and generate funds with which to partly defray the needed investments in infrastructure for new services.
23. The extremely low mobile prices in Hong Kong are doubly damaging to data services:
 - By increasing Minutes of Use (MOUs) they increase total carrier costs for traditional 2G services. Scarce investment capital is needed to expand 2G capacity instead of being available to fund the upgrades to 3G.

¹³ The extent of competition is frequently indicated by the extent of market concentration, as measured by the Hirschman-Herfindahl Index (HHI). The HHI is computed as the sum of the squares of the market shares of the firms in the market.

- Low voice prices retard the growth of demand for mobile data. Demand for new mobile data services like SMS is reduced because it is less expensive and easier simply to make a telephone call. While it would be inefficient to try to artificially force customers to migrate from voice into mobile data by forcing up the prices for traditional mobile services, it is important to recognize that the low 2G voice prices that prevail in the Hong Kong market adversely impact the evolution to mobile data and 3G services. The demand-pull into newer services is likely to be weak as long as the substitute products are cheap and deliver most of what consumers want.
- 24.** The slower development of SMS services based on 2.5G offerings has an additional negative spillover effect inasmuch as it depresses consumer learning about mobile data services. A large installed base of 2.5G data service customers provides a potential market for still better 3G data services. When such customer experience is lacking, the evolution to 3G will be slower.
- 25.** The saturated market and intense price-based competition also results in some of the highest churn rates in the world (see Figure 7). Customer churn increases vendors' costs and further strains limited corporate resources. That is, it appears that at present 2G carriers are so focused on surviving the vigorous competition for basic mobile telephone services that they lack the personnel, financial resources, and other business capacities needed to develop and launch new services like 3G. The retail marketing is so intense and the markets so fragmented that it is difficult to build customer awareness and understanding of 3G services. Mobile data services are an experience good. Customers need to understand what these services can do and how they can

benefit their social and work lives for a market for mobile data services to mature.

26. With eleven systems and six facilities-based mobile operators, Hong Kong has more competition than almost any other market in the world, and certainly more than any market of comparable size. The intensely rivalrous mobile service market in Hong Kong has been facilitated by a very pro-competitive regulatory environment. Hong Kong was one of the first to require carriers to adopt Mobile Number Portability (MNP), in March 1999, which makes it easier for customers to switch carriers. By contrast, MNP only began to be introduced in the United States in 2003, in South Korea in 2004 and has not yet been introduced in Japan.
27. Additionally, Hong Kong has licensed six Mobile Virtual Network Operators (MVNOs), but only three of these have ever been active (Shell Mobile, Trident, and China Motion Telecom) and Shell Mobile subsequently stopped service. MVNOs lease network services from facilities-based providers, and compete on the basis of retail service differentiation (*i.e.*, by focusing on niche markets that can be served at lower cost with a focused marketing strategy, by offering superior customer service, or by bundling the mobile services with other value-added services and features). The fact that MVNO competition has had difficulty establishing itself suggests the intensity of the facilities-based competition and the limited opportunities for them to be economically viable even with a differentiated strategy in the face of aggressive price competition.
28. While consumers may benefit in the short-run from bargain basement pricing, prices that fail to provide carriers with an adequate return on invested capital are not sustainable and deter infrastructure investment. As will be discussed

further below, the economics of competing as a facilities-based provider necessitates incurring substantial fixed¹⁴ and sunk¹⁵ costs that give rise to substantial scale and scope economies¹⁶ and which limit the number of economically viable carriers that can be sustained in a small market. As Exhibit 8 suggests, the sustainable number of facilities-based competitors may be four or less, which means that the Hong Kong market already has too many 2G carriers for long-term viability.

29. Finally, it is worth noting that if there is excessive entry beyond what the market can sustain that rationalizing the market either through restructuring or through some participants exiting the industry will be costly for the industry and for consumers. The losses can exceed the sunk costs of entry and include increased consumer confusion, slower market evolution, and additional fixed and variable costs associated with accomplishing the restructuring. Important skills and resources may be lost as a result and the provision of services may be disrupted causing unnecessary costs to subscribers. These additional adjustment costs are an unnecessary burden associated with encouraging excessive entry.

¹⁴ Fixed costs do not vary with the level of service actually provided. Therefore, average fixed costs decline with the size of the market served which makes it more economic to serve a larger market.

¹⁵ Sunk costs cannot be recovered once incurred. The presence of sunk costs presents an entry barrier for entry and new investment because they increase the cost of exit. Because it is profit maximizing in the short-run to continue to sell service as long as prices are above short-run marginal costs, price competition in an industry characterized by large sunk and/or fixed costs can be excessively aggressive with prices falling below average total short-run costs or average total long-run costs (which includes sunk costs). Prices at either level are insufficient to sustain continued investment.

¹⁶ Economies of scale arise when average costs decline with the size of the market served. Fixed and sunk costs can give rise to scale economies. When these are important, firms must be able to expect to attain a minimum level of sales in order to be viable, which limits the number of firms that which can be economically viable in a market of given size. Economies of scope are analogous, but arise when resources can be shared over multiple product lines.

C. Emerging 3G Services Are Responding to Market Forces

30. All of the 2G providers in Hong Kong are already offering some form of wireless data services. These support SMS, email, and a variety of other applications at data rates up to 144Kbps. These are offered via what are referred to as “2.5G” systems, reflecting intermediate upgrades to existing systems but which fall short of the full mobile broadband capabilities that are available on full-fledged “3G” systems. The most common form of these services is based on GPRS technology.
31. The decision to upgrade to 2.5G services is part of the normal evolution to 3G services. These upgrades can be accomplished with a relatively small incremental expenditure and provide a basis for end-users *and* carriers to learn about mobile data services. The hope is that end-users will become experienced users of 2.5G services, and hence, will become more receptive and willing-to-pay for the enhanced capabilities (and higher prices) associated with true 3G services. In both Japan and South Korea, the rapid growth of SMS as a “killer application” helped drive demand for mobile data, while providing high margins to carriers (*i.e.*, the costs of supporting SMS are substantially less than current retail tariffs). In both Japan and South Korea, the critical mass of demand for mobile data services was built via offerings on 2G networks (*i.e.*, PDC in Japan and cdmaOne in South Korea). As already noted, SMS has not been as successful in Hong Kong, in part because extremely low prices for mobile telephony has helped promote a phone-based (as opposed to text-messaging-based) culture. A similar phenomenon in the U.S. helps explain the more limited success of SMS relative to Europe. For example, in the United States, fixed line telephony services are provided under

flat-rate tariffs as opposed to the measured-rate service common in Europe and much of the rest of the world. Additionally, PC penetration is higher than in Europe. This has resulted in a phone-based culture that prefers fixed line to mobile telephony, and PC-based data (Internet) services to data services on mobile platforms. While this appears to be changing, and demand for mobile data services is growing, the United States lags far behind both Japan and South Korea in the use of mobile data.

D. The Advantages of Japan and South Korea

32. For 3G services to be viable, there have to be content and applications that make mobile broadband data services desirable. Both Japan and South Korea are noteworthy because of their remarkable success in promoting the development of domestic content and applications. For example, DoCoMo in Japan promoted a platform service for content and application providers that enabled it to market an extensive suite of services specially designed for and targeted to Japanese consumers. Because the development of wireless content and applications requires incurring a substantial upfront fixed cost that will be largely sunk once the application/content is created, there are large economies of scale associated with developing such complementary assets. The markets in Japan and South Korea are (respectively) 17 and 7 times larger than the Hong Kong market.¹⁷ These larger domestic markets significantly improve the economics for developers of 3G content and services, which in turn increase consumers' willingness-to-pay for broadband wireless. The markets for

¹⁷ The population of Japan and South Korea are estimated to be 127 million and 48 million respectively (see World Fact Book 2003, Central Intelligence Agency, <http://www.cia.gov/cia/publications/factbook/index.html>).

broadband mobile applications and content also benefit from the larger fixed broadband markets since some of the content can be shared across mobile and wired platforms.

33. Furthermore, the fact that the dominant carriers have much larger market shares (*i.e.*, the markets are less fragmented, as shown in Figure 2) means that the incumbents in Japan and South Korea could reasonably expect to realize substantial scale economies if they choose to upgrade to 3G and could anticipate being able to address a substantial installed base of existing mobile data users. These scale economies are very important since infrastructure is provisioned to meet peak demand and, as with the costs for developing complementary content and applications, much of the infrastructure costs of deploying a 3G network need to be incurred upfront and will be sunk or fixed (*i.e.*, will not vary with the actual amount of traffic carried) once the network is built. When costs can be spread over a larger market, average costs are lower which means prices can be lower (and still provide adequate cost-recovery and return on investment), which helps stimulate demand that can give rise to even larger scale economies. Finally, a carrier with a large installed base of customers can expect to more easily migrate those customers to a new service, thereby lowering customer acquisition costs and ensuring faster realization of scale economies for the new service. This virtuous cycle of growth feeding cost-lowering learning and scale economies helps drive investment in on-going upgrades.

E. Hong Kong Compared with Japan and South Korea

34. While the incremental costs of upgrading to 2.5G are relatively minor, the incremental costs of upgrading to 3G are large and represent a significant deterrent (see Figure 9). Because of the smaller and more fragmented market in Hong Kong, a potential 3G competitor in Hong Kong faces the expectation of much higher average costs which means that expected margins will be much lower given the willingness of consumers to pay for the extra features. In such an environment, where local demand is uncertain, it is reasonable that most carriers have adopted more of a “wait-and-see” approach to deploying 3G services. This approach is in keeping with the market conditions that prevail in the Hong Kong market.
35. While the wireless broadband service market in Hong Kong is less developed than in South Korea or Japan, this does *not* imply that 3G services are evolving inappropriately (i.e., *too slowly*) relative to an economic criterion of dynamic efficiency that properly considers the dynamic welfare effects from technological transition. The early success of 3G in Japan is largely due to the early success of DoCoMo’s 2G services, which owes much more to DoCoMo’s novel strategy to promote the development of complementary services and content than it does to the superiority of its technology. Additionally, the success of DoCoMo’s business model for promoting the development of complementary content and applications was critically dependent on DoCoMo’s position as the dominant facilities-based provider. In 1999, when NTT DoCoMo first offered its wireless data services, it served 57% of the market. In contrast, HTCL is the largest 2G provider in Hong Kong with a market share of only 25%. In Japan, DoCoMo’s large market

share gave it the necessary scale and scope economies to capture the benefits from its investments in creating a market for broadband data services. In contrast, HTCL's smaller scale means that the costs of promoting the development of mobile data are higher on average and the prospective revenues for HTCL are lower.

- 36.** Moreover, although Hong Kong is among the nations with the highest penetration of broadband *and* mobile services, and hence, clearly in the vanguard of customer markets that are potentially ripe for broadband wireless, the potential market is too small to influence global technology trends. Network equipment, handset manufacturers, and content providers may be willing to modify their plans and will compete aggressively for dominance in large markets like Japan, South Korea, United States, or Europe (European Union). While Hong Kong is an important market, it is not reasonable to expect that its choice of technology or wireless data adoption decisions will have much of an effect on global price trends for equipment or handsets associated with the different technologies. In fact, one would expect that Hong Kong will be a beneficiary of the global technology spillovers. Hence a delay (if any) in the roll-out of new services could have beneficial effects on the technology and its prices. Slower early adoption may translate into faster ultimate adoption at lower costs and with greater capabilities.
- 37.** The disadvantages associated with the small size of the Hong Kong market are further exacerbated by the fact that the market is so fragmented and competitive. This makes it difficult for carriers to collaborate on developing common standards, content, and applications. This further raises the costs for developing Hong Kong-specific wireless content. Moreover, Hong Kong's use

of traditional Chinese characters increases the costs associated with providing handsets and applications/content preparation and delivery. The uncertainty faced by handset providers and content developers will be reduced if the transition to 3G is orderly and does not raise inordinate risks that some of the operators (customers for the complementary goods) will fail to be economically viable in the market.

38. By somewhat lagging behind the growth of wireless broadband in neighboring larger markets such as Japan and South Korea, Hong Kong is better placed to take advantage of global scale and learning economies. Its small size and sophisticated, Internet-savvy customer-base mean that once it achieves critical mass it can catch up rapidly, while hopefully avoiding many of the “arrows-in-the-back” that plague early adopters (*e.g.*, experimentation with applications or service configurations which fail to become popular with end-users).
39. Furthermore, as with most other network-based services, positive network externalities are important with wireless broadband. These arise because the willingness-to-pay for subscribers increases as the total size of the market grows. This can be explained in a number of ways. First, a communication service such as mobile video telephone service is more valuable if there are more persons one can call. Second, information about the service and complementary goods are likely to be more readily available if the market for the service is larger. The adoption curves of services with positive network externalities are often “S”-shaped, with adoption accelerating rapidly once a critical mass of subscribers has been attracted, and then slowing as the market becomes saturated. With this kind of adoption pattern, it may appear as if the gap between wireless broadband “haves” and “have-nots” is widening, when

in fact, this is a transitory effect that market forces will render self-correcting: later adopters will catch up rapidly.

40. In Hong Kong, OFTA has already licensed four 3G competitors, and made mandatory provisions for other carriers to enter as MVNOs. Currently, only HTCL is offering 3G services via a WCDMA network. The other 3G licensees are still deciding whether or when to roll out their networks. The fact that they have licenses to the necessary spectrum but have not yet chosen to roll-out 3G service demonstrates that the market is not constrained by a lack of available spectrum, which in other markets (like the United States) has been a problem. Instead, the slower pace of development of 3G in Hong Kong reflects the impact of market forces and the intense rivalry that is due in part to past regulatory policies. The current menu of 2G and 2.5G services is priced low enough (potentially too low!) and offer data services of sufficient quality – given the maturity of Hong Kong’s wireless broadband content and applications markets – to make it optimal for carriers to postpone the roll-out of 3G services. This delay can be reasonably ascribed to market forces and to the lack of an adequate market for complementary goods.

III. Promoting entry of cdma2000 will harm prospects for 3G

41. The preceding discussion should make it clear that if there is a perceived problem with the pace of 3G development, it is not due to a lack of competitors or deficiency in the extent of competition. Therefore, OFTA’s attempt to use spectrum policy to encourage entry by a fifth 3G operator is ill-advised and likely to harm prospects for the speedier adoption of 3G. If there is a problem with competition, it is that there is too much competition so that

the expected returns to investment are potentially driven below the appropriate risk-adjusted cost of capital. Moreover, OFTA's attempt to use this additional entry to promote the introduction of a new technology, cdma2000, which is incompatible with the anticipated 3G services to be offered by the other four licensees, would only make matters worse.

42. There are numerous indicators that the current state of mobile competition in Hong Kong is not economically sustainable. As Figure 9 suggests, the break-even market share for 2G competition looks like something between 25 to 30 percent, which would suggest that the typical market can sustain somewhere between three to four facilities-based competitors – certainly less than the six that are currently competing in the Hong Kong market.
43. Since the costs of operating 3G networks are higher, demand has to grow substantially to make it feasible to support additional facilities-based entry. While the hope is that such demand will emerge, this growth has not occurred yet and it may make more sense for carriers to seek to promote demand growth for existing mobile data services provided via 2.5G systems before committing scarce capital for 3G upgrades. Public policies that encourage the growth of investment in Hong Kong-specific content and applications would help increase demand for mobile data network services which would motivate 2G carriers to accelerate their 3G upgrade plans.
44. Moreover, the data in Figure 9 is based on the economics of 2G markets that are much larger than Hong Kong which cannot sustain even six facilities-based providers. In the United States, the merger of Cingular and AT&T Wireless is the start of what is likely to be a trend towards consolidation. In that case, it is noteworthy that the two carriers that are consolidating are using

similar 2G technologies since integrating these networks is easier than with incompatible networks.

45. The ability of and incentives for 2G firms to invest in upgrading to 3G are directly related to their current and expected profit margins. The more intense is 2G competition, the higher the bar is for a would-be 3G competitor to be able to offer a higher-priced/higher-quality service that is an attractive substitute. In a less fragmented market with higher 2G prices, an incumbent faces an easier challenge in migrating its customer base to a new service. In a market as intensely competitive as Hong Kong's, customers are continuously bombarded with offerings from 2G and 2.5G providers (as well as non-wireless broadband offerings) that complicate the sales and marketing challenges faced by a would-be 3G provider.
46. Introduction of yet another 3G competitor would further intensify 2G competition because the entrant would need to build market share in order to realize scale and scope economies. While it is expected that broadband wireless services will become increasingly important in the future, the "killer app" remains mobile voice telephony today and the new cdma2000 licensee would need to offer a telephony package that is comparable in quality and price to the offerings of today's 2G carriers. The fact that the 3G networks have higher costs would not allow the carrier to charge a higher price for "2G"-like calling services, and the carrier's ability to charge higher prices for value-added services would be limited by evolving demand.
47. Because 2G carrier costs are mostly fixed and sunk, prices can readily fall below long-run incremental costs in the short-run, if the competition is very intense and firms are competing for market share. Prices that low fail to

provide investors with an adequate return on invested capital and make it uneconomic to invest in new capacity or services. This is not sustainable over the long-run and if such a situation persists, the financial viability of carriers will be threatened. Consumers will suffer as a consequence. They are denied the benefits of investment in new services and the quality and availability of even basic services may suffer.

48. In spite of assertions of technology neutrality, it is clear that OFTA's proposed plan to reauction the 800MHz spectrum currently used by HTCL's CDMA service will promote entry by a carrier offering 3G services via the cdma2000 technology. First, the proposed band plan is designed to synchronize with the spectrum requirements for cdma2000 systems deployed in Japan, South Korea, and elsewhere. Second, OFTA anticipates encumbering the license with additional requirements that make it unlikely that a carrier using another technology would find entry economic.
49. Even if one neglects for a moment the adverse impact of trying to induce entry by yet another facilities-based provider in what is already an over-crowded mobile marketplace, the introduction of another technology will further fragment the Hong Kong market and will further exacerbate the adverse economic conditions that have heretofore constrained more rapid evolution of 3G services. While individual engineers may differ in their opinions, there does not appear to be any significant technical advantage to one technology or the other (*i.e.*, WCDMA *v.* cdma2000). Both the 2G versions and the 3G versions can support a comparable range of services. While some have argued that cdmaOne (IS-95) is more spectrally-efficient than GSM, the inherent spectral efficiency is not an issue in Hong Kong where more than enough

spectrum has already been made available for the deployment of 3G services. For the foreseeable future, spectrum congestion is not a problem for the development of mobile broadband in Hong Kong.

50. Nevertheless, it is certainly the case that the 3G evolution path based on evolving from GSM to GPRS to WCDMA has a much larger global installed base than does the evolution path from cdmaOne (IS-95) to cdma2000 (see Figure 10). This suggests that although cdma2000 may be an early leader by virtue of its success in Japan and South Korea, that any scale or learning economies that are benefiting purchasers of handsets or network equipment for this technology are likely to be short-lived. In any case, the prices for this equipment need to fall substantially before either technology can realize its promise of supplanting 2G technology. Moreover, the small size of the Hong Kong market means that its choice of technology will not impact the global competition between the two technologies. Therefore, it may be preferable for Hong Kong to wait and see how the technologies evolve since there is no pressing need to extinguish the real option that waiting offers.¹⁸
51. Nevertheless, fragmenting the Hong Kong technology market will limit the realization of positive network externalities.¹⁹ When these are important, as is

¹⁸ That is, when confronted with making a sunk cost investment with uncertain prospects (*e.g.*, choosing a technology for mobile data), there are benefits to waiting to invest because the uncertainty is resolved over time. Because the learning that comes with waiting might induce one to make a different investment decision (*e.g.*, decide not to invest after all), acting before you learn such information extinguishes a real option that has economic value that should be added to the costs of the original investment. For further discussion of such real option effects, see Avinash K. Dixit and Robert S. Pindyck, *Investment under Uncertainty*, Princeton: Princeton University Press, 1994.

¹⁹ There is a rich economics literature on the economics of positive externalities in network industries and the role of these in technology adoption and market evolution. For a good early summary see, David, P. and Greenstein, S., "The Economics of Compatibility Standards: an Introduction to Recent Research", *Economics of Innovation and New Technology*, vol 1

typical for network services, user adoption patterns can be subject to bandwagon equilibriums. That is, users all wish to adopt the technology that proves dominant because that is the one that will yield the greatest positive network externalities. If multiple technologies are competing, users may be uncertain which will win and may be reluctant to choose either. It can be hard to get the bandwagon rolling. Introduction of the cdma2000 technology will increase end-user, content/application developer, and service provider uncertainty which will likely slow adoption. Furthermore, with only a single carrier licensed to offer cdma2000, prospective customers may be deterred because of the danger of being locked-in – that is, lacking an alternative carrier to migrate to if they adopt cdma2000 but wish to go to another service provider. The option of licensing multiple cdma2000 carriers which might address this problem would create an even greater problem by further fragmenting the market and further accentuating scale/scope economy issues. Finally, if cdma2000 proves to be less successful internationally, and specifically, in Hong Kong, policymakers may still have to contend with calls for regulatory protection to protect end-users and carriers which would be stranded if the cdma2000 technology were to be subsequently abandoned. It can be difficult both to adopt a new technology *and* to abandon one once adopted.

(1990) p3-41. For a discussion of the relevance of bandwagon equilibria in standards adoption, see Farrell, J. and G. Saloner (1986), "Competition, Compatibility and Standards: The Economics of Horses, Penguins and Lemmings", University of California, Berkeley, Economics Working Paper #8610. For an explanation of why government intervention to choose standards is often inefficient, see David, P., "Narrow Windows, Blind Giants and Angry Orphans: the Dynamics of Systems Rivalries and the Dilemmas of Technology Policy", Technology Innovation Project Working Paper Number 10, Center for Economic Policy Research, Stanford University, March 1986.

- 52.** Fragmenting the market by introducing a new incompatible technology likely will harm consumers (which will reduce industry demand) and service providers (which will reduce their incentives to invest) because it:
- (1) will limit realization of scale/scope economies (further aggravating the problems associated with Hong Kong's small market size);
 - (2) will limit the realization of network effects because of increased likelihood of interoperability issues, increased consumer confusion, and bandwagon effects;
 - (3) will reduce incentives to invest in complementary goods such as content and applications; and
 - (4) will impose additional "gateway" costs associated with interconnecting the incompatible networks.
- 53.** In its report, PA Consulting, presents the results from its detailed modeling of wireless markets in Hong Kong.²⁰ This analysis is wholly consistent with the above discussion, and provides support for the view that it is not economically viable for four or more 3G competitors to survive in the Hong Kong market. Their model shows that, over a wide range of future scenarios, licensing of a fifth operator will retard 3G evolution, resulting in slower growth in demand for data services, higher prices, fewer applications being offered and reduced investment in applications development. These results are consistent with economic theory and our analysis. Furthermore, these results are unambiguously detrimental to consumers and to the health of the telecommunications sector in Hong Kong.

²⁰ See PA Consulting, Market Simulation Report, Appendix D, Hutchison Submission in response to the Second Consultation Paper, 19 June 2004.

- IV. OFTA's proposed policy amounts to industrial engineering which is contrary to the goal of promoting competition and "letting the market decide."**
- 54.** OFTA's proposal to reauction spectrum currently allocated under HTCL's CDMA license is not consistent with its stated goals to "maintain technical neutrality," "provide a stable environment for investment," or to "let the market decide."
- 55.** In its choice of a band plan, in its plans for encumbering the proposed fifth 3G license with special requirements, and throughout the policy rationalization presented in *OFTA 2nd Report*,²¹ it is clear that the practical intent of re-auctioning the spectrum is to facilitate entry by a fifth 3G licensee that would deploy a network based on the cdma2000 technology. This is market engineering pure and simple.
- 56.** Because there are already four licensed 3G competitors and three of them have yet to commit to deploying services, it is simply not credible that OFTA's intent is to remove entry barriers to additional entry or to address spectrum inefficiency.²² While the success of the 2G services provided by CSL and HTCL under their TDMA and CDMA licenses is quite limited, and these systems serve a shrinking number of subscribers, these two technologies *do* contribute to consumer choice. Given the limited success of these systems *ex*

²¹ For example, OFTA cites the apparent success of cdma2000 technologies in Japan and Korea (see *OFTA 2nd Report*, paragraph 38). In paragraph 42, OFTA claims that in keeping with its technology neutral approach, it will not "mandate the new license to adopt the cdma2000 standard," however, it will still enforce the additional requirements. In paragraph 43, OFTA again reiterates its intention and belief that the bandplan for the spectrum to be reauctioned will be compatible with deploying a cdma2000 system.

²² In paragraph 25 of *OFTA 2nd Report*, OFTA cites its charter to ensure efficient spectrum use and the limited success of 2G CDMA and TDMA services as part of its justification for the asymmetric treatment of these licenses.

post, the important lessons to learn are about the difficulties of trying to sustain this sort of (multiple technology) choice in a market as small as Hong Kong. The choice that consumers have voted for in the market is 2G GSM-based mobile services provided by multiple service providers, instead of choosing multiple technologies.²³ This supports better roaming coverage and appealing handset choices.

57. The fact that the licensed spectrum associated with the TDMA and CDMA licenses *could* support substantially more shared use than they currently do, does not mean that the associated scarce spectrum resources are being used inefficiently.²⁴ The same is obviously true regarding the spectrum associated with the four existing 3G licenses, and even for the GSM licenses that are supporting 2G services that will be granted a right of first refusal to extend their licenses when these expire. There is no basis for concluding that the CDMA and TDMA technologies are inherently less spectrally efficient. Instead, OFTA is basing its conclusion on its assessment of the state of market competition. Because the GSM services have attracted more subscribers, and hence more attention from system operators, these services are taken to represent an “efficient” use of spectrum; whereas, the declining CDMA/TDMA 2G services are deemed “inefficient.” OFTA’s decision to treat the 2G licenses asymmetrically amounts to regulatory interference in

²³ In much larger markets, such as the United States, sustaining multiple technologies has been easier. Moreover, maintaining interoperability for voice telephony is easier than it will be for the advanced data applications which are expected to provide the “value-added” motivation for migrating to 3G (*e.g.*, video mobile telephony and mobile multimedia).

²⁴ That is, there is no target level of utilization that is optimal. If spectrum scarcity were constraining the evolution of markets, then the concern about spectral efficiency would be more relevant but that is not the case with 3G in Hong Kong, as we have already explained.

directing the market outcome. OFTA's proposed treatment amounts to a regulatory decision that GSM is the right 2G technology and WCDMA and cdma2000 ought to be the technologies for 3G.

- 58.** In light of global technology and market trends, traditional models of spectrum management based on regulators choosing which frequencies will be used for which services and technologies are becoming outmoded.²⁵ Such policies can contribute to artificial spectrum scarcity – that is scarcity that arises as a consequence of regulatory barriers or actions, as opposed to the market phenomenon of too many users trying to share the same frequency. Addressing the spectrum needs for commercial wireless services remains an important responsibility for regulatory policy, but this assessment has to be made within the larger framework that enables the transition to increased reliance on market forces to proceed. OFTA's policy is inconsistent with such a transition since it prolongs the legacy of regulatory attempts to interfere with and steer the market's technology choices.
- 59.** Inconsistent regulatory policies that treat one set of licensees one way and another differently do not promote a stable investment environment. Furthermore, even if one ignores the perverse impact of promoting introduction of an incompatible technology (that has already been rejected by

²⁵ In the United States and elsewhere, a significant debate is underway regarding how spectrum policy should be reformed (see, for example, *Comments of 37 Concerned Economists* (2001), In the Matter of Promoting Efficient use of Spectrum through Elimination of Barriers to the Development of Secondary Markets, Before the Federal Communications Commission, WT Docket No. 00-230, February 7, 2001; Kolodzy, Paul (2002), *Spectrum Policy Task Force*, Office of Engineering & Technology, Federal Communications Commission, November 2002; or, Cave, Martin (2002), "Review of Radio Spectrum Management," Independent Review Report prepared for Department of Trade and Industry, United Kingdom, March 2002 (available from: <http://www.ofcom.org.uk/static/archive/ra/spectrum-review/index.htm>)).

market participants!), the goal of promoting additional entry is also detrimental to the efficient operation of market forces.

- 60.** Entry into 3G mobile services necessitates a substantial commitment of fixed and sunk upfront investment. Should entry not prove viable, there are substantial exit costs. While consumers benefit from regulatory policies that promote effective competition, they are harmed by excessive competition that reduces incumbent and entrant incentives and abilities to optimally invest in new infrastructure. Any costs incurred in subsequently consolidating 2G or 3G mobile networks or in the exit of either incumbents or later entrants will be a deadweight loss to society and the industry. Promoting the introduction of a new and incompatible technology that further fragments an overly fragmented market will increase uncertainty and raise transition costs that will interfere with the natural, and market-based, evolution to 3G services in Hong Kong.
- 61.** The interventionist nature of OFTA's policy is apparent in its logic that by imposing additional burdens on the fifth license that OFTA will help ensure that incumbents are not harmed by the increased competition.²⁶ First, the very fact that OFTA is anticipating imposing special license restrictions to limit the fifth licensee's incentives/ability to compete with existing carriers reflects interference in market processes. The new 3G license is to be subject to minimum coverage restrictions,²⁷ allocation of capacity to data services,²⁸ and performance targets for the services.²⁹

²⁶ See paragraph 40 of *OFTA 2nd Report*.

²⁷ See paragraph 79 and 91 of *OFTA 2nd Report*. OFTA anticipates imposing geographic and population coverage requirements.

²⁸ See paragraph 90 of *OFTA 2nd Report*. The proposed restrictions would constrain the carriers business model with revenue and traffic share targets, coverage targets, and "other

62. These constraints will limit the licensee's business model, making it difficult for the business to adjust to changing market and technical circumstances. This kind of "remote steering" effort is completely inconsistent with the efficient operation of markets and the negative impact of such interventions and restrictions will not be limited solely to the new licensee. It will spill over to distort the behavior of other participants in the market. For example, the requirements may force the new licensee to over-invest in capacity to provide data services solely to meet an arbitrary regulatory requirement. Because the costs of establishing such a capability are largely fixed/sunk, this carrier may be driven to price well below long-run average cost in order to induce customers to buy a data service for which there is no market-driven demand. This in turn would deter investments by the other 3G licensees in mobile data capabilities, who would be deterred by the low pricing. In effect, the regulatory policy that seeks to compel faster investment in mobile data capabilities results in a pre-emptive build-out of capacity that deters subsequent investment and the smooth operation of competitive markets.³⁰ Alternatively, the regulatory restrictions may induce either the new licensee or the other 3G competitors to waste resources trying to influence regulatory

suitable parameters" (whatever that means) to ensure that the this new 3G licensee's service is focused on mobile data usage.

²⁹ See paragraph 91 of *OFTA 2nd Report*. OFTA proposes requiring meeting a peak data rate of 2Mbps within three years of granting the license. This constrains service design and build-out plans.

³⁰ In situations with imperfect competition, where market power is a risk (which is clearly not the case in Hong Kong's mobile markets), incumbents may seek to invest in excess capacity preemptively to signal to potential rivals that *ex post* price competition is likely to be severe. This credible threat then deters entry (see Dixit, Avinish, "The Role of Investment in Entry Deterrence," *Economic Journal*, 90 (1980) 95-106). In effect, OFTA's policy may create an analogous situation.

outcomes that would better be expended on trying to compete in the market.

The point is that regulators should not try to engineer market outcomes, but should remain ready to address barriers and market power issues when those arise.

- 63.** Second, the belief that introduction of the proposed new license would stimulate demand for next-generation mobile services is misguided. We have already explained why it will likely increase market confusion, further depressing financial returns in the already excessively competitive market for 2G/2.5G services, and will increase carrier costs (*e.g.*, by fragmenting the market, increasing churn, and encouraging MOU growth). While no carrier would build a 3G network without a plan to offer the new value-added services that require the additional capabilities of a 3G network, this does not mean that the 3G provider would not also compete for traditional 2G and 2.5G demand. Once the 3G network is built, most of the costs will be sunk or fixed, and both the incumbents and the 3G competitor will be compelled to compete aggressively on price. Of course the 3G carrier would prefer to compete only on the basis of differentiated services, but consumers will consider both the quality of the services offered *and* their price when making decisions. Service provider pricing by all mobile operators will have to respond to market forces.

V. A conservative and symmetric approach is the best policy

- 64.** The progress towards competition and the deployment of advanced communication services in Hong Kong to date makes Hong Kong a model for broadband development. OFTA should continue to monitor the evolution of this market to ensure that competition evolves efficiently. OFTA should adopt

a cautious approach before intervening. This means eschewing efforts to promote additional entry, and especially, efforts to steer the market's choice of technologies. When market distortions arise, OFTA should be prepared to act. These might arise if there are entry barriers such as spectrum scarcity that are impeding the smooth functioning of competition. Alternatively, excess consolidation might result in an operator gaining market power that could threaten competition. While either cause might provide a valid basis for OFTA intervening in the market, neither is relevant to the present situation with 3G. The problem is not too little competition in mobile services, but too much competition for too little demand.

- 65.** In the present context, we recommend that OFTA adopt a consistent and conservative policy toward 3G licenses. The most effective way to do this would be to treat the HTCL CDMA and CSL TDMA licenses analogously to the GSM and PCS licenses: grant incumbents a right of first refusal.
- 66.** Adopting this policy would offer a number of important benefits. First, it would be consistent with allowing the market to decide the pace of 3G competition, and the selection of which technologies should be deployed when and where. By treating all 2G licensees symmetrically, OFTA would be adopting a regulatory-neutral approach that would be consistent with prior regulatory decisions and expectations. This would help minimize regulatory distortions of market behavior.
- 67.** Second, if it turns out that cdma2000 is an attractive technology for deployment of 3G services in Hong Kong, HTCL is in the best position to rapidly take advantage of this technological option. The incremental costs of upgrading an existing cdmaOne network to cdma2000 are substantially lower

than the costs of constructing a wholly new network. Much of the infrastructure costs (*e.g.*, establishing base station sites) would be useable. Moreover, HTCL has a large base of 2G customers that could be migrated to the cdma2000 network and it would be easier to manage interconnection costs between HTCL's WCDMA and cdma2000 networks than if these systems were owned by independent providers. While the early analysis suggests that there is no *a priori* reason to believe that deployment of such a network *would* be desirable, were this presumption to prove wrong, the lowest cost way for this to happen would be to have HTCL deploy it.

- 68.** Furthermore, it is worthwhile stating that there is no reason to believe that HTCL would seek to block deployment of a cdma2000 system if it were efficient to deploy one. To do so would only make sense if HTCL believed that by restricting the extent of competition in the market, it could create or maintain market power. However, with the vigor of existing 2G competition and the presence of three other 3G licensees, there is no reasonable basis for believing that such a strategy would result in HTCL obtaining market power. Indeed, the only way a market power issue might arise is if the cdma2000 technology proved so successful that the 3G systems based on WCDMA could not compete adequately. However, were this to be the case, HTCL would be foolish not to take advantage of its license to deploy a cdma2000 system, and OFTA would be faced with regulating market power in any case.
- 69.** Third, if and when OFTA considers further reform of its spectrum management regime, such reform ought to be approached holistically and with an eye toward accommodating future technical and market trends.

70. Alternatively, if OFTA decides not to renew HTCL's CDMA license, it should not re-auction the spectrum at this time. Both the spectrum associated with CSL's TDMA license and HTCL's CDMA license should be reserved pending the resolution of further market and technical uncertainty and until such time as it is clear that the continued development of commercial wireless services is threatened by spectrum scarcity. This would permit the rationalization of mobile service competition which is needed to provide a stable investment environment that will encourage 2G carriers to upgrade their systems. This real-options approach would leave Hong Kong with maximum regulatory flexibility in a dynamic and uncertain market.

VI. Conclusion

71. In its recent report, OFTA recommends extending a right of first refusal to 2G licensees of GSM and PCS systems, but recommends reclaiming the spectrum associated with the 2G licensees of TDMA and CDMA (IS-95) systems, and reaucting the latter in order to accommodate entry by a fifth 3G operator. Although OFTA seeks to minimize its impact, it is clear that this fifth operator is expected to deploy a 3G system based on the cdma2000 standard. Such a system would be incompatible with the WCDMA system that the other four 3G licensees are expected to deploy.
72. This paper explains why such a policy would likely harm competition in mobile services and would retard the orderly evolution of 3G broadband wireless services in Hong Kong.
- While Hong Kong is a world-leader in terms of mobile and broadband penetration, it is a small market and cannot hope to influence the global competition between wireless technologies.

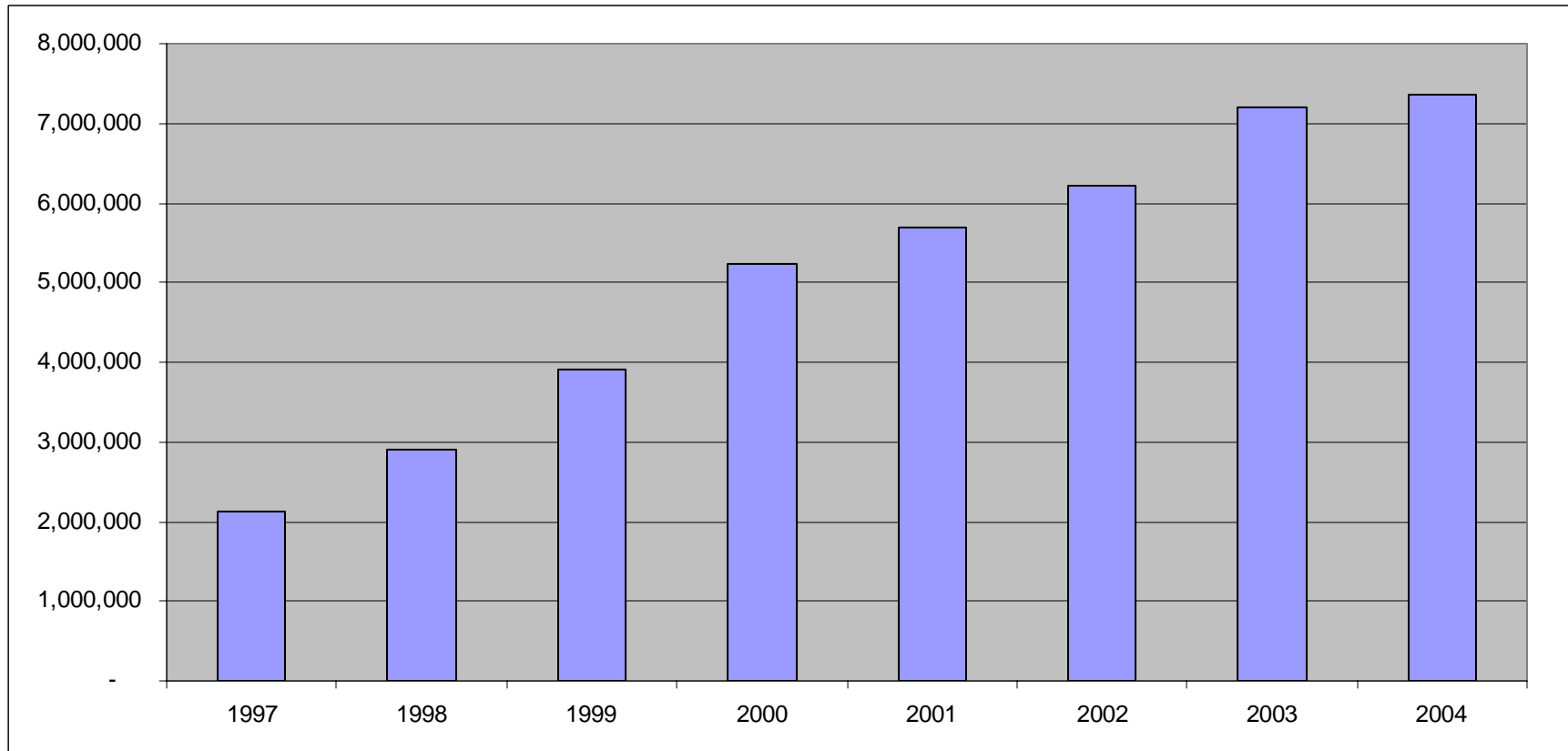
- Mobile services in Hong Kong appear to be excessively competitive already, with too many facilities-based providers competing in a saturated market that is just not big enough given the cost structure inherent in operating a broadband wireless network. While mobile data services are evolving more slowly than in Japan and South Korea, the reason for this is certainly not due to a lack of mobile service competition. Rather, the lack of complementary Hong Kong-specific content and applications that require 3G capabilities, and the excessive competition among current 2G and 2.5G services account for the slower pace of 3G evolution.
- Moreover, this slower evolution does not even appear to be a problem in need of solution. As with the evolution of other advanced communication capabilities in Hong Kong, 3G services will take off when the market is ready and when a compelling business case can be made by operators and customers for how these services justify the added cost associated with providing them.
- In any case, the regulatory policy of promoting additional entry using an incompatible technology will hinder rather than help the cause of promoting the development of 3G services. Additional entry will further fragment the market, thereby increasing costs and reducing incentives to invest in infrastructure and complementary content and applications.
- The activist policy represents interference in the smooth functioning of the market and will impose additional transition costs since there will

likely be deadweight losses associated with recovering from excess competition and in rationalizing market competition.

- 73.** Consequently, we recommend adopting a conservative and symmetric approach towards 2G licensing: grant all licensees a right of first refusal. Failing that, do not reallocate the CDMA (IS-95) spectrum at this time.

Figure 1: Rapid Growth in Mobile Services in Hong Kong

Figure 1: Rapid Growth in Mobile Subscribers in Hong Kong



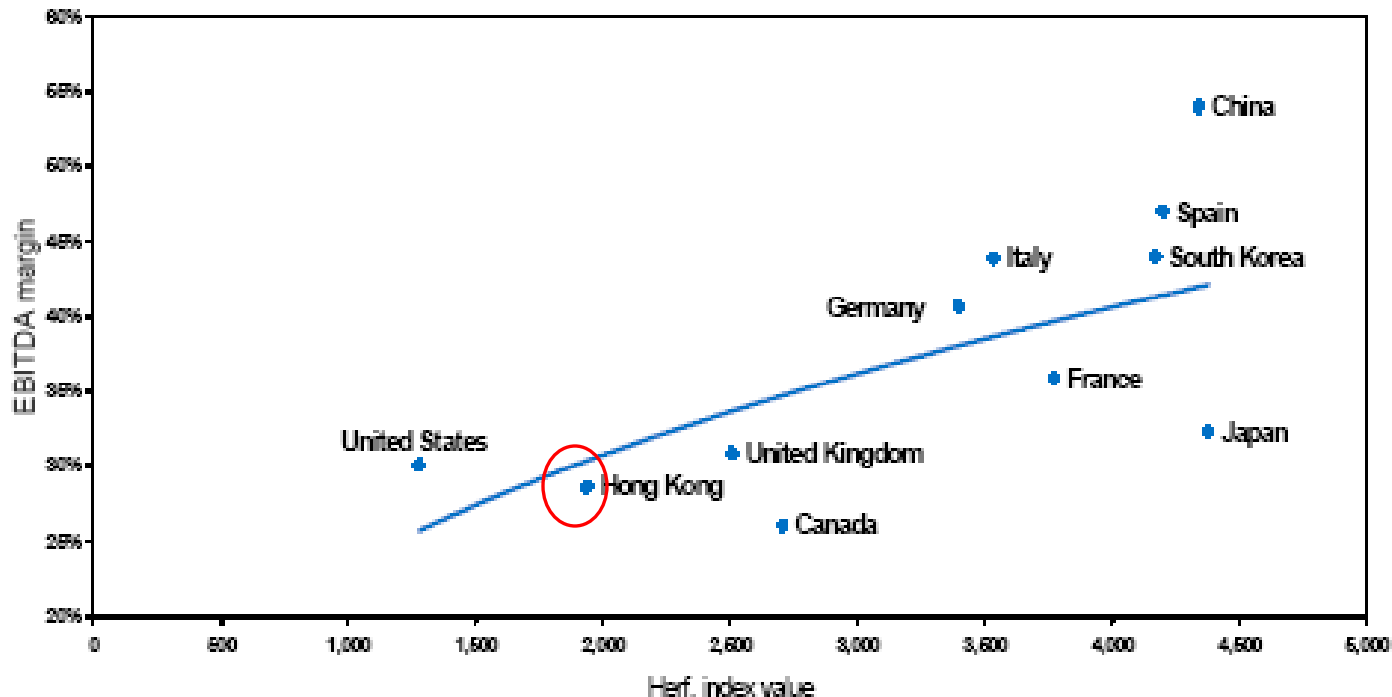
- 23% growth annually
- 7.35 Million subscribers (Mar2004)

Source: "Key Statistics Telecommunications in Hong Kong, Wireless," OFTA, June 7, 2004. Data for December for all years except 2004 when for March.

Figure 2: Hong Kong's Mobile Services are Hyper Competitive

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EBITDA margin vs. Herfindahl Index
More concentrated markets tend to have better margins



Source: Company reports and Goldman Sachs Research estimates.

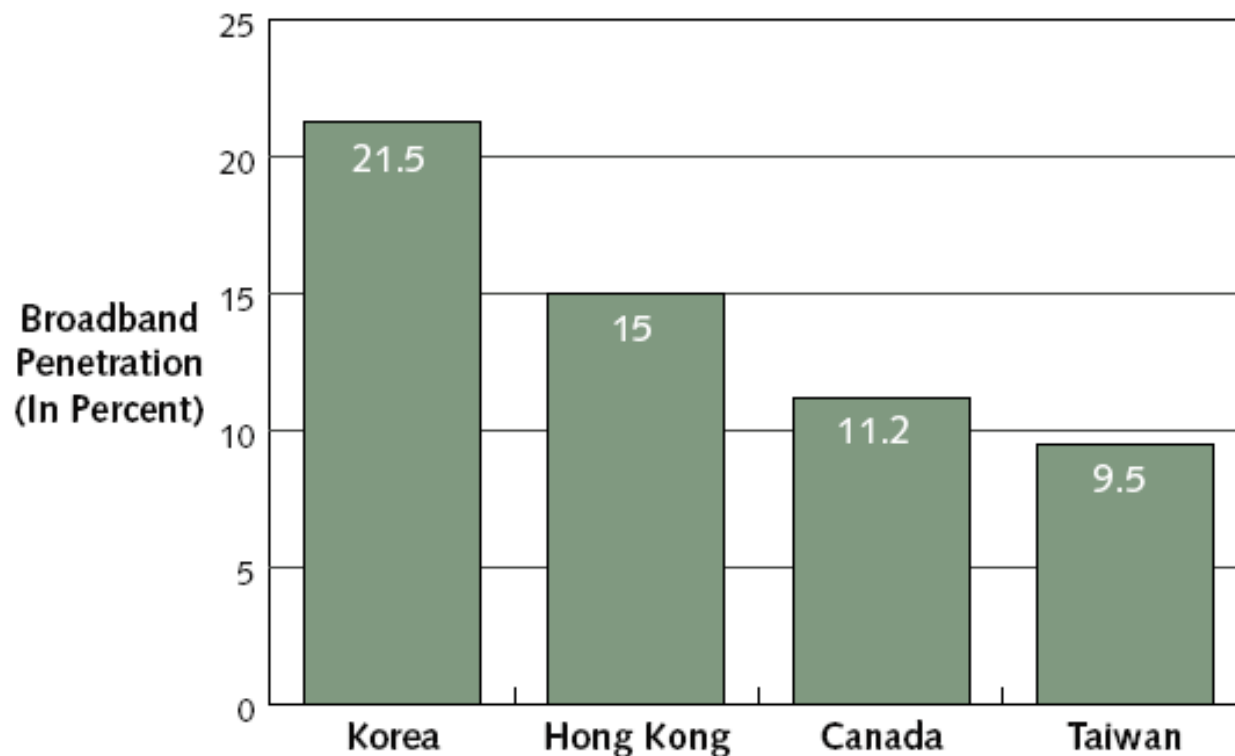
Source: "Wireless United States," Goldman Sachs Equity Research, January 23, 2003.

Figure 3: Hong Kong's Broadband Penetration Among Highest in World

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Top Four Countries by Broadband Penetration Percentage

Source: United Nations International Telecommunication Union, and the Yankee Group, 2004



Source: "Korea's Online Communities Get Massive Bang Out of Broadband," Yankee Group, March 2004.

Figure 4: Global Comparison of Mobile Service Markets (2002)

Figure 4: Global Comparison of Mobile Service Markets (2002)

	Herf. Index Calc.	Number of Operators	POPs	Subs	Penetration	% Contract	Churn	2002E-2005E Subscriber CAGR	ARPU	MOU	ARPU/ MOU	CPGA	Est. EBITDA Margin
GLOBAL AVERAGE	3,546	3.8	134	45.9	68%	57.1%	1.6%	5.5%	\$34.99	207	\$0.20	\$165	39%
NORTH AMERICA													
United States	1,279	6	285	141.6	49%	91.0%	2.8%	7.7%	\$52.23	443	\$0.12	\$323	30%
Canada	2,703	4	32	11.6	36%	73.5%	2.0%	9.5%	\$29.99	238	\$0.13	\$272	26%
ASIA													
Japan	4,514	3	127	71	59%		1.5%	7.4%	\$65.09	165	\$0.39		37%
China	4,340	2	1,287	200	16%	43.9%	1.1%	11.8%	\$12.59	182	\$0.07	\$95	54%
Hong Kong	1,939	6	7	6	82%	76.5%	3.5%	4.9%	\$32.30	396	\$0.08	\$52	29%
South Korea	4,170	3	48	31	65%		1.7%	3.7%	\$28.17	302	\$0.09		44%
Australia	3,660	4	20	13	65%	67.8%	1.7%	7.3%	\$32.45	87	\$0.37		
EUROPE													
United Kingdom	2,509	5	59	49	83%	30.2%	1.9%	0.7%	\$33.45	126	\$0.27	\$134	29%
Germany	3,398	4	83	57	70%	45.3%	1.4%	2.0%	\$25.18	89	\$0.28	\$118	41%
France	3,934	3	60	39	65%	52.8%	1.6%	5.8%	\$34.28	152	\$0.23	\$188	36%
Italy	3,535	4	58	54	94%		1.4%	2.4%	\$27.58	119	\$0.23	\$37	44%
Spain	4,196	3	42	32	77%	38.0%	1.1%	3.1%	\$29.11	146	\$0.20	\$183	47%
Finland	4,322	4	5	4	85%		0.9%		\$39.86	243	\$0.16	\$185	44%
Norway	5,596	2	4	4	80%	52.3%	1.5%		\$46.34	212	\$0.22		40%
Netherlands	2,804	5	16	12	79%		1.5%		\$30.75	124	\$0.25	\$119	40%
Sweden	3,835	3	9	8	85%		0.8%		\$34.88	134	\$0.26	\$162	43%

Source: Company reports and Goldman Sachs Research estimates.

Source: "Wireless United States," Goldman Sachs Equity Research, January 23, 2003.

Figure 5: Mobile Services in Hong Kong

Figure 5: Mobile Services in Hong Kong

Service Provider	Subscribers (Dec03, millions)	Market Share	Technology	3G Licensee?
CSL*	1.00	15%	Dual-band GSM 900/1800, D-AMPS	Y
Hutchison	1.83	27%	Dual-band GSM 900/1800, IS-95 CDMA	Y
SmarTone Mobile**	1.04	15%	Dual-band GSM 900/1800	Y
New World Mobility**	1.20	18%	GSM 1800 (PCS)	N
Sunday Communications***	0.66	10%	GSM 1800 (PCS)	Y
Peoples Telephone****	1.04	15%	GSM 1800 (PCS)	N
Total	6.77	100%		

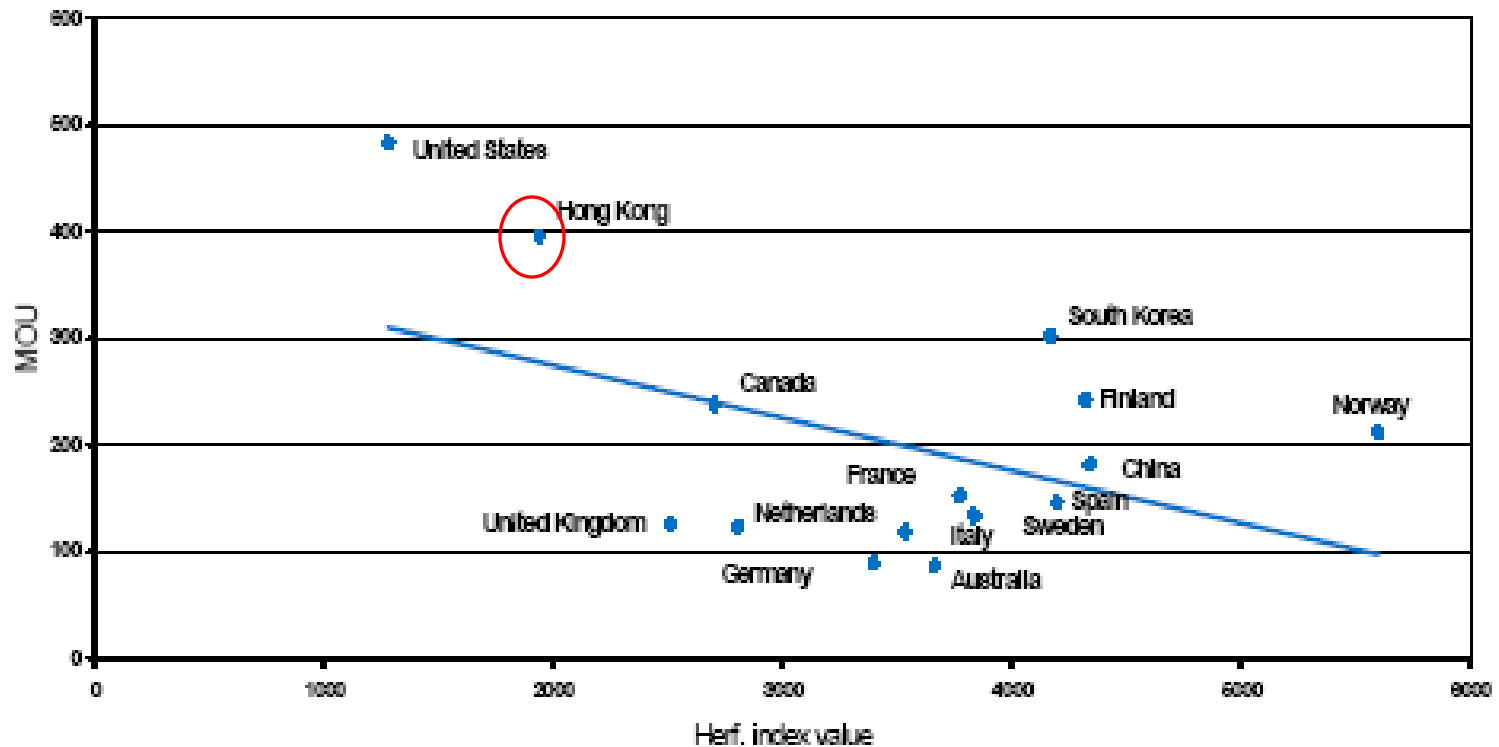
Source: * Telstra's report, ** Interim results 2003-2004, *** Published annual results, ****Prospectus for IPO.

Figure 6: Low Concentration Means High MOU, Higher Costs

Figure 6: Low Concentration Means High MOU, Higher Costs

MOU vs. Herfindahl Index

More concentrated markets exhibit more modest MOU



Source: Company reports and Goldman Sachs Research estimates.

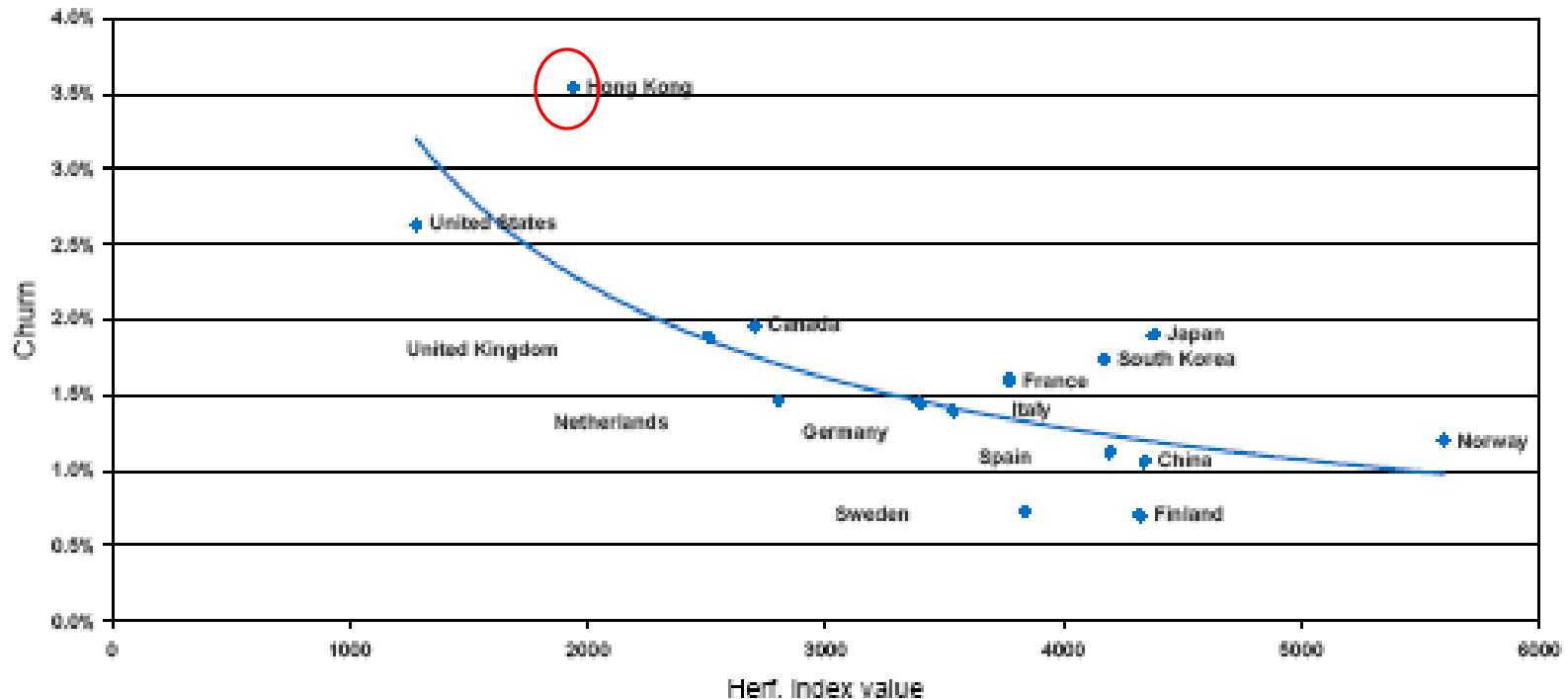
Source: "Wireless United States," Goldman Sachs Equity Research, January 23, 2003.

Figure 7: Churn Rates in Hong Kong Among Highest

Figure 7: Churn Rates in Hong Kong Among Highest

Global monthly churn rates vs. market concentration measured by Herfindahl index

There is a loose correlation between churn rate and market concentration



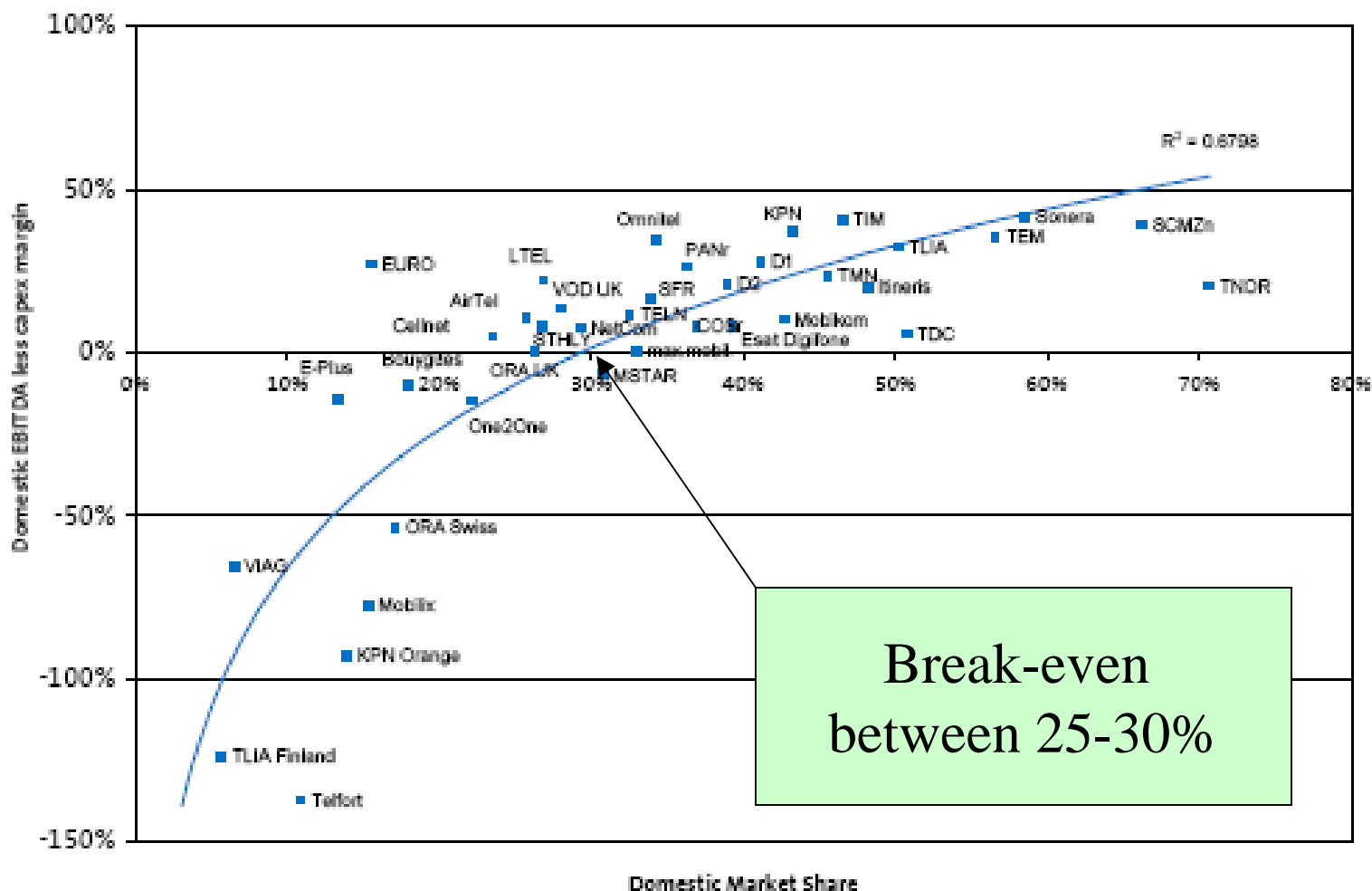
Source: Company reports and Goldman Sachs Research estimates.

Source: "Wireless United States," Goldman Sachs Equity Research, January 23, 2003.

Figure 8: Break-even Market Share Between 25-30%

Exhibit 8: Break-even market share between 25-30%

In Europe, larger carriers tend to have larger margins



Source: Goldman Sachs Research estimates.

Source: "Wireless United States," Goldman Sachs Equity Research, January 23, 2003.

Figure 9: Upgrading to 3G Requires A Significant Investment

Figure 9: Upgrading to 3G Requires A Significant Investment

Table 3.2: Estimated cost of GSM and UMTS networks

	Cost per Subscribers		Percent Change	GSM (percent)	UMTS (percent)
	GSM	UMTS			
Core Network	\$20.00	\$24.50	22.5%	10	7
Radio Network	\$70.00	\$101.50	45.0%	35	29
Transmission Links	\$40.00	\$80.50	101.3%	20	23
Network Maintenance	\$22.00	\$38.50	75.0%	11	11
Sales and Marketing	\$16.00	\$35.00	118.8%	8	10
Customer Care and Billing	\$20.00	\$42.00	110.0%	10	12
IT Management Services	\$12.00	\$28.00	133.3%	6	8
Total	\$200.00	\$350.00	75.0%	100	100

Source: Gartner Dataquest.

One estimate indicates incremental cost per subscriber for 3G is 75% higher.

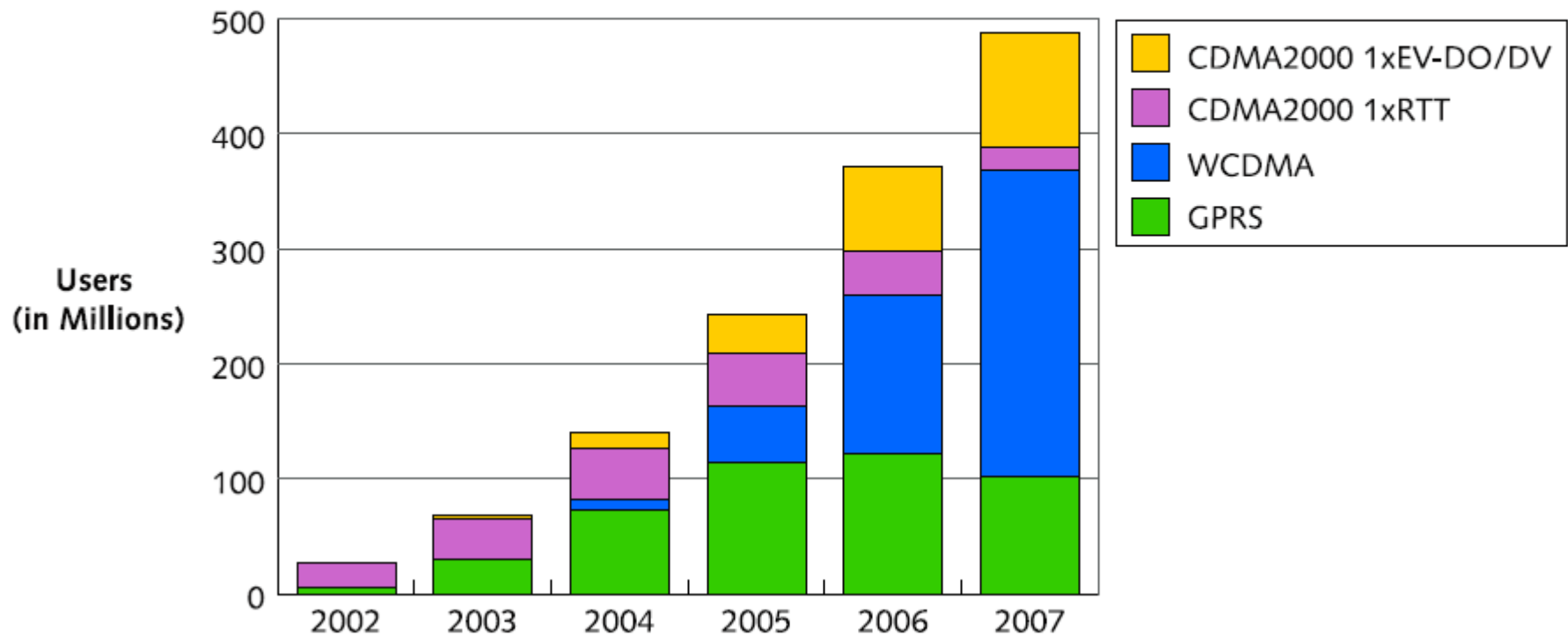
Source: Xavier, Patrick (2001), "Licensing of Third Generation (3G) Mobile: Briefing Paper," prepared for ITU Workshop on Licensing 3G Mobile, 19-21 September 2001, Geneva, Switzerland.

Figure 10: WCDMA Swamps CDMA2000 by 2007

Figure 10: WCDMA swamps CDMA2000 by 2007

The Road to 3G in the Asia-Pacific Region

Source: *The Yankee Group, 2003*



Source: "2003 Asia-Pacific Mobile User and Revenue Forecast Sees Strong Growth for Data," Yankee Group, September 2003.

Appendix 1: Curriculum Vitae Professor Janusz A. Ordovery

March 2004

JANUSZ ALEKSANDER ORDOVERY

Department of Economics
 New York University
 269 Mercer Street
 New York, New York 10003

Fax: (212) 995-3932
 Home: (203) 966-3788
 Fax: (203) 972-3615
 e-mail: jao@ordover.com

EDUCATION

- 1968-1973 Columbia University, New York, New York
 Graduate Department of Economics and European Institute of the
 School of International Affairs
 Doctoral Dissertation: Three Essays on Economic Theory (May
 1973). Ph.D 1973.
- 1967-1968 McGill University, Montreal, Canada
 Departments of Economics and Political Science
- 1963-1966 Warsaw University, Warsaw, Poland
 Department of Political Economy. B.A. (equiv.), 1966.

HONORS

- 1973 Columbia University: Highest distinction for the doctoral
 dissertation
- 1971-1972 Columbia University: Honorary President's Fellow
- 1969-1971 Columbia University: President's Fellow
- 1967-1968 McGill University: Honors Student
- 1964, 1965 Warsaw University: Award for Academic Achievement,
 Department of Political Economy
- Who's Who in the World
 Who's Who in America
 Who's Who in the East

PROFESSIONAL EXPERIENCE

June 1982 - Professor of Economics
 present Department of Economics, New York University, New York, New York

Sept. 1996 - Director of Masters in Economics Program
 Aug. 2001 Department of Economics, New York University, New York, New York

Summer 1996-Lecturer
 2000 International Program on Privatization and Reform
 Institute for International Development, Harvard University,
 Cambridge, Massachusetts

Aug. 1991 - Deputy Assistant Attorney General for Economics
 Oct. 1992 Antitrust Division
 United States Department of Justice, Washington, D.C.

Sept. 1989 - Visiting Professor of Economics
 July 1990 School of Management, Yale University, New Haven, Connecticut

Lecturer in Law
 Yale Law School

Mar. 1984 - Visiting Professor of Economics
 June 1988 Università Commerciale "Luigi Bocconi", Milan, Italy

June 1982 - Director of Graduate Studies
 Feb. 1985 Department of Economics, New York University

Sept. 1982 - Adjunct Professor of Law (part-time)
 June 1986 Columbia University Law School, New York, New York

Feb. 1982 - Acting Director of Graduate Studies
 June 1982 Department of Economics, New York University

June 1978 - Associate Professor of Economics
 June 1982 Department of Economics, New York University

Sept. 1979 - Lecturer in Economics and Antitrust
 May 1990 New York University Law School

Sept. 1977 - Member, Technical Staff
 June 1978 Bell Laboratories, Holmdel, New Jersey

Associate Professor of Economics

Columbia University

Visiting Research Scholar

Center for Law and Economics, University of Miami, Miami,
Florida

Sept. 1973 - Assistant Professor of Economics

Aug. 1977 New York University

Summer 1976 Fellow, Legal Institute for Economists,
Center for Law and Economics, University of Miami

Summer 1976 Visiting Researcher Bell Laboratories, Holmdel, New Jersey

OTHER PROFESSIONAL ACTIVITIES

2003 - present Director, Competition Policy Associates, Inc., Washington, D.C.

1997 – 1999 Consultant, Inter-American Development Bank, Washington, D.C.

1997 – present Board of Editors, *Antitrust Report*

1995 – 2001 Consultant, The World Bank, Washington, D.C.

1998 – present Senior Consultant
Applied Economic Solutions, Inc., San Francisco, California

1995 - 2000 Senior Affiliate
Cornerstone Research, Inc., Palo Alto, California

various Testimony at Hearings of the Federal Trade Commission

1994 - 1996 Senior Affiliate
Law and Economics Consulting Group, Emoryville, California

1994 - 2000 Senior Affiliate
Consultants in Industry Economics, LLC, Princeton, New Jersey

1993 - 1994 Director
Consultants in Industry Economics, Inc., Princeton, New Jersey

1992 - 1993 Vice-Chair (*pro tempore*)
Economics Committee, American Bar Association, Chicago, Illinois

1992 - 1995 Senior Consultant
1990 - 1991 Organization for Economic Cooperation and Development, Paris,
France

1991 Member
Ad hoc Working Group on Bulgaria's Draft Antitrust Law

- The Central and East European Law Initiative
American Bar Association
- 1990 - 1991 Advisor
Polish Ministry of Finance and Anti-Monopoly Office
Warsaw, Poland
- 1990 - 1991 Member
Special Committee on Antitrust
Section of Antitrust Law, American Bar Association
- 1990 - 1991 Director and Senior Advisor
Putnam, Hayes & Bartlett, Inc., Washington, D.C.
- 1990 - 1996 Member
Predatory Pricing Monograph Task Force
Section of Antitrust Law, American Bar Association
- 1989 Hearings on Competitive Issues in the Cable TV Industry
Subcommittee on Monopolies and Business Rights of the Senate
Judiciary Committee
Washington, D.C.
- 1989 Member
EEC Merger Control Task Force, American Bar Association
- 1988 -
present Associate Member
American Bar Association
- 1987 - 1989 Adjunct Member
Antitrust and Trade Regulation Committee, The Association of the Bar
of the City of New York
- 1984 Speaker, "Industrial and Intellectual Property: The Antitrust Interface"
National Institutes, American Bar Association, Philadelphia,
Pennsylvania
- 1983 - 1990 Director
Consultants in Industry Economics, Inc
- 1982 Member
Organizing Committee
Tenth Annual Telecommunications Policy Research Conference,
Annapolis, Maryland
- 1981 Member
Section 7 Clayton Act Committee, Project on Revising Merger
Guidelines
American Bar Association

- 1980 Organizer
Invited Session on Law and Economics
American Economic Association Meetings, Denver, Colorado
- 1978 - 1979 Member
Department of Commerce Technical Advisory Board
Scientific and Technical Information Economics and Pricing
Subgroup
- 1978 – present Referee for numerous scholarly journals, publishers, and the
National Science Foundation

MEMBERSHIPS IN PROFESSIONAL SOCIETIES

American Economic Association
American Bar Association

PUBLICATIONS

A. Journal Articles

“All-units Discounts in Retail Contracts,” with S. Kolay and G. Shaffer, *J. of Economics and Management Strategy* (forthcoming).

“Archimedean Leveraging and the GE/Honeywell Transaction,” with R. J. Reynolds, *Antitrust Law Journal*, vol. 70, no. 1, 2002, 171-98.

“Entrepreneurship, Access Policy and Economic Development: Lessons from Industrial Organizations,” with M. A. Dutz and R. D. Willig, *European Economic Review*, vol. 4, no. 4-6, May 2000.

"Parity Pricing and its Critics: Necessary Condition for Efficiency in Provision of Bottleneck Services to Competitors," with W. J. Baumol and R .D. Willig, *Yale Journal on Regulation*, vol. 14, Winter 1997, 146-63.

"Competition and Trade Law and the Case for a Modest Linkage," with E. Fox, *World Competition, Law and Economics Review*, vol. 19, December 1995, 5-34.

"On the Perils of Vertical Control by a Partial Owner of Downstream Enterprise," with W.J. Baumol, *Revue D'économie industrielle*, No. 69, 3^e trimestre 1994, 7-20.

"Competition Policy for Natural Monopolies in Developing Market Economy," with R.W. Pittman and P. Clyde, *Economics of Transition*, vol. 2, no. 3, September 1994, 317-343. Reprinted in B. Clay (ed), *De-monopolization and Competition Policy in Post-Communist Economies*, Westview Press 1996, 159-193.

- "The 1992 Agency Horizontal Merger Guidelines and the Department of Justice's Approach to Bank Merger Analysis," with M. Guerin-Calvert, *Antitrust Bulletin*, vol. 37, no. 3, 667-688. Reprinted in *Proceedings of the 1992 Conference on Bank Structure and Competition: Credit Markets in Transition*, Federal Reserve Bank of Chicago, 1992, 541-560.
- "Entry Analysis Under the 1992 Horizontal Merger Guidelines," with Jonathan B. Baker, *Antitrust Law Journal*, vol. 61, no. 1, Summer 1992, 139-146.
- "Economics and the 1992 Merger Guidelines: A Brief Survey," with Robert D. Willig, *Review of Industrial Organization*, vol. 8, 139-150, 1993. Reprinted in E. Fox and J. Halverson (eds.), *Collaborations Among Competitors: Antitrust Policy and Economics*, American Bar Association, 1992, 639-652.
- "Equilibrium Vertical Foreclosure: A Reply," with G. Saloner and S.C. Salop, *American Economic Review*, vol. 82, no. 3, 1992, 698-703.
- "A Patent System for Both Diffusion and Exclusion," *Journal of Economic Perspectives*, vol. 5, Winter 1991, 43-60.
- "R&D Cooperation and Competition," with M. Katz, *Brookings Papers on Economic Activity: Microeconomics*, 1990, 137-203.
- "Equilibrium Vertical Foreclosure," with G. Saloner and S. Salop, *American Economic Review*, vol. 80, March 1990, 127-142.
- "Antitrust Policy for High-Technology Industries," with W.J. Baumol, *Oxford Review of Economic Policy*, vol. 4, Winter 1988, 13-34. Reprinted in E. Fox and J. Halverson (eds.), *Collaborations Among Competitors: Antitrust Policy and Economics*, American Bar Association, 1991, 949-984.
- "Conflicts of Jurisdiction: Antitrust and Industrial Policy," *Law and Contemporary Problems*, vol. 50, Summer 1987, 165-178.
- "Market Structure and Optimal Management Organization," with C. Bull, *Rand Journal of Economics*, vol. 18, no. 4, Winter 1987, 480-491.
- "A Sequential Concession Game with Asymmetric Information," with A. Rubinstein, *Quarterly Journal of Economics*, vol. 101, no.4, November 1986, 879-888.
- "The G.M.-Toyota Joint Venture: An Economic Assessment," with C. Shapiro, *Wayne Law Journal*, vol. 31, no. 4, 1985, 1167-1194.
- "Economic Foundations and Considerations in Protecting Industrial and Intellectual Property: An Introduction," *ABA Antitrust Law Journal*, vol. 53, no. 3, 1985. 503-518, Comments, 523-532.
- "Antitrust for High-Technology Industries: Assessing Research Joint Ventures and Mergers," with R.D. Willig, *Journal of Law and Economics*, vol. 28, May 1985, 311-334.

"Use of Antitrust to Subvert Competition," with W.J. Baumol, *Journal of Law and Economics*, vol. 28, May 1985, 247-266. Reprinted in *Journal of Reprints for Antitrust Law and Economics*, vol. 16, no. 2.

"Advances in Supervision Technology and Economic Welfare: A General Equilibrium Analysis," with C. Shapiro, *Journal of Public Economics*, vol. 25/3, 1985, 371-390.

"Predatory Systems Rivalry: A Reply," with A. O. Sykes and R. D. Willig, 83 *Columbia Law Review*, June 1983, 1150-1166. Reprinted in *Corporate Counsel*, Matthew Bender & Company, 1984, 433-450.

"The 1982 Department of Justice Merger Guidelines: An Economic Assessment," with R. D. Willig, 71 *California Law Review*, March 1983, 535-574. Reprinted in *Antitrust Policy in Transition: The Convergence of Law and Economics*, E. Fox and J. Halverson (eds.), American Bar Association Press, 1984, 267-304.

"Unfair International Trade Practices," with A. O. Sykes and R. D. Willig, 15 *Journal of International Law and Politics*, Winter 1983, 323-338.

"On Non-linear Pricing of Inputs," with J. Panzar, *International Economic Review*, October 1982, 659-675.

"Herfindahl Concentration, Rivalry and Mergers," with A. O. Sykes and R. D. Willig, *Harvard Law Review*, vol. 95, June 1982, 1857-1875.

"A Reply to 'Journals as Shared Goods: Comment,'" with R. D. Willig, *American Economic Review*, June 1982, 603-607.

"Proposed Revisions to the Justice Department's Merger Guidelines," with S. Edwards, *et al.*, *Columbia Law Review*, vol. 81, December 1981, 1543-1591.

"An Economic Definition of Predation: Pricing and Product Innovation," with R.D. Willig, *Yale Law Journal*, vol. 91, November 1981, 8-53.

"On the Consequences of Costly Litigation in the Model of Single Activity Accidents: Some New Results," *Journal of Legal Studies*, June 1981, 269-291.

"On the Political Sustainability of Taxes," with A. Schotter, *American Economic Review Papers and Proceedings*, May 1981, 278-282.

"Information and the Law: Evaluating Legal Restrictions on Competitive Contracts," with A. Weiss, *American Economic Review Papers and Proceedings*, May 1981, 399-404.

"Redistributing Incomes: *Ex Ante* or *Ex Post*," *Economic Inquiry*, April 1981, 333-349.

"On the Nonexistence of *Pareto Superior* Outlay Schedules," with J. Panzar, *The Bell Journal of Economics*, Spring 1980, 351-354.

"The Role of Information in the Design of Public Policy Towards Externalities," with R. D. Willig, *Journal of Public Economics*, December 1979, 271-299.

"On the Concept of Optimal Taxation in the Overlapping-Generations Model of Efficient Growth," with E.S. Phelps, *Journal of Public Economics*, August 1979, 1-27.

"Products Liability in Markets With Heterogeneous Consumers," *Journal of Legal Studies*, June 1979, 505-525.

"Costly Litigation and the Tort Law: Single Activity Accidents," *Journal of Legal Studies*, June 1978, 243-261.

"On the Optimal Provision of Journals Qua Excludable Public Goods," with R. D. Willig, *American Economic Review*, June 1978, 324-338.

"Distortionary Wage Differentials in a Two-Sector Growth Model: Some Theorems on Factor Earnings," *International Economic Review*, June 1978, 321-333.

"On the Optimality of Public-Goods Pricing with Exclusion Devices," with W.J. Baumol, *Kyklos*, Fasc. 1, 1977, 5-21.

"Public Good Properties in Reality: The Case of Scientific Journals," with W.J. Baumol, *Proceedings of the ASIS Meetings*, San Francisco, October 1976.

"Merger Illusions and Externalities: A Note," with A. Schotter, *Eastern Economic Review*, November 1976, 19-21.

"Distributive Justice and Optimal Taxation of Wages and Interest in a Growing Economy," *Journal of Public Economics*, January 1976, 139-160.

"Linear Taxation of Wealth and Wages for Intragenerational Lifetime Justice: Some Steady-State Cases," with E.S. Phelps, *American Economic Review*, September 1975, 660-673.

B. Books and Monographs

Proceedings of the Tenth Annual Telecommunications Policy Research Conference, editor with O. Gandy and P. Espinosa, ABLIX Publishers, 1983.

Obstacles to Trade and Competition, with L. Goldberg, OECD, Paris, 1993.

Predatory Pricing, with William Green, *et al.*, American Bar Association, Section of Antitrust Law, Monograph 22, 1996.

C. Book Chapters

"Practical Rules for Pricing Access in Telecommunications," with R. D. Willig, Chap. 6, in *Second-Generations Reforms in Infrastructure Services*, F. Basanes and R. D. Willig (eds.), Inter-American Development Bank, Washington, D.C., April 2002, 149-76.

"Sustainable Privatization of Latin American Infrastructure: The Role of Law and Regulatory Institutions," with Evamaria Uribe, Chap. 1 in F. Basanes, E. Uribe, R. D. Willig (eds.), *Can Privatization Deliver? Infrastructure for Latin America*, The Johns Hopkins U. P. for Inter-American Development Bank, 1999, 9-32.

"Access and Bundling in High-Technology Markets," with R. D. Willig, Chap. 6, in J. A. Eisenach and T. M. Leonard, (eds.), *Competition, Innovation, and the Microsoft Monopoly: The Role of Antitrust in the Digital Marketplace*, Kluwer Academic Press, 1999, 103-29.

"The Harmonization of Competition and Trade Law," with E. Fox, Chap. 15 in L. Waverman, *et al.* (eds.), *Competition Policy in the Global Economy*, Routledge, 1997, 407-439.

"Transition to a Market Economy: Some Industrial Organization Issues," with M. Iwanek, Chap. 7 in H. Kierzkowski, *et al.* (eds.), *Stabilization and Structural Adjustment in Poland*, Routledge, 1993, 133-170.

"Competition Policies for Natural Monopolies in a Developing Market Economy," with Russell Pittman, *Butterworth's Trade and Finance in Central and Eastern Europe*, Butterworth Law Publishers Ltd., 1993, 78-88, Reprinted in *Journal for Shareholders* (published by the Russian Union of Shareholder), Moscow, January 1993, 33-36; *Versenyfelugyeleti Ertesito* (Bulletin of Competition Supervision), Budapest, vol. 3, no. 1-2, January 1993, 30-41; *Narodni Hospodarstvi* (National Economy), Prague; *ICE: Revista de Economia*, No. 736 (December 1994) (in Spanish), 69-90.

"Antitrust: Source of Dynamic and Static Inefficiencies?" with W.J. Baumol, in T. Jorde and D. Teece (eds.), *Antitrust, Innovation, and Competitiveness*, Oxford University Press, 1992, 82-97. Reprinted in "The Journal of Reprints for Antitrust Law and Economics," vol. 26, no. 1, 1996.

"Economic Foundations of Competition Policy: A Review of Recent Contributions," in W. Comanor, *et al.*, *Competition Policy in Europe and North America: Economic Issues and Institutions, Fundamentals of Pure and Applied Economics* (Vol. 43), Harwood Academic Publishers, 1990, 7-42.

"The Department of Justice 1988 Guidelines for International Operations: An Economic Assessment," with A.O. Sykes, in B. Hawk (ed.), *European/American Antitrust and Trade Laws*, Matthew Bender, 1989, 4.1-4.18.

"Predation, Monopolization, and Antitrust," with G. Saloner, in R. Schmalensee and R.D. Willig (eds.), *Handbook of Industrial Organization*, vol. 1, North Holland, 1989, 538-596.

"Supervision Technology, Firm Structure, and Employees' Welfare," in *Prices, Competition and Equilibrium*, M. Peston and R.E. Quandt (eds.), Philip Allan Publishers, Ltd., 1986, 142-163.

"Perspectives on Mergers and World Competition," with R.D. Willig, in *Antitrust and Regulation*, R. Grieson (ed.), Lexington Books, 1986, 201-218.

"Transnational Antitrust and Economics," in *Antitrust and Trade Policies in International Trade*, B. Hawk (ed.), Matthew Bender, 1985, 233-248.

"Pricing of Interexchange Access: Some Thoughts on the Third Report and Order in FCC Docket No. 78-72," in *Proceedings of the Eleventh Annual Telecommunications Policy Research Conference*, Vincent Mosco (ed.), ABLEX Publishers, 1984, 145-161.

"Non-Price Anticompetitive Behavior by Dominant Firms Toward the Producers of Complementary Products," with A.O. Sykes and R.D. Willig, in *Antitrust and Regulation: Essays in Memory of John McGowan*, F. Fisher (ed.), MIT Press, 1985, 315-330.

"Local Telephone Pricing in a Competitive Environment," with R.D. Willig, in *Regulating New Telecommunication Networks*, E. Noam (ed.), Harcourt Brace Jovanovich, 1983, 267-289.

"An Economic Definition of Predatory Product Innovation," with R.D. Willig, in *Strategy, Predation and Antitrust Analysis*, S. Salop (ed.), Federal Trade Commission, 1981, 301-396.

"Marginal Cost," in *Encyclopedia of Economics*, D. Greenwald (ed.), McGraw-Hill, 2nd ed. 1994, 627-630.

"Understanding Economic Justice: Some Recent Development in Pure and Applied Welfare Economics," in *Economic Perspectives*, M. Ballabon (ed.) Harwood Academic Publishers, vol. 1, 1979, 51-72.

"Problems of Political Equilibrium in the Soviet Proposals for a European Security Conference," in *Columbia Essays in International Affairs*, Andrew W. Cordier (ed.) Columbia University Press, New York, 1971, 1951-197

D. Other Publications

"Safer Than A Known Way? A Critique of the FTC's Report on Competition and Patent Law and Policy," with I. Simmons and D. A. Applebaum, *Antitrust Magazine*, Spring 2004, 39-43.

"Predatory Pricing," in Peter Newman (ed.), *The New Palgrave Dictionary of Economics and the Law*, Grove Dictionaries, New York, 1999.

Book review of L. Philips, *Competition Policy: A Game Theoretic Perspective*, reviewed in *Journal of Economic Literature*, vol. 35, No.3, September 1997, 1408-9.

"The Role of Efficiencies in Merger Assessment: The 1997 Guidelines," *Antitrust Report*, September 1997, 10-17.

"Bingaman's Antitrust Era," *Regulation*, vol. 20, No. 2, Spring 1997, 21-26.

"Competition Policy for High-Technology Industries," *International Business Lawyer*, vol. 24, No. 10, November 1996, 479-82.

"Internationalizing Competition Law to Limit Parochial State and Private Action: Moving Towards the Vision of World Welfare," with E.M. Fox, *International Business Lawyer*, vol. 24, No. 10, November 1996, 458-62.

"Economists' View: The Department of Justice Draft for the Licensing and Acquisition of Intellectual Property," *Antitrust*, vol. 9, No. 2, Spring 1995, 29-36.

"Competition Policy During Transformation to a Centrally Planned Economy: A Comment," with R.W. Pittman, in B. Hawk (ed.), *1992 Fordham Corporate Law Institute*, 533-38.

"Poland: The First 1,000 Days and Beyond," *Economic Times*, vol. 3, no. 9, October 1992, 6-7.

"Interview: Janusz A. Ordovery: A Merger of Standards? The 1992 Merger Guidelines," *Antitrust*, vol. 6, no. 3, Summer 1992, 12-16.

"Interview: U.S. Justice Department's New Chief Economist: Janusz A. Ordovery," *International Merger Law*, no. 14, October 1991.

"Poland: Economy in Transition," *Business Economics*, vol. 26, no. 1, January 1991, 25-30.

"Economic Analysis of Section 337: Protectionism versus Protection of Intellectual Property," with R.D. Willig, in *Technology, Trade and World Competition*, JEIDA Conference Proceedings, Washington, D.C., 1990, 199-232.

"Eastern Europe Needs Antitrust Now," with E. Fox, *New York Law Journal*, November 23, 1990, 1-4.

"Understanding Econometric Methods of Market Definition," with D. Wall, *Antitrust*, vol. 3, no. 3, Summer 1989, 20-25.

"Proving Entry Barriers: A Practical Guide to Economics of Entry," with D. Wall, *Antitrust*, vol. 2, no. 2, Winter 1988, 12-17.

"Proving Predation After Monfort and Matsushita: What the New 'New Learning' has to Offer," with D. Wall, *Antitrust*, vol. 1, no. 3, Summer 1987, 5-11.

"The Costs of the Tort System," with A. Schotter, Economic Policy Paper No. PP-42, New York University, March 1986. Reprinted in *Congressional Record*, U.S. Government Printing Office, Washington, D.C., 1987.

"An Economic Definition of Predation: Pricing and Product Innovation," with R.D. Willig, Report for the Federal Trade Commission, October 1982, 131 pp.

"Market Power and Market Definition," with R.D. Willig, Memorandum for ABA Section 7 Clayton Act Committee, Project on Revising the Merger Guidelines, May 1981.

"Herfindahl Concentration Index," with R.D. Willig, Memorandum for ABA Section 7 Clayton Act Committee, Project on Revising the Merger Guidelines, March 1981.

"Public Interest Pricing of Scientific and Technical Information," Report for the Department of Commerce Technical Advisory Board, September 1979.

"Economics of Property Rights as Applied to Computer Software and Databases," with Y.M. Braunstein, D.M. Fischer, W.J. Baumol, prepared for the National Commission on New Technological Uses of Copyrighted Works, June 1977, 140 pp. Reprinted in part in *Technology and Copyright*, R.H. Dreyfuss (ed.), Lemond Publications, 1978.

Book review of O. Morgenstern and G.L. Thompson, *Economic Theory of Expanding and Contracting Economies*, reviewed in *Southern Economic Journal*, September 1978.

"Manual of Pricing and Cost Determination for Organizations Engaged in Dissemination of Knowledge," with W.J. Baumol, Y.M. Braunstein, D.M. Fischer, prepared for the Division of Science Information, NSF April 1977, 150 pp.

UNPUBLISHED PAPERS

"All Units Discounts in Retail Contracts," with S. Kolay and G. Shaffer, August 2002.

"Economics, Antitrust and the Motion Picture Industry," C.V. Starr Center Policy Paper, July 1983.

"On Bargaining, Settling, and Litigating: A Problem in Multiperiod Games With Imperfect Information," with A. Rubinstein, C.V. Starr Working Paper, December 1982.

"Supervision and Social Welfare: An Expository Example," C.V. Starr Center Working Paper, January 1982.

"Should We Take Rights Seriously: Economic Analysis of the Family Education Rights Act," with M. Manove, November 1977.

"An Echo or a Choice: Product Variety Under Monopolistic Competition," with A. Weiss; presented at the Bell Laboratories Conference on Market Structures, February 1977.

GRANTS RECEIVED

Regulation and Policy Analysis Program, National Science Foundation, Collaborative Research on Antitrust Policy, Principal Investigator, July 15, 1985 - December 31, 1986.

Regulation of Economic Activity Program, National Science Foundation, Microeconomic Analysis of Antitrust Policy, Principal Investigator, April 1, 1983 - March 31, 1984.

Economics Division of the National Science Foundation, "Political Economy of Taxation," Principal Investigator, Summer 1982.

Sloan Workshop in Applied Microeconomics (coordinator), with W.J. Baumol (Principal Coordinator), September 1977 - August 1982.

Economics Division of the National Science Foundation, "Collaborative Research on the Theory of Optimal Taxation and Tax Reform," July 1979 to September 1980, with E.S. Phelps.

Division of Science Information of the National Science Foundation for Research on "Scale Economies and Public Goods Properties of Information," W.J. Baumol, Y.M. Braunstein, M.I. Nadiri, Fall 1974 to Fall 1977.

National Science Foundation Institutional Grant to New York University for Research on Taxation and Distribution of Income, Summer 1974.

Appendix 2: Curriculum Vitae Dr. William H. Lehr**WILLIAM HERNDON LEHR**
Curriculum Vitae

Home/Office	Alternate Office
94 Hubbard Street Concord, MA 01742 Tel: 978-287-0709 Cellular: 978-618-3775 Fax: 978-287-5467 Email: wlehr@brimstoneassociates.com	Massachusetts Institute of Technology 1 Amherst Street (E40-222) Cambridge, MA 02139 Tel: 617-258-0630 Fax: 617-253-7326

EDUCATION

Ph.D., Economics, Stanford University, 1992.

M.B.A., with distinction, The Wharton School, University of Pennsylvania, 1984.

M.S.E., Chemical Engineering, University of Pennsylvania, 1984.

B.S., Chemical Engineering, *cum laude*, University of Pennsylvania, 1979.

B.A., European History, *magna cum laude*, University of Pennsylvania, 1979.

Academic Honors: Graduate Student Research Award, Telecommunications Policy Research Conference, 1991; Lynde and Harry Bradley Foundation Fellowship, 1990; Stanford Fellowship, 1987

PROFESSIONAL EXPERIENCE

MIT Internet Telecoms Convergence Consortium, Center for Technology, Policy and Industrial Development, Massachusetts Institute of Technology (Cambridge, MA), Research Associate, January 1997-present, Associate Director, August 1999-present.

Graduate School of Business, Columbia University (New York, NY), Associate Research Scholar of Finance and Economics, 1997-2002; Assistant Professor of Finance and Economics, July 1991 to December 1996.

RAND Corporation (Santa Monica, CA), Graduate Student Intern, Summer 1990.

Economic Analysis Group, Ltd. (Washington, DC), Senior Consultant, 1985-1987.

M.C.I. Telecommunications (Washington, DC), Manager of Financial Analysis, 1985; Senior Financial Analyst, 1984.

Office of Management and Budget, National Security Division (Washington, DC), Graduate Student Intern, Summer 1983.

Putnam, Hayes and Bartlett (Cambridge, MA), Research Associate 1980-1982.

TEACHING EXPERIENCE

Communications Policy and Regulation
 Internet Pricing and Quality of Service
 Internet Commerce
 Internet Economics 101
 Internet Telephony Tutorial
 Internet Commerce Video Course
 Economics of Telecommunications Pricing
 Economics and Strategy in Media Industries
 Economics of Strategic Management
 Managerial Economics
 Theory of the Firm (teaching assistant for Paul Milgrom)

PAPERS and PUBLICATIONS

"Municipal Wireless Broadband: Policy and Business Implications of Emerging Access Technologies," with Marvin Sirbu and Sharon Gillett, paper prepared for "Competition in Networking: Wireless and Wireline," London Business School, April 13-14, 2004.

"Economic Case for Dedicated Unlicensed Spectrum Below 3GHz," paper prepared for New America Foundation Conference, April 2004.

"TELRIC and the Cost of Capital," with R. Glenn Hubbard, white paper prepared on behalf of AT&T for *ex parte* submission to the FCC, December 2003.

"Coordinating User and Device Behavior in Wireless Grids," with Lee McKnight and James Howison, draft paper, Syracuse University, October 2003.

"Local Government Broadband Initiatives," with Sharon Eisner Gillett and Carlos Osorio, paper prepared for the 31st Annual Telecommunications Policy Research Conference, George Mason University, September 2003.

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"Optical Networks and the Future of Broadband Services," with Pedro Ferriera and Lee McKnight, *Technological Forecasting and Social Change*, 69 (2002) 741-758.

"Show me the money: contracts and agents in service level agreement markets," with Lee McKnight, *info*, vol. 4, no. 1 (2002) 24-36.

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"Best Effort versus Spectrum Markets: Wideband and Wi-Fi versus 3G MVNOS?" with Raymond Linsenmayer and Lee McKnight, forthcoming in Proceedings of the 29th TPRC: Research Conference on Information, Communication, and Internet Policy, edited by Shane Greenstein and Lorrie Cranor.

"The Disruptive User – Internet Appliances and the Management of Complexity," with Sharon Gillett, David Clark, and John Wroclawski, *BT Technology Journal*, Vol. 19, No. 4 (October 2001) 40-45.

"Rescuing Competition to Stimulate Telecom Growth," with Robert Hall, white paper prepared on behalf of AT&T, October 2001, available from <http://www.sandhillecon.com/hlpaper/>.

"Do Appliances Threaten Internet Innovation?" with Sharon Gillett, David Clark, and John Wroclowski, *IEEE Communications Magazine*, vol. 39, no. 10 (October 2001) 46-51.

"No Optical Illusion: A market for Bandwidth is Emerging," with Lee McKnight, *WorldLink*, World Economic Forum, May/June 2001.

Book Review of *Letting Go: Deregulating the Process of Regulation* by Alfred Kahn, *Journal of Economic Literature*, vol. XXXIX (September 2001) 943-944.

"Competition in Telecommunications and Economic Growth," with Jim Glassman, report prepared for TechCentral Station, July 2001 (<http://www.techcentralstation.com>)

"The Economics of the Tauzin-Dingell Bill: Theory and Evidence," with Jim Glassman, report prepared for TechCentral Station, June 2001 (<http://www.techcentralstation.com>)

"Assessing the Cost of Capital for a Standalone Transmission Company," with Michael Cragg and Ron Rudkin, *The Electricity Journal*, Volume 14, Issue 1, January-February 2001, Pages 80-88.

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"The Tax on Talking Is a Luxury We Can No Longer Afford," with R. Glenn Hubbard, paper prepared for submission to the U.S. Senate, May 2000.

"Telecommunications, the Internet, and the Cost of Capital," with R. Glenn Hubbard, in The Internet Upheaval, edited by Ingo Vogelsang and Ben Compaine, MIT Press: Cambridge, 2000.

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"Availability of Broadband Internet Access: Empirical Evidence," with Sharon Gillett, paper presented to the Twenty-Seventh Annual Telecommunications Policy Research Conference, September 25-27, 1999, Alexandria, VA

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